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MACROANATOMICAL STUDY ON THE SPLEEN BLOOD SUPPLY IN DOGS

Iliyan Georgiev*, Georgi I. Georgiev, Iliana Ruzhanova-Gospodinova, Lyubomir Hristakiev, Georgi D. Georgiev

University of Forestry, Faculty of Veterinary medicine, Sofia, Bulgaria
E-mail: i.georgiev@ltu.bg

ABSTRACT

The aim of the present study is to investigate the main arterial and venous vessels responsible for the blood supply of the spleen in dogs. The vessels were visualized through corrosion cast and radiographic imaging in 5 mixed breed dogs. For the purposes of the corrosion cast two polymers were used – Biodur (Biodur Products GmbH, Germany) and Duracril-Plus (SpofaDental, Kerr Corporation, USA) introduced through the splenic artery and vein. The radiographic images were taken after injection of barium sulfas solution in a. lienalis. The main external and intramural vessels were established together with their branches in the parenchyma and the stroma of the dogs´ spleen.

Key words: spleen, dog, *a. lienalis*, *v. lienalis*, corrosion cast, radiography.

Introduction

The spleen is a well-vascularized hematopoietic organ in the form of a double bell, a bell with a dilated ventral end or boot shape. The blood supply to the spleen is extremely important for the formation of white blood cells, the distruction of old red blood cells and the metabolism of iron in the body. These functions can be performed by other organs, which allows the removal of the spleen (Kovachev & Vodenicharov, 2021). The anatomical and histological structure of the spleen in dogs is well known and studied by a number of authors (Ayers et al., 1976; Eberlova et al., 2016; Schaller, 2007; Carneiro & Donald, 2020). The introduction of different polymeric compounds for the study of blood vessels of different organs is widely applicable. Eberlova et al. (2016) made a comparative study of two types of polymers, Mercox II and Biodur E20® Plus, on the blood supply to pig liver. The portal blood circulation of the dog's liver was studied by introducing Duracryl-plus dental plastic for the corrosion cast preparation and compared with contrast ultrasound and computed tomography angiography (Georgiev et al., 2018; Georgiev, 2020). The microvascularization of the spleen of the dog was examined by contrast radiography by Ayers et al. (1976) using barium sulfate.

The aim of the present study was to identify extra and intraorgan blood vessels of the spleen in the dog, as well as possible variations relevant to changes in organ size under stress, anesthesia and splenectomy Wolschrijn (2018).

Materials and methods

Ten mixed breed dog’s cadavers were used for this study, with weight 23-28 kg.

Corrosion cast

Introduction of polymers allows a more detailed visualization of blood vessels and their location relative to each other (Kovachev et al., 2019). For this purpose the spleens from 5 dogs were separated and 2 types of polymer were used – Duracril-Plus® dental polymer (SpofaDental, Kerr Corporation, USA) and Biodur (Biodur Products GmbH, Germany), both prepared according to their instructions for use. The mixing of the two ingredients of the respective products was made with a

plastic container and a metal stirrer. The so prepared Duracril-Plus solution was introduced through the splenic artery in three dogs' spleens. The Biodur polymer was divided in two – one was colored in red and the other in blue. The red was injected in *a. lienalis* and the blue in v. *lienalis* of 2 spleens. After subsequent ligation of the blood vessels, the target organs were placed in a refrigerator for complete polymerization. For the maceration of soft tissues and visualization of the arterial and venous vessels casting, the organs were immersed in a 25% potassium hydroxide solution (Georgiev, 2020).

Contrast radiography with $BaSO_4$

The introduction of a contrast solution into the vascular network and the subsequent radiography allows for a more accurate examination of both the arterial and venous networks. Five dogs' cadavers were used for the contrast radiography. At first the solution of BaSO4 (Milve AD, Bulgaria) diluted with tap water (200 g barium sulphate in 400 ml of water at room temperature) was introduced through the common carotid artery and a x-ray images were made. Then subsequently after removing of the spleen through the splenic artery. The radiography was performed with an Eickemeyer® Vet, model E 7239X in lateral and ventro-dorsal projection of the dog's carcasses and lateral projection of the removed spleen (Aminkov, 2007; Filipov, 1999; Coulson & Lewis, 2008; Georgiev, 2020). All used terms of structures are according to NAV (2017) and NHV (2017).

Results and discussion

The main arterial vessel supplying the spleen was identified by all methods in this study. *A. lienalis*, the strongest branch of the celiac artery (Vodenicharov 2021) which separates at the level of the thirteenth thoracic vertebra at 5 mm cranially of the cranial mesenteric artery, was observed on a radiographic image in lateral projection (Fig. 1). This variability in the separation of the celiac artery has been established in our previous studies (Georgiev et al., 2014), which differs from the most common observation which is at the level of the first lumbar vertebra described by Hermanson et al. (2020). On radiographic images and corrosion casts the splenic artery was identified separating in two branches – *r. dorsalis* and *r. ventralis* (Fig. 2; 3). The dorsal branch after the detachment of *a. gastrica brevis* gave off 15-16 *rr. lienalis*, while the ventral one was divided into 5 *rr. lienalis*, after the detaching *a. gastroepiploica sinistra*. Two branches from the last artery to the spleen were established (Fig. 2; 3). The number of *rr. lienales* from the dorsal and ventral branches of the splenic artery correlates with those reported by Gupta (1978) and Hermanson et al. (2020), but there is no data for branches to the hilusof the spleen from *a. gastroepiploica sinistra*. *Rr. lienalis* branch off as *a. trabecularis*, which continue as laterally directed *aa. pulpae albae* (Sapundzhiev & Chervenkov, 2020) confirmed on corrosion cast and radiographic images by us (Fig. 2; 3). These arterial branches are a confirmation of their macroscopic description made by Gupta (1978), Wolschrijn (2018) and Hermanson et al. (2020) and their histological determination in the NHV (2017) and the described by Sapundzhiev & Chervenkov (2020). The branching of the splenic artery to splenic branches was also shown by Schaller (2007). The subsequent arterial branches described by NHV (2017), but not shown by Schaller (2007) were established macroanatomically by the present study.

On the Biodur corrosion casts *sinus venosus (lienalis/venulares)* were established due to their overflow with red colored polymer introduced through the splenic vein (Fig. 4) which is evidence of the closed type of blood circulation in the spleen in dogs described by Takubo et al. (1986). Several sinuses unite into small veins of red pulp – *vv. pulpae rubrae* with blue colour (Fig. 4), that

initially do not follow the arteries in the trabeculae. They form short, large-caliber *vv. trabecularis* just before the formation of the venous *rr. lienalis* (Fig. 4). This sequence of converging venous vessels was also described by Konig and Liebih (2004), Sapundzhiev and Chervenkov (2020) and Hermanson et al., (2020) and has been visualized by us with corrosion casts. The venous splenic branches form *v. lienalis* that lies caudally from the artery at the hilus, which is observed on Figure 5. The position of the splenic vessels in the hilus is similar to that reported by Kovachev & Vodenicharov (1999).

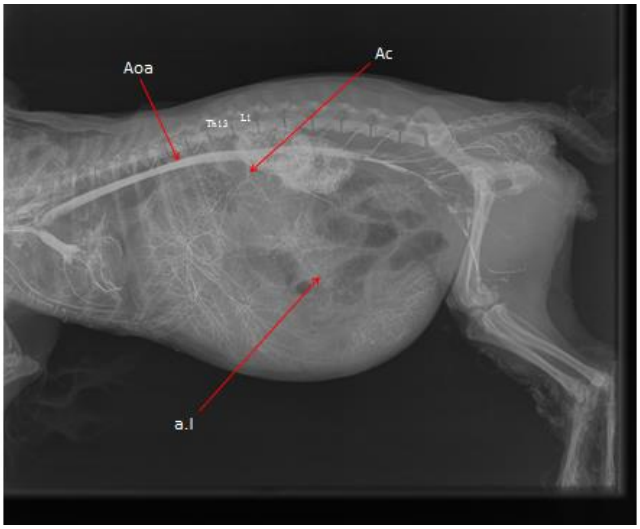

Figure 1: Contrast radiography of the dog */post mortem/*, lateral recumbency: Aoa – aorta; Ac – *a. celiaca*; a.l – *a. lienalis*; Th13 – 13th thoracic vertebra; L1 – 1st lumbar vertebra

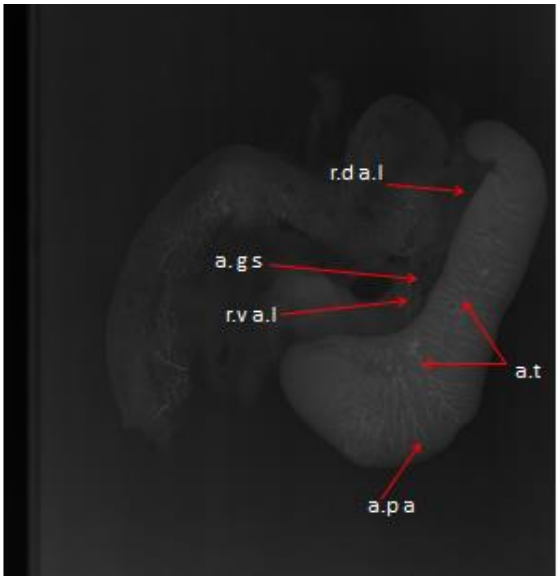

Figure 2: Contrast radiography of the spleen of the dog, parietal surface, lateral pojection: r.d a.l – *r. dorsalis* of *a. lienalis*; a. g s – *a. gastroepiploica sinistra*; r.v a.l – *r. ventralis* of *a. lienalis*; a.t – *a. trabecularis*; a.p a – *a. pulpae albae*.

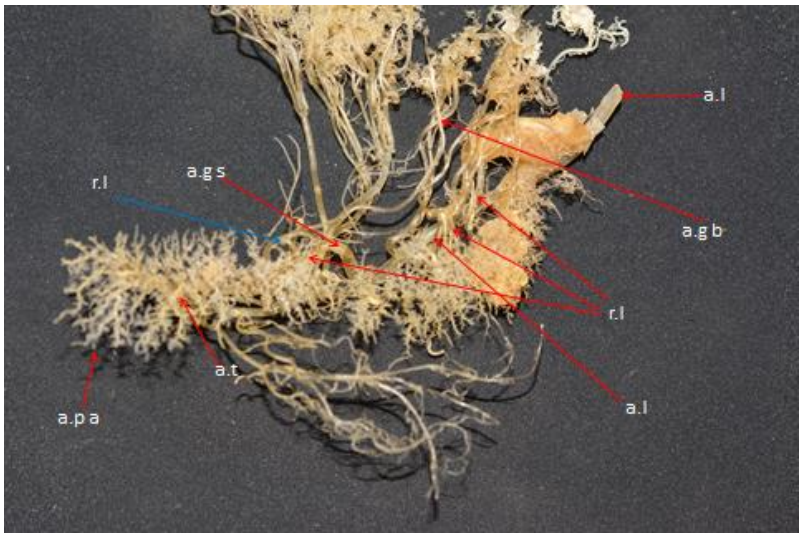

Figure 3: Corrosion cast of the arteries of the spleen of the dog with Duracryl, lateral view – a.l – a.lienalis; a.g b – *a. gastrica brevis*; r.l – *r. lienalis* of *a. lienalis*; a.l – a. *lienalis*; a.t – *a. trabecularis*; a.p a – *a. pulpae albae*; a.g s – *a. gastroepiploica sinistra*; r.l of *a. gastroepiploica sinistra*.

Figure 4: Corrosion cast of the vessels of the spleen of the dog with Biodur, visceral surface – a.p a – *a. pulpae albae*; a.t – *a. trabecularis*; S v lienalis – *Sinus venosus (lienalis/venulares)*; v.t – v.trabecularis; v.p r – *venae pulpae rubrae*.

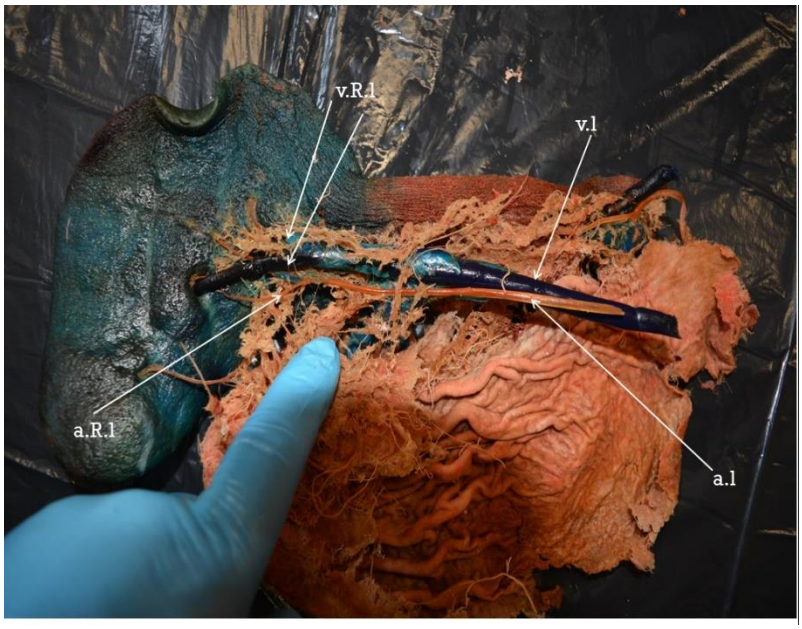

Figure 5: Corrosion cast of the vessels of the spleen of the dog with Biodur, visceral surface – v.l – *v. lienalis*; a.l – *a. lienalis*; a.R.l – arterial *r. lienalis*; v.R.l – venous *r. lienalis*.

Conclusion

After the conducted study on the blood supply of the spleen in dogs with the combination of anatomical and imaging methods we can conclude the following:

1. It was confirmed that the blood supply to the spleen is carried out by *a. lienalis*, which is divided into a dorsal branch that gives approximately 15 *rr. lienalis* and a ventral branch giving 5 *rr. lienalis*. Additionally, the blood supply includes *a. gastroepiploica sinistra*, which gives two branches towards the spleen.
2. The arterial vessels of the microcirculatory net are visualized by the corrosion method with Biodur and radiography with barium sulfate – *a. trabecularis*; *aa. pulpae albae*. From the venous vessels are found *vv. trabeculares* and *sinus venosus (lienalis/venulares)* and *vv. pulpae rubrae* on corrosion cast only.
3. The corrosion casts prepared with the Biodur polymer show that there is no mixing of the two colors, which is a confirmation of the closed type of arterial circulation of the spleen in the dog.
4. The celiac artery detaches from the aorta variably – at the level of the 13th thoracic vertebra or at the level of the 1st lumbar vertebra, which has been observed with our study.

The ligation of the visible branches from the splenic artery in the dog is of great importance in veterinary practice, especially in the removal of the spleen /splenectomy/ to maintain the normal blood supply to the stomach in the dog.

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