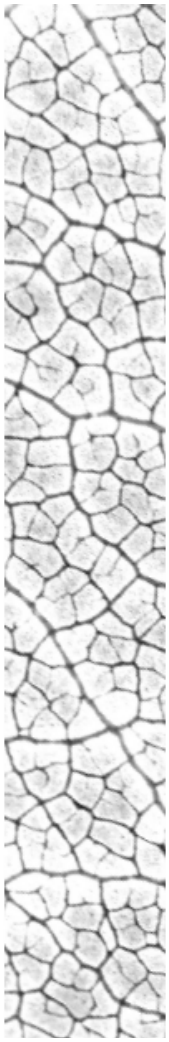

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Some ways of filling of the vascular bed of domestic animals

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Abstract
Studying of the vascular bed of mammals by means of classical methods of vessels filling is used generally in the conditions of classrooms. In this work the assessment of some methods of filling of the mammals blood channels is presented. As injection masses there were used the gelatine solution of 5%, painted with the ink by Borisevich V.B. technique and the solution consisting of Bustilat-M glue and the water in a proportion of 2:1. The conducted researches showed that the most successful, in terms of simplicity of execution, is filling of vessels with the solution consisting of Bustilat-M glue and water, as it allows with the little effort and with the smallest expenses to fill in both large and average vessels. To fill in the smaller vessels it is more preferable to use the methods with the injection solution with the ink and gelatin mass, as the contrast substance hardens practically at once that excludes the effluence of the filling mass from the damaged vessel.

Keywords: blood-vascular system, arterial bed, injections, vessels, veins, aorta, clamp, preparation, vein

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INTRODUCTION

The standard and rather accessible methods of a vascular bed studying in the modern science are the computer tomography and a contrast X-ray analysis. However, the classical methods during the animals anatomy studying did not lose its relevancy. For example, when studying the anatomy of mammals vascular bed in the conditions of classrooms it is preferable to use the ready fixed specimens received as a result of an injection of blood vessels. This method of the receiving of the obvious material is one of the classical methods. The knowledges gained on a obvious specimen allows to study in more detail the blood channels, practically all branches of the main vessels that is necessary when performing the surgery on different bodies and parts of a dead body of an animal. Due to the aforesaid there is relevant an identification of the fastest and accessible methods of filling of a vascular bed.

The main objective of this research is a definition of the simplest method of blood vessels filling which would allow to transfer the drawing of a vascular bed most precisely.

The task of the carried-out work was the preparation of a teaching specimen for studying of a circulatory system of mammals.

MATERIALS AND METHODS

As a material there were used the frozen dead bodies of domestic animals.

On a fresh cadaveric material it is possible to consider and to study in detail only the largest vessels, as on the main background of muscle bulk, with a large amount of the blood which is flowing down from the body walls or the muscles injured when opening, fine details of a vascular bed are indiscernible (Zhdanov 1955). Besides, knowing that vessels are rather elastic bodies, in fresh subjects (no more than 2 h after death) their posthumous deformation is possible. The last complicates further work on separation of vessels from surrounding textures. It is rather difficult to define small vessels on the fixed subjects since they under the influence of a clamp. They are condensed and change the color. During the work with vessels on a fresh corpse of an animal their insignificant damages are possible, that leads to effluence of yet not curtailed part of blood and further work with this vessel stops. And, the most important, at a technique of a simple preparation there

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is not a clear picture of interrelations of various vessels of a small diameter, whereas at an injection of a vascular bed practically all small anastomosis are shown.

In modern practice as injection solutions a large amount of substances and their structures is used. Because for detection of the most effective way of filling of vessels, it is necessary to carry out a set of tests with various filling masses. In this case the researcher faces a problem of the choice of available, rather cheap and convenient substances in work. Today a quite large of amount of such substances is known, however not each of them is suitable for filling of small vessels. As shortcomings it is possible to allocate the following: some quickly stiffen, the others on the contrary, need rather long time for consolidation of a mass in a vessel, the third is rather expensive in use.

From the all variety of injection masses, we chose several ways of filling of vessels.

Blood vessels were injected by the contrasting masses. As a contrast agent we used the solution consisting of Bustilat-M glue and water in a proportion 2:1 and also the solution of 5% of gelatin painted by ink by Borisevich's technique of V.B. (Borisevich 1969).

Bodies of four adult dogs (18 months elder) who have got under the car wheels have served as objects of researches.

RESULTS AND THEIR DISCUSSION

For a preparation of the contrasting mass ink and gelatin as a basis dry edible gelatin has been taken. Preparation of filling agent was conducted as follows. On 2-3 h gelatin was filled in with cold water. After the put time the received mass was heated on water bath to homogeneous mass that was reached at full dissolution of gelatin. 1-3 ml of the ink issolved in 0.5-1 ml. waters of certain color, depending on what vessels are lanned to be injected, are added to warm gelatin. So, for the arterial system shades of red color are considered as standard, and for the venous the blue ink is used. Use of not dissolved ink causes the formation in the injection mass of lumps with which small vessels clog and work with the last becomes impossible. Gelatin with the added ink after hashing is placed on a water bath and brought to temperature 37-40ºC. Prepared for filling the ink and gelatinous mass has to be fresh, as during the storage in it the ink drops out in deposit, and because of that the mass becomes more dense and its color changes. Gelatin gradually cools down, in this connection the mass needs to be entered enough quickly. However, the pressure at injection has to be such that the mass entering vessel has not broken off the last. This should be remembered when filling smaller vessels of the blood bed. There is also one more lack of this mode of filling vessels. Even at the correct administration and respect of all nuances, there are vessels in which gelatin does not get.

After the introduction of the ink and gelatinous mass the place of an injection is stitched a ligature, and the body of an animal is immersed under the cold water (it is necessary to cool evenly ink and gelatinous mass) in the beginning, and only then fixe in 5% solution of formalin during 24-48 h. Then vessels carefully separate from surrounding textures.

"Bustilat-M" glue was the second solution used by us for filling of vessels. This substance is made on the basis of latex. Full hardening of this glue occurs during 24-36 h. Mixing the "Bustilat-M" with water in concentration 2:1, it is possible to inject vessels of small animals and even their babies that allows to reveal features of branching of vessels, existence of small anastomoz, to carry out their morphometry, etc. The filled-in substance begins to get thick only after 12 h that allows to fill in the maximum number of vessels. And its concentration allows to get under small pressure into small vessels of the blood bed. When using "Bustilat-M" the solution is not warmed up as this suspension does not form undesirable lumps. When filling in this way, it is also required to alloy places of injections in order to avoid the expiration of solution from the damaged vessel.

After filling of vessels the cadavers plunged into the fixing solution – initially in formalin solution of 5%, and then for storage – in 10%. In this case the uniform cooling is not required. After fixing the vessels are accurately separated from surrounding textures, creating thereby an objective picture of a vascular bed.

All cadavers of animals used for filling of vessels were frozen. Defrosting was carried out at the room temperature. After defrosting cadavers were fixed in back condition. The abdominal cavity was opened on the white line, a chest cavity – on cartilages of a chest bone; the diaphragm was cutted on the tendinous center, a visceral pleural layer was also opened. At the same time changes of location of organs and their changes to rather healthy organs were fixed. All bodies of the cadavers used for preparation of a vascular bed are located anatomically correctly and pathological changes are not revealed in them.

For injections of vessels syringes with a capacity of 10 ml. and systems for intravenous administration were used. Before filling the vascular bed was washed out with a warm normal saline solution of 0.9% utill full washing away of clots of blood. Then vessels were filled with warm water (40-50 °C). The injection of vessels of a front part of a body was made through the left subclavial artery (a. subclavia sinistra) in which a system for intravenous administration was introduced. For introduction through the system of solutions the usual large syringe needle was used, as both suspensions very quickly hammered thinner opening of needles.

When forcing solution in the left subclavial artery, the mix got into the left axillary artery. The subclavial artery gradually passes into a vertebral artery which breaks into three branches going one – to muscles, the second

Table 1. Assessment of efficiency of filling of arteries of a dog the studied condensing masses

Filling options	The number of successfully filled in arteries				Share of the damaged vessels by further preparation, %	
	Large vessels		Small vessels		Large vessels	Small vessels
	piece	%	piece	%		
"Bustilat-M" and water in concentration 2:1	56	35.3	103	64.7	5.7	9.3
Solution of ink and gelatinous mass	74	73.3	27	26.7	11.2	7.9

– to a backbone and the third – into cervical muscles. One more branch of a subclavial artery is the costal and cervical trunk which on the course gives two branches – cross and deep cervical arteries (Akaevsky et al. 1984, Dyce et al. 2009). The deep cervical artery passes under muscles and even after filling and fixing it can be found only after preparation of textures. Near the first edge the subclavial artery gives a shoulder and a cervical trunk from which four branches depart. The first – supply the blood to a biceps of a shoulder and a pectoral muscle. The ascending branch feeds lymph nodes of a neck and a sternal and brachiocephalic muscle. After filling two more branches of a shoulder and a cervical trunk become well visible: cross scapular and superficial cervical arteries. The last one supplies diamond-shaped and trapezoid muscles, and a cross scapular artery – shovel muscles (surpaspinatus and infraspinatus).

Internal and external chest arteries also depart from a subclavial artery. At a dog the first is quite well developed and on the course of the movement it gives small branches for blood supply of chest muscles (Gudimov et al. 1984). And the external chest artery is badly filled as it quite thin and is poorly developed. In this regard at preparation it is necessary to observe extra care not to cut its fiber. After a branch of chest arteries the axillary artery departs from subclavial.

Powerful development of carotid arteries at the specified ways of an injection of vessels does not give their full filling, solution gets only into initial sites. It is most likely connected with the insufficient pressure of mass when filling vessels. During separation of a limb on a medial surface the axillary artery becomes well visible. At an injection of an arterial system of a chest limb through this vessel all anastomosis of an arterial system becomes very well visible. The axillary artery connects to external chest. On the course of its way it passes into a humeral artery. Below the axillary artery gives an infrascapular branch (Budras et al. 2007, Done et al. 2009, Evans 2012, Ivanova 1975, Zelenevsky 1997). In its turn, the lateral humeral, scapular arteries and an artery of a triceps muscle of a shoulder depart from an infrascapular artery. The lateral humeral artery goes to a tricipital muscle of a shoulder (its long and lateral heads). The scapular artery and an artery of a tricipital muscle of a shoulder, respectively go to the called muscles.

Going down below the infrascapular artery passes into humeral which gives the rise to an artery of a biceps of a shoulder, a superficial beam artery, deep humeral (a. profunda brachii) and elbow (collateral - a. collateralis ulnaria and returnable – a. recurrens ulnaris) arteries (Boyd 2000, Coulson and Lewis 2008, Gardiner and Raynor 2014). The beam artery leaves under the skin where it is subdivided into two thin branches, one of which goes to a wrist and forms arterial network there; the second – passes into dorsal manual arteries (**Table 1**).

The humeral artery passes even more detailed into median from which branches go to the dorsal and ventral surfaces of fingers. As for us it was relevant to carry out filling of vessels of scapularhumeral area, further manipulations by us were not carried out. After an injection to avoid an outflaw of a solution, the ligatures on vessels were imposed (Goody 2006).

Back part of a body was filled in on cadavers of two other dogs. In this case an injection carried out through the largest and available vessel – through a ventral aorta. It settles down under bodies of lumbar vertebrae on the left from a caudal vena cava, between nerves. The first filled in a celiac artery (a. coeliaca) which has a rather short trunk and is divided into three branches: splenic (a. lienalis), gastric (a. gastrici) and hepatic arteries (a. hepatica) (Zelenevsky 2013). At a further injection of vessels the hepatic artery which is located in portal fissures together with a portal vein is most brightly expressed. The hepatic artery gives the right gastric and gastroduodenal arteries, the last passes into the right gastroomental artery. Due to such a disposing first of all liver vessels, then a part of the sealing gland and a duodenum were filled. The vascular bed of a spleen was filled partially. Then contrast masses came to renal, seed, mesenteric and lumbar arteries. The branch receives from a mesenteric artery ileal and phrenic arteries (Khromov et al. 1972). The first supply blood to the lumbar and belly muscles and to skin of these areas. The phrenic artery breaks up to two branches, one of which goes to a diaphragm, and another – to abdominal walls, in this connection, at dogs this artery has also the second name – phrenic and belly. The renal arteries going to kidneys and adrenal glands depart from a mesenteric artery from two parties. In this place the vascular bed can be distinguished from nervous branchings or by the thinnest preparation, or after an injection of vessels (Worobiow 1925). In kidneys they branch on smaller vessels, forming vascular network (Zhedanov 1958). Seed arteries were injected poorly that did not give the chance to track their further branching. Lumbar arteries were filled in number of

Table 2. Assessment of efficiency of filling of veins of a dog the studied condensing masses

Filling options	The number of successfully filled in veins				Share of the damaged vessels by further preparation, %	
	Large vessels		Small vessels		Large vessels	Small vessels
	piece	%	piece	%		
"Bustilat-M" and water in concentration 2:1	72	43.9	92	56.1	20.8	30.4
Solution of ink and gelatinous mass	32	29.1	78	70.9	15.1	10.7

seven couples. After manipulations the place of an injection on a ventral aorta was stitched.

The venous system was filled with the condensing masses through a portal vein of a liver. This vein collects blood from a stomach, a pancreas, a spleen, thick and thin guts. The short trunk of a portal vein is formed by a merge of gastrosplenic, cranial and caudal mesenteric veins, enters portal fissures where is divided into interlobular veins, and then into capillaries of hepatic segments. In each segment capillaries join the central vein of a segment. These are initial areas of the veins which are taking away blood from a liver in a caudal vena cava. The so-called wonderful network is formed (**Table 2**).

After injections all injured vessels were alloyed (for prevention of an exit of contrast substance), and dead bodies plunged into the fixing solutions. For preliminary fixing and consolidation of the contrasting masses dead bodies with the filled-in vascular course were plunged for 24h into a solution of 5% formalin. Then the prepared material was reloaded into the capacities for storage filled with formalin of 10%. In the need of consideration of smaller vessels the preparation of surrounding textures was carried out in addition. At the same time the fixed vascular system even at accidental damage by a scalpel did not get out of its shape.

CONCLUSIONS

These researches showed that the least labor-consuming and more effective is the filling by the solution consisting of "Bustilat-M" and water in concentration 2:1 as this mix hardened through a quite long time that gave time for careful performance of work; the existence in solution of a water allowed to get to it into a rather far located and smaller vessels. However, a lack of this technique is a fast effluence of the contrasting masses at negligent manipulations.

For the filling of the smallest vessels the method by the injection with the solution of ink and gelatinous mass is more preferable, as the contrast substance hardens practically at once that practically excludes the fast effluence of filling mass from the damaged vessel. But at the same time, it is necessary to remember, that a solution, and a dead body of an animal have to be at least of a room temperature, otherwise the filling of small vessels becomes impossible.

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