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DORSAL BRANCHES OF ABDOMINAL AORTA IN THE RABBIT AND THE EUROPEAN HARE

Flešárová S., Maženský, D.

Department of Anatomy, Histology and Physiology
University of Veterinary Medicine and Pharmacy, Komenského 73, 041 81 Košice
The Slovak Republic

slavka.flesarova@uvlf.sk

ABSTRACT

The aim of this study was to describe the anatomical arrangement of the branches arising from the dorsal surface of the *aorta abdominalis* in the rabbit and the hare. The study was carried out on ten adult rabbits and ten adult European hares using the corrosion technique. After the euthanasia, the vascular network was perfused with saline. After polymerization of the casting medium, the maceration was carried out in a KOH solution. We found different variations in; the number of arteries, level of their origin and arrangement. The *aa. lumbales* of the same level arose by means of a common trunk or their origin was independent. The *aa. lumbales* VI or *aa. lumbales* VI et VII originated also from the *a. sacralis mediana*. By *aa. lumbales* we found an important interspecies difference in; number, diameter, ramification and density of dorsal branches, which are designated for the dorsal muscles of the body stem. All listed parameters of branches were higher in the hare. This anatomical arrangement of dorsal branches is adapted to the higher movement activity of the hare. According to our results, it can be concluded that the anatomical arrangement of the branches of the *aorta abdominalis* shows a higher number of variations in the domesticated rabbit in comparison with the hare.

Key words: abdominal aorta; *a. sacralis mediana*; *aa. lumbales*, hare; rabbit

INTRODUCTION

One of the most frequently occurring wild animals in Europe is the European hare. Despite its relatively abundant occurrence, there is a significant gap of knowledge about its anatomy in the literature. Up to now, the works dealing with the study of the arterial system in the European hare have only been published sporadically [3], [4].

Variations in the origin, branching and course of several arteries have long received attention of anatomists, surgeons and particularly vascular specialist. The variations in the arterial system of several species are the object of interest in a large number of studies [8]. The arterial arrange-

ment of the branches arising from the *aorta abdominalis* was studied in several experimental animals, such as; dogs [1], cats [2], rabbis [5], rats [17] and guinea pigs [15].

The aim of this study was to compare the variations of the *aorta abdominalis* branches arising from its dorsal surface in the domesticated rabbit and the European hare.

MATERIALS AND METHODS

This study was carried out on 10 adult European hares (*Lepus Europaeus*, L. 1758, age 140 days) and on 10 adult rabbits (*Oryctolagus cuniculus f. domestica*, L. 1758, age 140 days). We used hares (obtained from ISFA APRC, Nitra, Slovak Republic) of both sexes (female n = 5; male n = 5) with a weight range of 2.5—3.2 kg and New Zealand White rabbits (obtained from HYLAPA s.r.o., Prešov, Slovak Republic) of both sexes (female n = 5; male n = 5) with a weight range of 1.8—2.3 kg in an accredited experimental laboratory of the University of Veterinary Medicine and Pharmacy in Kosice. The animals were kept in cages under standard conditions (temperature 15—20 °C, relative humidity 45 %, 12-hour light period), and fed with a granular feed mixture (O-10 NORM TYP, Spišské kŕmne zmesi, Spišské Vlachy, Slovak Republic). The drinking water was available to all animals *ad libitum*. The animals were injected intravenously with heparin (50 000 IU.kg^{-1}) 30 min before they were sacrificed by intravenous injection of embutramide (T-61, 0.3 ml.kg^{-1}). Immediately after euthanasia, the vascular network was perfused with a physiological solution [10]. During manual injection through the ascending aorta, the right atrium of the heart was opened in order to lower the pressure in the vessels in order to ensure an optimal injection distribution. Batson's corrosion casting kit No. 17, using a volume of 50 ml (Dione, České Budějovice, Czech Republic) was used as the casting medium. The maceration was carried out in a 2—4 % KOH solution for a period of 5 days at 60—70 °C. This study was carried out under the authority of decision No. 2647/07-221/5.

RESULTS

The paired *aa. lumbales* arose from the dorsal surface of the *aorta abdominalis* as segmental vessels. They supplied the; lumbar spinal cord, lumbar vertebrae, muscles of the back, inner lumbar muscles and skin of the back. In the rabbit, the independent origin of the *aa. lumbales* was pres-

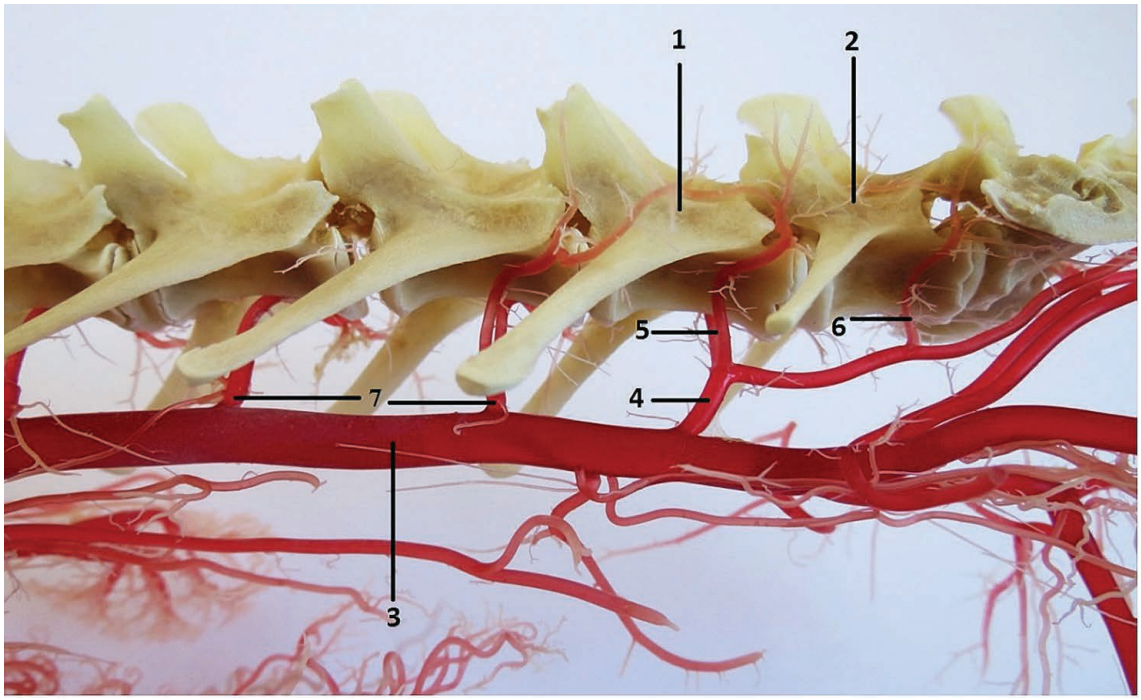

Fig. 1. *Aa. lumbales* and *a. sacralis mediana* in the rabbit. Origin of *aa. lumbales* VI et VII from *a. sacralis mediana*. 1 — *vertebra lumbalis* VI; 2 — *vertebra lumbalis* VII; 3 — *aorta abdominalis*; 4 — *a. sacralis* mediana; 5 — *aa. lumbales* VI; 6 — *aa. lumbales* VII; 7— common trunk for *aa. lumbales* V et IV. Macroscopic image, lateral view

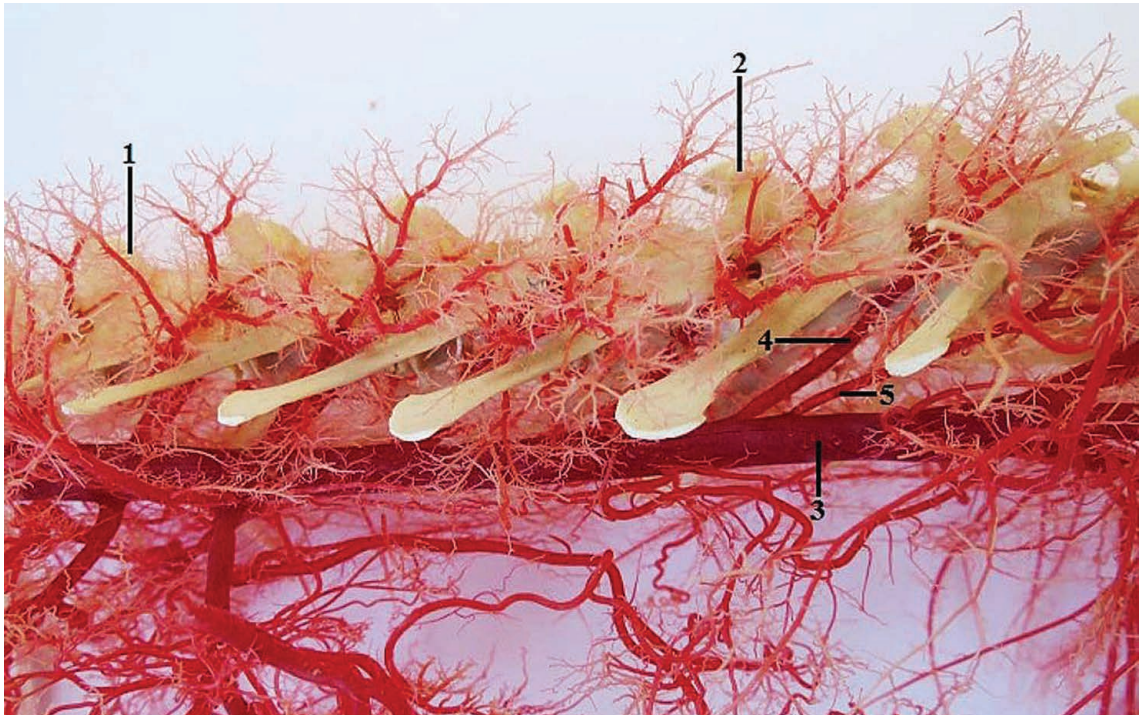

Fig. 2. ***Aa. lumbales*** **and a.** ***sacralis mediana*** **in the hare. 1 —** ***vertebra lumbalis*** **I; 2 —** ***vertebra lumbalis*** **V; 3 —** ***aorta abdominalis*****; 4 —** ***a. lumbalis*** **V; 5 —** ***a. sacralis mediana*****. Macroscopic image, lateral view**

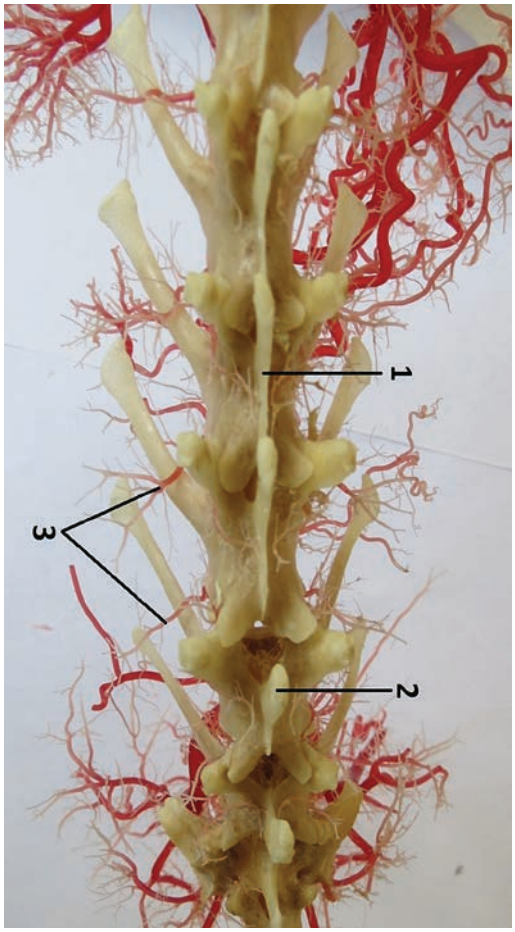

Fig. 3. ***Rr. dorsales*** **arising from** ***aa. lumbales*** **in the rabbit. 1 —** ***vertebra lumbalis*** **IV; 2 —** ***vertebra lumbalis*** **VI; 3 —** ***rr. dorsales*****. Macroscopic image, dorsal view**

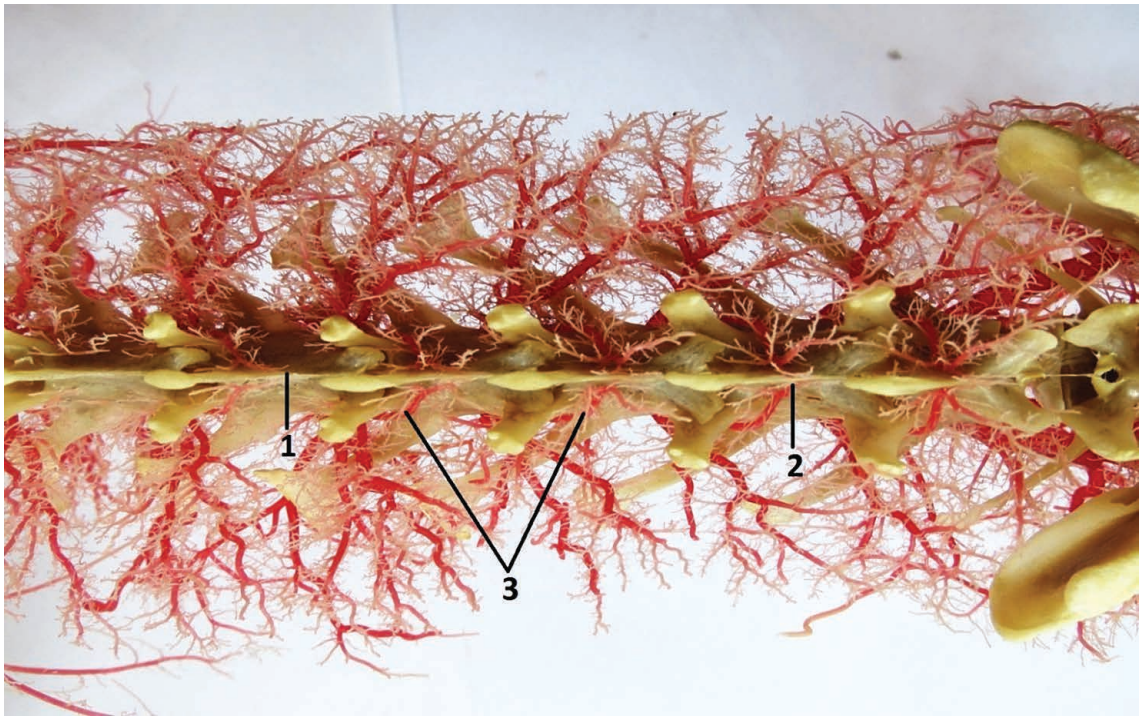

Fig. 4. *Rr. dorsales arising* from *aa. lumbales* in the hare. 1 — *vertebra lumbalis* III; 2 — *vertebra lumbalis* VI; 3 — *rr. dorsales*. Macroscopic image, dorsal view

ent in the first pair in 20 % of the cases, in the first two pairs in 20 % of the cases and in the first three pairs in 10 % of the cases. In the remaining cases, the paired *aa. lumbales* originated by means of a common trunk at each level (Fig. 1). In the hare, the first pair originated independently in 20 % of the cases and the first two pairs in 60 % of the cases. In the remaining cases, the paired *aa. lumbales* originated by means of a common trunk at each level (Fig. 2). From the *aa. lumbales* arose *rr. dorsales* supplying the muscles of the body stem. In the rabbit, from each a. lumbalis arose *rr. dorsales* in number of 3—6 and in the hare in number of 7—9. Also their diameter, ramification and density were higher in the hare in comparison with the rabbit (Fig. 3, 4).

The *a. sacralis mediana* was the direct continuation of the *aorta abdominalis*. It ran ventrally to the sacrum, to reach the coccygeal vertebrae and continued caudally as *a. caudalis mediana*. In the rabbit, *a. sacralis mediana* originated from *aorta abdominalis* at the level of the 6th lumbar vertebra (Fig. 1). From *a. sacralis mediana* in the rabbit arose the last pair of *aa. lumbales* in 30 % of the cases and last two pairs in 70 % of the cases (Fig. 1). In the hare, the origin of *a. sacralis mediana* was located at the level of the 5th lumbar vertebra in 60 % of the cases (Fig. 2) and at the level of the 6th lumbar vertebra in 40 % of the cases. From *a. sacralis mediana* in the hare originated the last pair of *aa. lumbales* in 20 % of the cases and last two pairs in 80 % of the cases (Fig. 2).

DISCUSSION

The knowledge of anatomical variations is important for radiological and surgical procedures in humans and other animals due to its practical and theoretical significance for experimental research and surgical practice in experimental and domesticated animals [11], [12], [16].

Six pairs of *aa. lumbales* with symmetrical origin from the dorsal surface of the *aorta abdominalis* were found in the rabbit [13]. Krause [9] described, in the rabbit, the *aa. lumbales* as branches arising from the dorsal surface of the *aorta abdominalis* by means of a common trunk. This arrangement was found by the *aa. lumbales* I—VI. The *aa. lumbales* VII were arising by means of a common trunk with an origin from *a. sacralis mediana*. This unpaired artery arose from the dorsal surface of the *aorta abdominalis* at the level of aortic bifurcation. Popesko et al. [13] described *a. sacralis mediana* in the rabbit as an independent branch arising from the dorsal surface of the *aorta abdominalis*. From the *a. sacralis mediana* arose the *aa. lumbales*

VII. In the majority of cases in our study, the *aa. lumbales* arose by means of a common trunk and the *a. sacralis mediana* gave off the *aa. lumbales* VI et VII.

The well-developed *rr. dorsales* arising from the *aa. lumbales* in the hare was the most visible interspecies difference in our study. These differences are associated with the way of life. The wild living hares are better and permanently trained. Training induces dimensional adaptions of the vascular system concerning the vessel diameter, distensibility, density and wall thickness in a proportional manner [7].

There is a very significant gap in the literature concerning the description of the arterial system in the European hare. The anatomical differences between familiar species will help to understand the behavioral differences in the wild and domesticated animals. We hope that this work will be the starting point for possible future studies in this research area. Such knowledge is also critical in comparative studies across species, as well as in the professional's daily practice [6].

CONCLUSIONS

A good understanding of the anatomical variations can facilitate surgical interventions, including the interpretation of a number of modern medical procedures of clinical interest, such as computed tomography and angiography [14]. Therefore, both the normal and variant anatomy of the region should be well known for accurate diagnosis, better treatment and avoidance of iatrogenic injuries during interventional vascular procedures.

REFERENCES

1. Abidu-Figueiredo, M., Xavier-Silva, B., Cardinot, T.M., Babinski, M.A., Chagas, M.A., 2008: Celiac artery in New Zealand rabbit: Anatomical study of its origin and arrangement for experimental research and surgical practice. *Pesq. Vet. Bras.,* 28, 237—240.

2. Bednarova, Z., Malinovsky, L., 1986: Ramification of celiac artery in the domestic cat. *Folia Morphol.*, 34, 36—44.

3. Brudnicki, W., Macherzyńska, A., Nowicki, W., 2007: Variation in the arteries of the aortic arch in European brown hare (*Lepus Europaeus*), Electronic Journal of Polish Agricultural Universities 10, http://www.ejpau.media.pl/volume10/issue1/art-03.html.

4. Brudnicki, W., Kirkillo-Stacewicz, K., Skoczylas, B., Nowicki, W., Jablonski, R., Brudnicki, A., Wach, J., 2015: The arteries of the brain in hare (*Lepus europaeus* Pallas, 1778). *Anat. Rec.*, 298, 1774—1779.

5. Dabanoglu, I., 2000: A quantitative study of the aorta of the New Zealand rabbit (*Oryctolagus cuniculus* L.). *Anat. Histol. Embryol.*, 29, 145—147.

6. Dugat, D., Rochat, M., Ritchey, J., Payton, M., 2011: Quantitative analysis of the intramedullary arterial supply of the feline tibia. *Vet. Comp. Orthop. Traumatol.*, 24, 313—319.

7. Huonker, M., Schmid, A., Schmidt-Trucksäß, A., Grathwohl, D., Keul, J., 2003: Size and blood flow of central and peripheral arteries in highly trained able-bodied and disabled athletes. *J. Appl. Physiol.*, 95, 685—691.

8. Koirala, S., Baral, P., 2012: A series of study of anatomic variation on arterial system. Webmed Central Anatomy, 3, 6. WMC003513. DOI: 10.9754/journal.wmc.2012.003513

9. Krause, W., 1884: *Die Anatomie des Kaninchens in Topographischer und Operative Rűcksicht*. Verlag von Wilhelm Engelman, Leipzig, 383 pp.

10. Krešáková, L., Boldižár, M., Prokeš, M., 2011: Variations in branching of arteria mesenterica cranialis in rabbit. In *Proceedings of the International Conference: Morfologie v Čechách a na Slovensku*, Ostrava, Czech Republic, June 3, 75—78.

11. Krotscheck, U., Adin, C.A., Hunt, G.B., Kyles, A.E., Erb, H.N., 2007: Epidemiologic factors associated with the anatomic location of intrahepatic portosystemic shunts in dogs. *Vet. Surg.*, 36, 31—36.

12. Mechirova, E., Zacharias, L., Jalc, P., Domorakova, I., 1999: Spinal cord white matter injury after single and repeated ischaemia/reperfusion observed by a light microscope. *Biologia*, 54, 163—167.

13. Popesko, P., Rajtova, V., Horak, J., 1990: *Anatomic Atlas of Small Laboratory Animals I* (In Slovak). 1st edn., Príroda, Bratislava, 255 pp.

14. Saunders, A.B., Winter, R.L., Griffin, J.F., Thieman, K.M., Miller, M.W., 2013: Surgical management of an aberrant left subclavian artery originating from a left patent ductus arteriosus in a dog with a right aortic arch and abnormal branching. *J. Vet. Cardiol.*, 15, 153—159.

15. Shively, M.J., Stump, J.E., 1975: The systemic arterial pattern of the guinea pig: the abdomen. *Anat. Rec.*, 182, 355—366.

16. Swindle, M.M., Smith, A.C., Hepburn, B.J.S., 1988: Swine as models in experimental surgery. *J. Invest. Surg.*, 1, 65—79.

17. Zamir, M., Wrigley, S.M., Langille, B.L., 1983: Arterial bifurcations in the cardiovascular system of a rat. J. *Gen. Physiol.*, 81, 325—335.

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