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Brachiocephalic trunk and its major branches in rabbit: a comparison between anatomic and ultrasonographic approaches

Mohammad reza Paryani [1*], Hassan Gilanpour[2], Somaye Hamedi[1], Vorya Tohidi[3], Soroush Mohit mafi[3], Seyed mehdi Rajaei[3], Reza Sadjadi[4], Mahdi Khademlo[5]

[1] Department of Basic Sciences, Faculty of Veterinary Medicine, Karaj branch, Islamic Azad University, Karaj, Iran
[2] Department of Basic Sciences, Faculty of Specialized Veterinary Sciences, Science and Research branch, Islamic Azad University, Tehran, Iran
[3] Department of Clinical Sciences, Faculty of Veterinary Medicine, Karaj branch, Islamic Azad University, Karaj, Iran
[4] Department of Clinical Sciences, Faculty of Specialized veterinary sciences, Science and Research branch, Islamic Azad University, Tehran, Iran.
[5] Faculty of Veterinary Medicine, Karaj branch, Islamic Azad University, Karaj, Iran

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ABSTRACT

Regarding the anatomical variation of the branches of the arteries in different animals and the importance of New Zealand white rabbit as an animal model in researches, the brachiocephalic trunk and its major ramifications were studied in 20 New Zealand white rabbits by anatomic and ultrasonographic approaches. Ultrasonography was performed by using a linear probe with a frequency between 6 to 12 MHz. The major branches of the brachicephalic trunk were detected and their diameter measured. The rabbits were euthanized and embalmed by 10 percent formalin. The brachiocephalic trunk and its branches were dissected. The distances between the branches of the brachiocephalic trunk were measured and their diameters also were measured by caliper. Branching pattern of the brachiocephalic trunk of the rabbits were similar to what has been described by other authors. The ultrasonographical measurements of diameter for left subclavian, right subclavian, left common carotid, right common carotid and brachiocephalic trunk were respectively 1.86,2.02,1.38,1.43,2.88 millimeters and the anatomical measurements were 1.85,2.01,1.32,1.40,3.16 millimeters. It seems that the ultrasonographic examination of the brachiocephalic branches is a reliable method to estimate the size of these vessels in living rabbits but there was difference between ultrasonographic and dissection method in Brachiocephalic trunk.

Keywords: Brachiocephalic Trunk, Rabbit, Anatomy, Ultrasonography

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INTRODUCTION

The aortic arch (AA) is found between the ascending aorta and descending aorta cranial to the heart. One or more major arteries branch off from the (AA) with patterns differing according to the species of the mammal [1]. In humans [2, 3, 4, 5], Chimpanzees [6], mice [7], rats [1, 8, 7] and hamsters [7], monotremata and sloth [4]: three

major branches; the brachiocephalic trunk (Bct), left common carotid artery (LCc) and left subclavian artery (LSb), arise from the (AA). However, in rabbits [9, 10, 11], dogs, cats [12, 13] monkeys [14, 6] guinea pigs [15], pigs [16] and llamas [19], the (Bct) and (LSb) branch off from the (AA). In some species of Chiroptera, Edentata and Cetacea [21], two trunks, the right brachiocephalic trunk and left brachiocephalic trunk, branch off from the AA. The right brachiocephalic trunk is a common trunk of the right common carotid artery (RCc) and right subclavian artery (RSb). The left brachiocephalic trunk is a common trunk of the LCc and LSb. Domestic ruminants and horses show only one artery, the brachiocephalic trunk, branching off from the AA [17, 18, 19, 20, 21, 4].

Regarding the anatomical variation of the branches of the arteries in different animals and the importance of New Zealand white rabbit as an animal model in a variety of research fields, the brachiocephalic trunk and its major ramification was studied in the present study by anatomical and ultrasonographic approaches**.**

MATERIALS AND METHODS

The brachiocephalic trunk and its major branches were studied by ultrasonography and dissection in 20 adult New Zealand white rabbits from. Ultrasonography was performed by using linear probe with a frequency between 6 to 12 MHz. The major branches of the brachiocephalic trunk were detected and their diameter measured. Then the rabbits were euthanized and embalmed by 10 percent formalin. The brachiocephalic trunk and its branches were dissected. The distances between the branches of the brachiocephalic trunk and their diameters were measured by a caliper with the precision of mm be compared with ultrasonographical findings. Data presented as mean±SD. Data analysis was carried out by using un-paired t-test. Differences were considered significant at $p<0.05$.

RESULTS

The brachiocephalic trunk and the left subclavian artery, originated from the aortic arch in rabbits. The brachiocephalic trunk gave rise to the common root of the right subclavian artery and the right common carotid artery, and the left common carotid artery in rabbits.

The aortic arch in rabbit branched off to brachiocephalic trunk and LSb. The brachiocephalic trunk, in turn, gave rise to the LCc, RCc and RSb (Fig.1, 2).

Figure 1. Dissection of the Aorta and the brachiocephalic trunk with their branches, Ventral View. A=Aorta, B= brachiocephalic trunk, L.S= Left Subclavian, R.S= Right Subclavian, L.C= Left Common Carotid, R.C= Right Common Carotid, V= Vertebral, D= Dorsal Scapular, Sup.= Superficial Cervical, Ax.= Axillary, Int.= Interbal Thoracic.

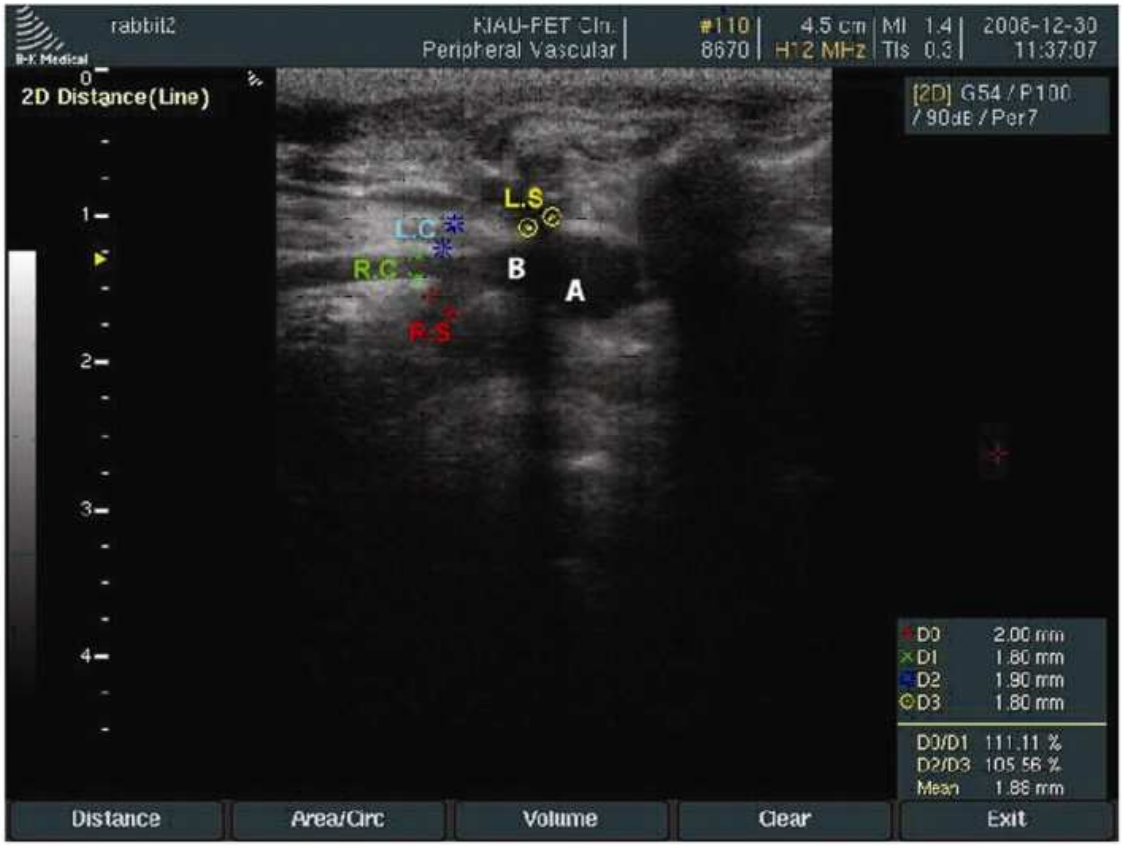

Figure 2. A Sonograph of the Aorta and the Brachiocephalic Trunk with their major branches. A= Aorta, B= Brachiocephalic Trunk, R.C= Right Common Carotid, L.S= Left Subclavian, L.C= Left Common Carotid, R.S= Right Subclavian.

This Branching pattern of the brachiocephalic trunk was similar in all 20 rabbits (Fig.3). The anatomical measurements of distances between LSb and brachiocephalic trunk and between two common carotid arteries were respectively 6.5 and 5.25 millimeters (Fig.1) (Table 1).

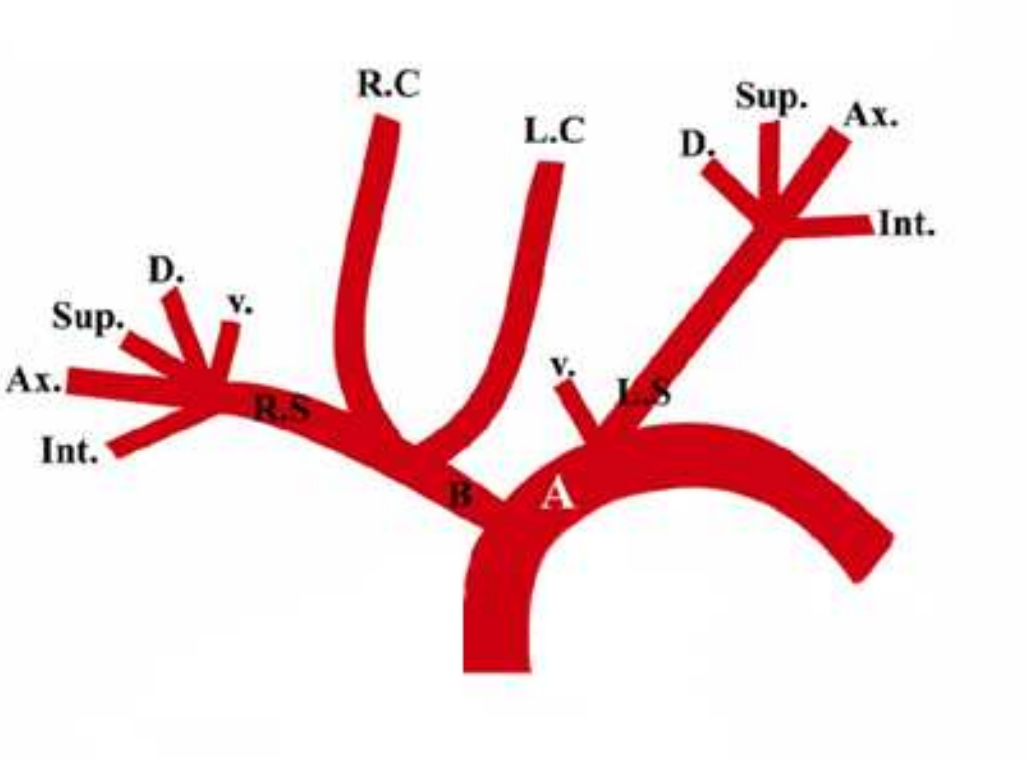

Figure 3. Diagram of the Aorta and the brachiocephalic trunk with their branches, Ventral View. A= Aorta, B= Brachiocephalic trunk, L.S= Left Subclavian, R.S= Right Subclavian, L.C= Left Common Carotid, R.C= Right Common Carotid, V. = Vertebral, D. = Dorsal Scapular, Sup. = Superficial Cervical, Ax. = Axillary, Int. = Internal Thoracic.

The ultrasonographical measurements of diameter for left subclavian, right subclavian, left common carotid, right common carotid and brachiocephalic trunk were respectively 1.86,2.02,1.38,1.43,2.88 millimeters and the anatomical measurements were 1.85,2.01,1.32,1.40,3.16 millimeters . The only parameter which showed significant difference in anatomic and ultrasonographic approach was BCt, where its diameter was measured lower by ultrasonography than direct measurement ($p<0.05$) (Table 1).

Table 1: Ultrasonographic and dissection measurements of arteries as mean±SD.

Approach Artery name	Ultrasonographic (mm)	Dissection (mm)
LSb	1.86±0.32	1.85±0.29
RSb	2.02±0.44	2.01±0.40
LCc	1.38±0.35	1.32±0.28
RCc	1.43±0.35	1.40±0.35
BCt	2.88±0.37*	3.16±0.39*

Asterisk sign has been used to show significant difference ($p<0.05$)

DISCUSSION

Generally, the Bct in domestic mammals is formed by remodeling the aortic sac and its fusion with part of the third and fourth aortic arches on both sides at the embryonic period [17]. During embryonic growth, the heart is moved caudal, and the AA begins to remodel. At this time, the seventh dorsal intersegmental arteries for the distal part of the RSb or LSb move to the cranial. The degree of movement to the left for the LSb differs among domestic animals. There is a great degree of movement in cattle and horses than in dogs and pigs. Hence, the LSb arises from the Bct directly [22].

Parson [4] believed that the immediate cause of the difference in the arrangement of the aortic branching pattern is attributed to an association with the increased breadth of the thorax in which the AA lies. Those animals with their

thoraces compressed from side to side are more likely to have their aortic branches fused. In ungulates, such as the bovidae, equidae, and cervidae, the outlet of the thorax is often twice as deep as it is broad. Moreover, these animals show maximum fusion of the great vessels [4].

Ding [11] described five predominant variations in the origin of vessels arising from aortic arch in rabbit by using digital subtraction angiography. However, in our anatomic and ultrasonographic study only one pattern was observed in all 20 rabbits which might be due to the limited number of cases [11].

Kaiser et al [23] described normal values for aortic diameters in children and adolescents –assessment *in vivo* by contrast-enhanced CMR-angiography. They reported that normative diameters were ($0.57 + 19.37*BSA^{0.5}$) mm for the aortic sinus, ($-3.52 + 18.66*BSA^{0.5}$) mm for the first segment of the aortic arch, ($-3.37 + 16.52*BSA^{0.5}$) mm for the isthmic region and ($-1.27 + 9.89*BSA^{0.5}$) mm for the descending aorta at the level of the diaphragm [23].

An interesting finding of our study was that ultrasonographical data were in close accordance with direct measurements especially for smaller vessels and the negligible differences between the ultrasonographic and anatomic measurements might be due to blood pressure in the arteries in living animals. This demonstrates that ultrasonography could be used as a reliable and non-invasive approach for evaluation of these arteries. However, regarding the larger vessels ultrasonography does not demonstrate the required precision.

In conclusion, ultarsonography is a good approach for measuring the diameter of small branches of barachiocephalic trunk in rabbits.

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