

## Aortic arch in rabbits: Morphological and Histological study

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### Summary

The study aimed to investigate the morphological and histological variations of the aortic arch of local breed rabbits (*Oryctylagus conniculus*). Nine adult local rabbits were obtained to study the aortic arch (four animals for corrosion cast technique, two injected with colored latex and three for histological study). All the rabbits were euthanized and exsanguinated, for the cast of the aortic arch they injected by self polymerizing resin via the left ventricle of the heart and the specimens were macerated in (KOH %25) for two weeks and the cast of the aortic arch were prepared. Two main branches were identified from aortic arch (except in one cadaver has three branches). The brachiocephalic trunk firstly and the left subclavian artery, the two common carotid artery (right and left) and the right subclavian artery arising from brachiocephalic trunk, the right and left subclavian arteries gave the same branches (double vertebral arteries, costocervical trunk, cervical profunda artery, internal thoracic artery, external thoracic artery, superficial cervical artery and continuous as axillary artery). Histologically the wall of the aortic arch is consist of three layers from internal to external: tunica intima, it's the thinnest layer ( $1\pm 0.166$ )  $\mu\text{m}$ , tunica media, it's the thickest layer ( $12\pm 0.0149$ )  $\mu\text{m}$  and tunica adventitia, the thickness of this layer is ( $5\pm 0.166$ )  $\mu\text{m}$ . Tunica intima consisted of single layer of endothelial cells, tunica media consisted of numerous elastic lamina in a circular arrangement and the tunica adventitia was consisted of connective tissue, smooth muscle fibers, collagen fibers, few elastic fibers, fibroblast cells, and mast cells vasavosorum. The aortic arch has a large diameter ( $98\pm 0.2019$ )  $\mu\text{m}$  and thickness of the wall is ( $18\pm 0.0282$ )  $\mu\text{m}$  to convey the high blood pressure in aortic arch. In conclusion, there was a variation in the branches of the aortic arch in different species of animals when the results compared with other studies and also, the diameter, thickness of the wall of aortic arch varies from one animal to another.

**Keywords:** Aortic arch, Histology, Rabbits, Brachiocephalic trunk, left and right subclavian arteries.

### Introduction

Aorta is the major elastic artery of circulatory system and the arteries branched from it which supply all tissues of organs in the body, aorta is divided into four segments according to the region, ascending aorta, aortic arch, descending thoracic and abdominal aorta (1 and 2). Aortic arch or arcus aortae is the convexity of aorta toward caudo-dorsal, exiting the heart. this segment of aorta was very important it gave several vessels which supplied head, neck, fore limb and the proximal half of thoracic region like right and left common carotid arteries, vertebral artery, axillary artery, internal thoracic, costocervical trunk and dorsal scapular artery respectively (3). Three vessels originated from aortic arch were studied in several researches like in domestic mammals (4), hamster (5), chinchilla (6), guinea pig (7), fox (8), human (9) and korean native goat (10). The major branches of

aortic arch are brachiocephalic trunk and left subclavian artery which described in equine, ruminants, pig dog and cats (3).

Histologically the wall of the aortic arch consists of three tunica from internal to external (intima, media, and adventitia). Tunica intima is relatively thick and is lined by single layer of endothelial cells beneath it subendothelial layer which consist of loose connective tissue that contain elastic fibers and few smooth muscle cells. tunica media is the thickest layer which consist of numerous elastic laminae as a sheet in a circular and oblique arrangement and between them, there is a thin layer of connective tissue contain collagen fibers and smooth muscle cells, tunica intima and tunica media separated from each other by internal elastic lamina. Tunica adventitia is the relatively a thin layer contain a bundles of collagen fibers and few elastic fibers, fibroblasts, mast cells and vasa

vasorum. The aortic wall diameter and thickness of each layer of the wall is change in four segments of the aorta with the variation in variable species (11 and 12) guinea pig and rat. The research work aimed for study aortic arch in rabbits morphologically and histologically.

### Materials and Methods

Nine adult local breed rabbits (*Oryctylagus Conniculus*) aged 6-12 months and weighted (1.5-2 Kg) were used for morphological and histological study of the aortic arch, (four for preparing aortic cast, two injected with colored latex and three for histological study). All the animals were euthanized with (Ketamine 50 mg/k.g ml and Xylazine 10 mg/k.g), the thoracic cavity of all the animals were opened. A cannula was inserted into the left ventricle to exsanguinated the animals after that injected with normal saline 0.9% into the left ventricle to prevent formation of blood clotting. For the cast technique we used the self polymerizing resin to study the aortic arch and the arteries arises from it, repaired resin rapidly self curing powder 5 mg mixed with 15 ml of self polymerizing liquid and injected into the left ventricle of the heart of cadaver by using the disposable syringe 50 ml after that the rabbit left 24 hrs. and transferred into 25% KOH bath for two weeks for maceration (13-15).

For colored latex (5 ml of latex mixed with red carmine stain) injected into the left ventricle by using syringe 50 ml after 24 hrs. the arteries arises from the aortic arch were dissected carefully (13). For histological study the specimen of aortic arch was removed and fixed in 10% formalin, then washing and dehydrated by ascending series of ethanol 70%, 80%, 90% and 100% in which two times 1-2 hrs. Clearing by xylol (15 min.) and embedded in paraffin wax (2-4 hrs.) after that blocks sectioned by rotary microtome with (five-six) micrometer in thickness and staining by Hematoxyline- Eosine stain, the diameter of aortic arch and the thickness of each layer of aortic arch wall was measured by using ocular micrometer and documented by fluorescent- microscope.

### Results and Discussion

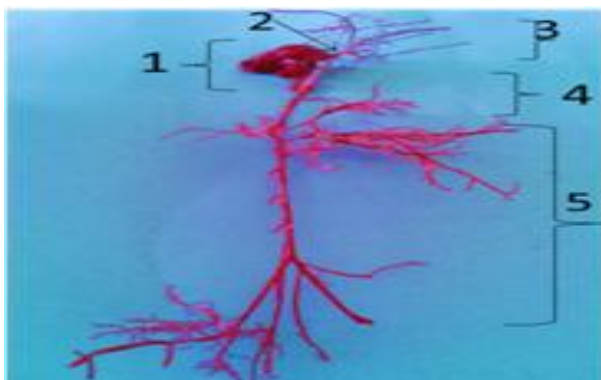
The aortic arch of local breed rabbits was the second segment of aorta (Fig. 1) which present between ascending and descending segments at the level of vertebral coloumn at fourth to fifth intervertebral disc over the bifurcation of pulmonary trunk near left pulmonary artery. It passes in caudodorsal course; it end when the descending thoracic aorta begins. This result is in agreement with (16) in human, (17) in rabbits in red squirrels (*Scicurus Vulgaris*) (18).

The aortic arch gives two main branches (Fig. 2 and 3) brachiocephalic trunk and left subclavian artery. This in agreement with researchers in other species like ruminants, equine, pigs, carnivores and domestic mammals (3 and 4), red squirrels (18 and 19) in ground squirrels (*Spermophilus citellus*), chinchilla (6) guinea pigs (7) and fox (8). While, this result is in disagreement with other studies; the aortic arch gives a rise to three branches, brachiocephalic trunk, left common carotid artery and left subclavin artery in human (20), rat (21), porcupine (*Hystrix Cristata*) (22), in mole-rats (*Spalax Leucodon*) (23), and in Turkish spiny mice and in adult Cyprus spiny mice (24). Some human cadavers showed variations in branching pattern some of them gave two branches, left subclavian artery and common trunk which gave brachiocephalic trunk, left common carotid artery and another give aris for four branched are brachiocephalic trunk, lef and rightt common carotid arteries and left vertebral artery (25). Brachiocephalic trunk branched to left common carotid artery and common trunk from which the right common carotid and right subclavian artery arising (Fig. 4) and this result is corresponding with (7, 18 and 19) in guinea pig, red and ground squirrels. Right common carotid artery passing to right side of head and neck region, then the right subclavian artery give branches supply the right limb and right side of thoracic region, while the left subclavian artery passing to the left limb and left part of thoracic region and it respected with (3 and 16) in domestic animals and human. The branched ramified from the left and right subclavian arteries were: two vertebral arteries, common trunk (costocervical trunk, cervical profund artery,

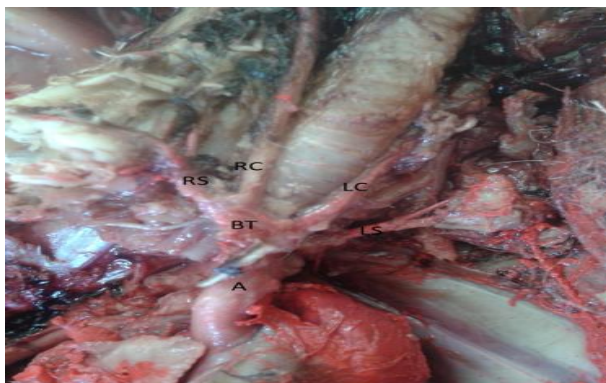
internal thoracic artery), external thoracic artery, superficial thoracic artery and it continuous as axillary artery (Fig. 4 and 5) and this noticed was similar to (6 and 23) in the study of chinchilla and mole-rats, and differs with (7) in the study of guinea pig.

**Table, 1: Mean diameter and thickness (µm) of the intimal, medial, adventitial layers and thickness of the wall of aortic arch in local breed rabbits.**

| Variables                   | Mean ± SE (µm) |
|-----------------------------|----------------|
| Diameter of aortic arch     | 98 ± 0.2019    |
| Tunica intima               | 1 ± 0.166      |
| Tunica media                | 12± 0.0149     |
| Tunica adventitia           | 5 ± 0.166      |
| Thickness of wall of aortic | 18± 0.0282     |



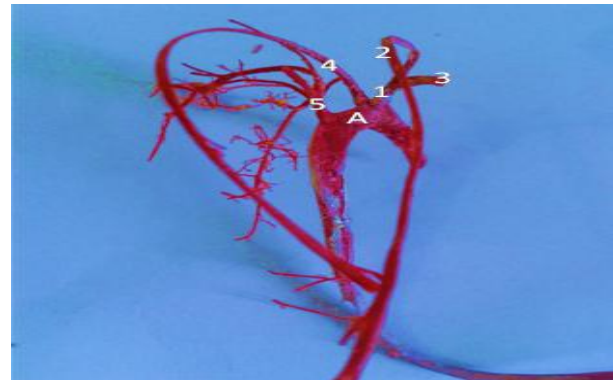
**Figure, 1: The cast of the aortic arch in local breed rabbits showing: 1.heart, 2. Ascending aorta, 3. Aortic arch, 4.Descending thoracic aorta, 5.Abdominal aorta.**



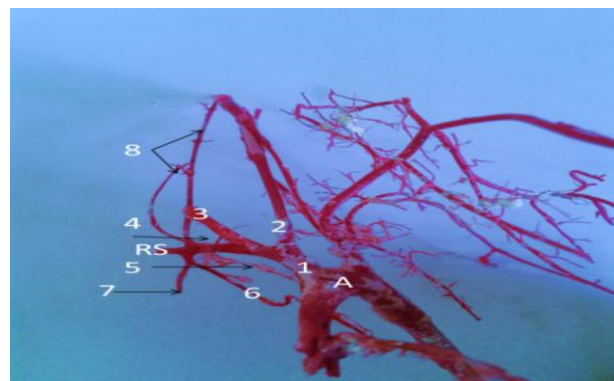
**Figure, 2: Aortic arch insitue in rabbit showing: (A) aortic arch (BT) Brachiocephalic trunk (LS) left subclavian artery (LC) Left common carotid artery (RC) right common carotid artery (RS) Right subclavian artery.**

The wall of the aortic arch was composed of three layers from internal to external tunica intima, tunica media and tunica adventitia (Fig. 6a) and this is in agreement with (11 and 26-28). Tunica intima consisted of single layer of flattened endothelial cells, few elastic fibers and few smooth muscle cells, between tunica intima and tunic media there was internal elastic lamina, the thickness of tunica intima in

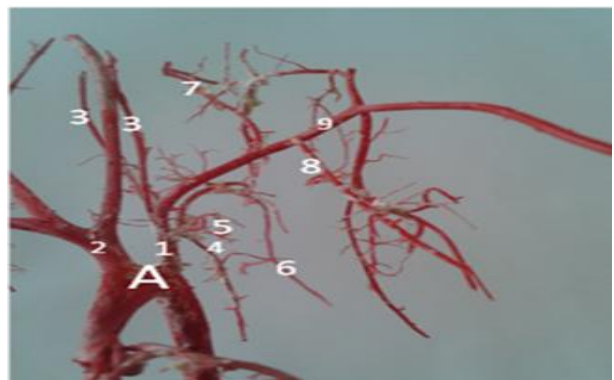
aortic arch was (1±0.166 µm) (Table, 1) and (Fig. 6b and 6c).



**Figure, 3: The cast of the aortic arch and it's major branches in rabbits (dorsal view) showing (A) Aortic arch (1) Brachiocephalic trunk (2) right common carotid artery (3) Right subclavian artery (4) left common carotid artery (5) left subclavian artery.**



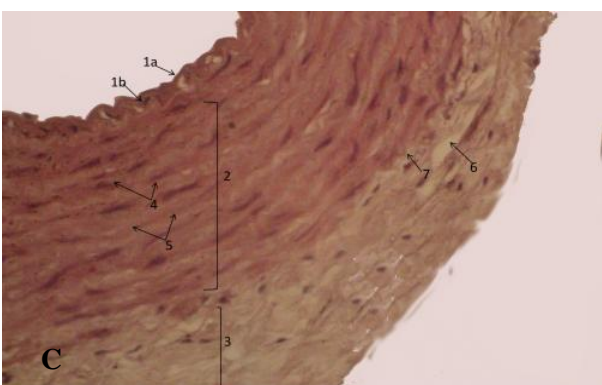
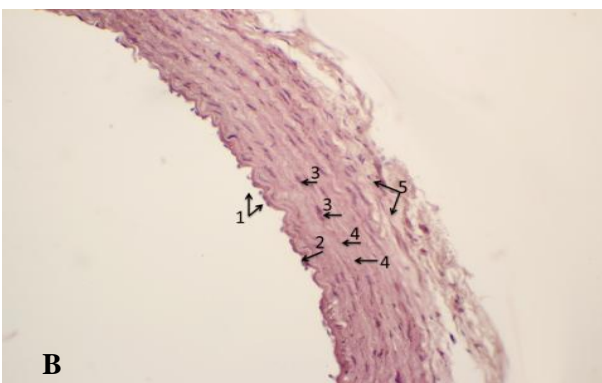
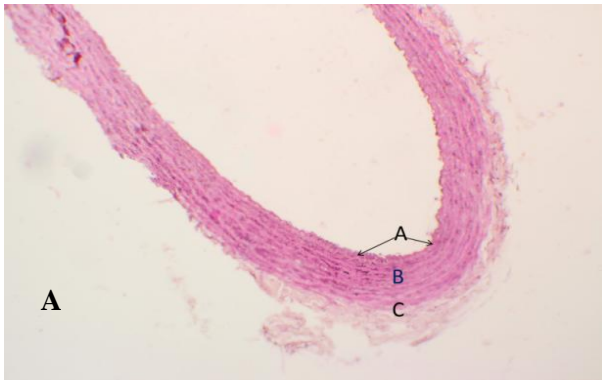
**Figure, 4: The cast of the aortic arch in rabbits (right lateral view) showing branches of Brachiocephalic trunk (A)aortic arch (RS) Right subclavian artery (1) brachiocephalic trunk (2) left common carotid artery (3) Right common carotid artery (4) Cervical profund artery (5) Costocervical artery (6) intrnal thoracic artery (7) external thoracic artery (8) Vertebral arteries.**



**Figure, 5: The cast of the aortic arch in rabbits (left lateral view) showing, (A)aortic arch (1) Left subclavian artery (2) Brachiocephalic trunk (3) Vertebral arteries (4) Costocervical artery (5) Cervical profund artery (6) Internal thoracic artery (7) superficial thoracic artery (8) External thoracic artery (9) Axillary artery.**

Tunica media was composed of elastic concentric laminea with circular arrangement

and in the space between elastic laminae were thin layer of connective tissue contain collagen fibers, smooth muscle cells, tunica media was the thickest layer ( $12 \pm 0.0149 \mu\text{m}$ ) (Table, 1) and (Fig. 6b and 6c). Tunica adventitia (Fig. 6b and 6c) was relatively thin and contain bundles of collagen fibers and few elastic fibers, also present of fibroblasts, mast cells, smooth muscle cells and vasa vasorum. The thickness of tunica adventitia was ( $5 \pm 0.0166 \mu\text{m}$ ), (Table, 1).



**Figure, 6: The histological structure of Aortic arch in rabbits showing: (6a) (A) Tunica intima (B) Tunica media (C) Tunica adventitia (100x) H and E stain. (6b) (1) Endothelial layer cells (2) Internal elastic lamina (3) Smooth muscle cells (4) Elastic fibers lamina (5) connective tissue. (200 x) H and E Stain. (6c) (1a) Endothelial cells layer (1b) Internal elastic lamina (2) Tunica media (3) Tunica adventitia (4) Smooth muscle cells (5) Elastic fibers lamina (6) vasa vasorum (7) external elastic lamina (400 x) H and E stain.**

The diameter of aortic arch was ( $98 \pm 0.2019 \mu\text{m}$ ) and thickness of aortic arch wall was ( $18 \pm 0.0282 \mu\text{m}$ ) so the aortic arch has large diameter and thick wall to convey the high blood pressure of the blood that passing through it, present result was differ from the result of (11 and 23) in the (guinea pig and rat) and spiny mice might be due to the nature of histological structure of aortic arch wall also in the study of hamster (28) they can observed ER stress on the aortic arch wall under normal condition.

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## القوس الأبهرية في الأرناب: دراسة شكلية ونسجية

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### الخلاصة

ان الهدف من الدراسة الحالية هو بيان الاختلاف النسيجي والشكلي للقوس الأبهرية في الأرناب المحلية (*Oryctylagus conniculus*). اجريت دراسة القوس الأبهرية في تسع ارناب محلية، اربع ارناب استعملت لتحضير قالب القوس الأبهرية، اثنان منهما حقنتا بمادة اللاتكس الملون. واستعملت ثلاثة للدراسة النسجية، جميع الحيوانات خُدرت واستنزفت وحُضِر قالب القوس الأبهرية وذلك بحقن مادة الراتنج عن طريق البطن الأيسر للقلب، ثم عُنُت باقي انسجة الحيوان وذلك بوضعة في محلول هيدروكسيد البوتاسيوم بتركيز 25% ولمدة اسبوعين. بنشأ من القوس الابهرية فرعان رئيسان هما الجذع العضدي الدماغية أولاً والشريان تحت الترقوي الأيسر ويعطي الفرع الاول الشريانيين السباتيين الأيمن والأيسر والشريان تحت الترقوي الأيمن والذي يعطي نفس الفروع التي يعطيها الشريان تحت الترقوي الايسر (شريانان فقاريان و الجذع العنقي الضلعي وشريان ضلعي غائر وشريان صدري داخلي وشريان صدري خارجي وشريان عنقي سطحي ويستمر باسم الشريان الابطي). نسيجياً يتكون جدار القوس الابهرية من ثلاث طبقات وهي من الداخل الى الخارج (الغلالة الداخلية وهي اقل الطبقات سما (1±0.166) مايكروميتر والغلالة الوسطى وهي أكثر الطبقات سما (12±0.0149) مايكروميتر والغلالة البرانية ويبلغ سما هذه الطبقة (5±0.166) مايكروميتر). وتتكون الغلالة الداخلية من طبقة واحدة من الخلايا البطانية. أما الغلالة الوسطى فتتكون من طبقات من الألياف المرنة التي تترتب ترتيباً دائرياً، أما الغلالة البرانية فتتكون من النسيج الضام، الألياف العضلية الملساء، الألياف الغراوية، القليل من الالياف المرنة، الارومات الليفية والاعوية الدموية المغذية لجدار الوعاء الدموي، ويبلغ قطر القوس الابهرية (98±0.2019) مايكروميتر ويبلغ سما جدار القوس الابهرية (18±0.0282) مايكروميتر لكي يستطيع تحمل ضغط الدم العالي في القوس الابهرية. ونستنتج من الدراسة الحالية أن فروع وقطر وكذلك سما جدار القوس الأبهرية وقطره تختلف باختلاف نوع الحيوان وذلك عند مقارنة نتائج هذه الدراسة مع الدراسات السابقة.

الكلمات المفتاحية: القوس الابهرية، نسيجياً، أرناب، الجذع العضدي الدماغية، الشريانان تحت الترقوي الأيمن والأيسر.