

# The Anatomical Investigation of the Arcus Aortae in Persian Squirrel (*Sciurus Anomalus*)

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## ABSTRACT

**Introduction:** The Persian Squirrel (*Sciurus anomalus*) is the only member of the Sciuridae family found in the Middle East. Some people maintain them as pets, thus their referrals to veterinary hospitals has been increased recently. Several morphological studies have been carried out mainly on the arch of aorta and its branches in common rodents, small mammals, and domestic animals but there are no reports on the details of the arcus aortae and its branches in the Persian squirrel despite the massive distribution of this species. Therefore, this study aimed to investigate the anatomy of the arcus aortae in this species to promote future investigations in this field.

**Methods:** Four adult Persian squirrels were used for this research. The subjects were injected with red-colored latex into their left ventricles. Then, they were dissected and the pattern of arcus aortae branches was illustrated in the Persian squirrel.

**Results:** The arcus aortae branches off to the truncus brachiocephalicus and the arteria subclavia sinistra. At first the arteria carotis sinistra arises from the truncus brachiocephalicus and then continues to give off the arteria carotis dextra and arteria subclavia dextra. The subclavia dextra and sinistra branch into the same vessels, including arteria thoracica interna, arteria vertebralis, arteria cervicalis superficialis, arteria cervicalis profunda, and a common root which ramifies to the arteria scapularis dorsalis and the arteria intercostalis supreme.

**Conclusion:** The vessels originating from the arcus aortae showed significant differences, especially in the arteria subclavia branches compared to other rodents and small mammals.

## Key Words:

Squirrel, Anatomy, Aortic-arch

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## 1. Introduction

**R**odents are the largest group of mammals with over 1700 different species [1]. Squirrels belong to the order Rodentia. There are approximately 50 genera and 273 species recognized in the family Sciuridae [2]. The Persian Squirrel (*Sciurus anomalus*), the middle eastern representative of the Sciuridae family, is found in Greece, Turkey, Armenia, Georgia, Azerbaijan, Iran, Lebanon, and Syria in coniferous and temperate mixed forests [3].

Several morphological studies have been carried out mainly on the arcus aortae and its branches in common rodents, including the mouse [4], rat [5, 6], guinea pig [7] and small mammals such as the rabbit [6, 8]. There is also relatively more information on the arcus aortae of domestic animals like ruminants, equines, and carnivores [9]. Although there is information about the arcus aortae of the red squirrel (*Sciurus vulgaris*) [10] and the ground squirrel (*Spermophilus citellus*) [11], there are no reports on the details of the arcus aortae and its branches in the Persian squirrel despite the massive distribution of this species.

The vessels originating from the arcus aortae supply the blood of the head, neck, proximal extremities of the forelimbs and the cranial portion of the thoracic cavity [9]. It was shown that many factors, including drugs can cause arcus aortae malformations in rats, mice, and rabbits [12]. Some people keep the Persian squirrel as a pet therefore the admissions to the veterinary hospitals have increased [13]. Sufficient anatomical knowledge of the vascular distribution may help analyze the clinical findings in this species. Therefore, in the present study, the branches of the arcus aortae will be described in the Persian squirrel in comparison with the data from other rodents to extend the knowledge in this field.

## 2. Materials and Methods

Four adult Persian squirrels weighing 300-320 g that had orthopedic problems were used for this research with their owner's consent. The subjects were euthanized using deep halothane inhalation followed by a swift cervical dislocation. The ribs were cut and the thoracic cavity was opened. The bleeding of the animals was accomplished by cutting the apex of the heart. After that, the vessels were washed with 0.9% saline solution by placing a cannula on the left ventricle of the hearts. Red-latex was injected through the same cannula allowing easy identification of vessels. The cadavers were

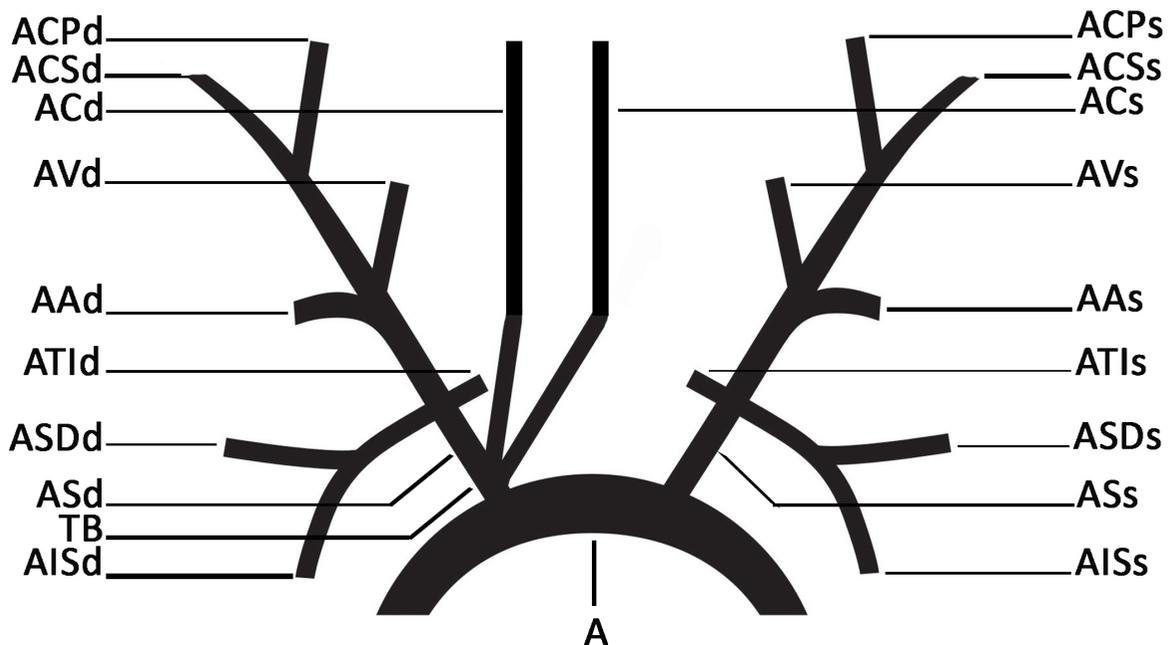
kept at room temperature for 24 hours. Finally dissection was performed using a stereomicroscope and the pattern of the arcus aortae branches was illustrated in the Persian squirrel. The nomenclatures used in this paper are correspondents to *Nomina Anatomica Veterinaria* [14].

## 3. Results

The schematic illustration of the arcus aortae branches in the Persian squirrel is shown in Figure 1. It branched off to the truncus brachiocephalicus and the arteria subclavia sinistra (Figure 1, 2 a, b). At first the arteria carotis sinistra arose from the truncus brachiocephalicus and then continued to give off the arteria carotis dextra and the arteria subclavia dextra. The arteriae carotis was present on both sides of the trachea. The arteriae subclavia sinistra and dextra branched into the same vessels, including the arteria thoracica interna, arteria vertebralis, arteria cervicalis superficialis, arteria cervicalis profunda, and a common root which ramified to the arteria scapularis dorsalis and the arteria intercostalis suprema (Figure 1, 2b). The arteria thoracica interna entered into the floor of the thoracic cavity and gave off the rami intercostales ventrales in series at its origin, which entered into the first intercostal space. The arteria vertebralis originated from the craniodorsal aspect of the arteria subclavia and ran cranially into the transverse canal of the cervical vertebrae. The arteria subclavia also yielded off to a common root which branched off the scapularis dorsalis and the intercostalis suprema arteries which entered into the interscapular region and first intercostal space, respectively. Cervicalis superficialis and cervicalis profunda feed the superficial and deep muscles of the neck. The arteria axillaris was the continuation of the arteria subclavia, which entered into the axillary region to supply blood to the thoracic limb muscles with its branches.

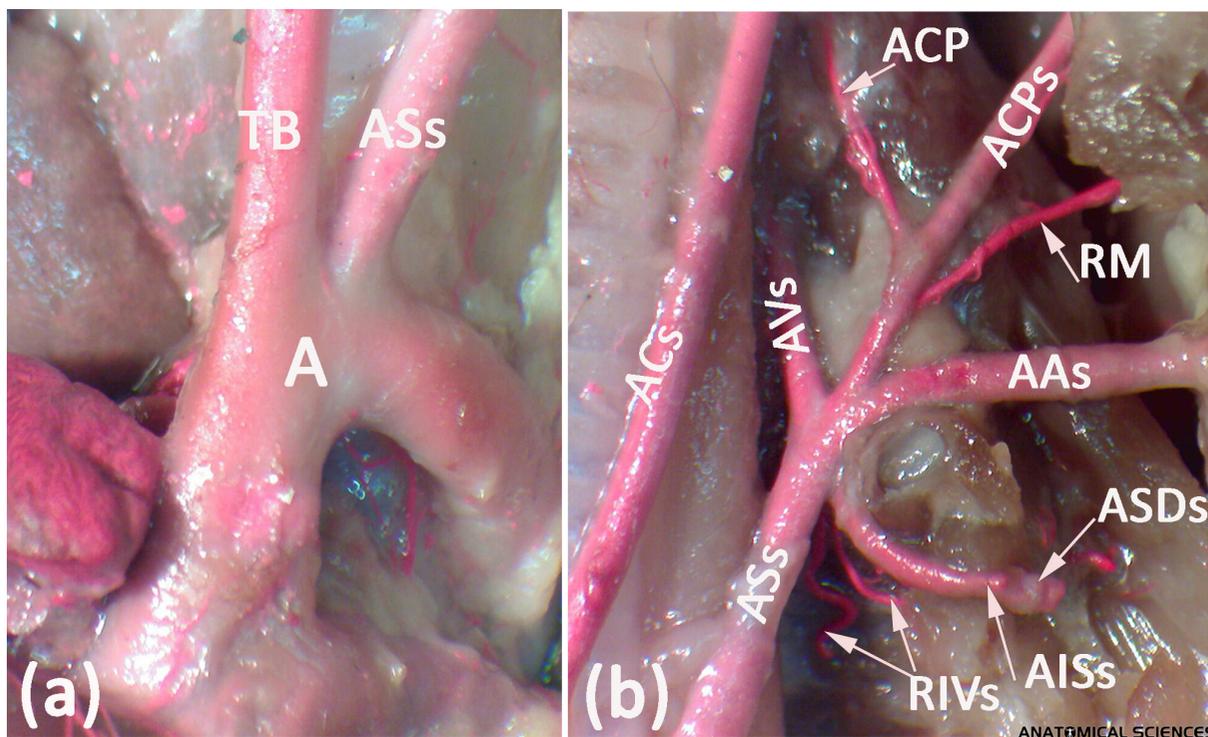
## 4. Discussion

The vessels branching from the arcus aortae are different among species. In this study, the truncus brachiocephalicus and the arteria subclavia sinistra originated from the arcus aortae in the Persian squirrel which agrees with the observations made for the arcus aortae of red squirrels [10], ground squirrels [11], chinchillas [15], pacas [16], rabbits [6, 8, 17], guinea pigs [7, 8], and also domestic animals such as pigs and carnivores [9, 18]. It has been reported that only the truncus brachiocephalicus in ruminants and equines [9, 8] and 3 branches named truncus brachiocephalicus, subclavia sinistra, and carotis communis sinistra in porcupines [19], rats [5, 20], laboratory mice [21], and hamsters [22] originate from the arcus aortae.



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**Figure 1.** Schematic view of aortic arch and its branches in Persian squirrel. Abbreviations: A: arcus aortae, TB: truncus brachiocephalicus, ASd: arteria subclavia dextra, ACd: arteria carotis dextra, ACs: arteria carotis sinistra, ASDd: arteria scapularis dorsalis dextra, AISd: arteria intercostalis suprema dextra, ATId: arteria thoracica interna dextra, AAd: arteria axillaris dextra, AVd: arteria vertebralis dextra, ACSd: arteria cervicalis superficialis dextra, ACPd: arteria cervicalis profunda dextra.



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**Figure 2.** Aortic arch and its branches in latex injection method in Persian squirrel. (a): Aortic arch and its two main branches; (b): Aortic branches of the left side. Abbreviations: A: arcus aortae, TB: truncus brachiocephalicus, ASs: arteria subclavia sinistra, ASDs: arteria scapularis dorsalis sinistra, AISs: arteria intercostalis suprema sinistra, RIVs: rami intercostalis ventralis sinistra, AAs: arteria axillaris sinistra, AVs: arteria vertebralis sinistra, RM: ramus muscularis, ACSs: arteria cervicalis superficialis sinistra, ACPs: arteria cervicalis profunda sinistra.

The truncus brachiocephalicus in the Persian squirrel, gives off the carotis communis sinistra at first and then continues to divide into subclavia dextra and carotis communis dextra. These findings are in agreement with the findings from guinea pigs [7], rabbits [8], chinchillas [15], pacas [16], red squirrels [10], ground squirrels [11], and domestic carnivores [9]. It has been stated that in rats [5, 22], hamsters [22], mice [21, 22], and porcupines [19], the truncus brachiocephalicus branches off to subclavia dextra and carotis communis dextra. In domestic ruminants and equines, the truncus brachiocephalicus ramifies to subclavia dextra and sinistra; but in pigs, it divides into truncus bicaroticus and subclavia dextra [9].

The arteria subclavia sinistra and dextra give off the arteria thoracica interna, arteria vertebralis, arteria cervicalis superficialis, arteria cervicalis profunda, and a common root for the scapularis dorsalis and intercostalis suprema during their course in the Persian squirrel. It was reported that the arteria subclavia sinistra in the guinea pig, gives origin to truncus costocervicalis, arteria thoracica interna, arteria vertebralis, arteria scapularis dorsalis, and arteria cervicalis superficialis but on the arteria subclavia dextra, the truncus costocervicalis, the arteria vertebralis and the arteria scapularis dorsalis branch off as a common trunk [7]. The arteria subclavia sinistra in the rabbit branches off to arteria vertebralis, arteria thoracica interna, arteria cervicalis superficialis, and truncus costocervicalis, but the right one gives arteria vertebralis, thoracica interna, truncus costocervicalis, and thyrocervicalis [23]. The arteria subclavia in the chinchilla gives branches of arteria thoracica interna, arteria scapularis dorsalis, arteria vertebralis, arteria cervicalis superficialis, and arteria axillaris [15]. In paca, the arteria vertebralis, truncus costocervicalis, arteria cervicalis superficialis, arteria thoracica interna, and the arteria axillaris originate from the arteria subclavia sinistra and dextra [16]. In ground squirrel, similar branches arising from the arteria subclavia sinistra and dextra are the common branch of the arteria thoracica interna and the arteria intercostalis suprema and separate branches to the arteria vertebralis and arteria scapularis descendens and a common branch of the cervicalis superficialis, cervicalis profunda, suprascapularis and the ramus spinalis [11]. The red squirrel showed branches, including the arteria thoracica interna, arteria intercostalis suprema, ramus spinalis, arteria vertebralis, arteria scapularis descendens, and a common branch formed by the cervicalis superficialis, cervicalis profunda and suprascapularis on the arteriae subclavia dextra and sinistra [10].

This study is the first description of the branches of the arcus aortae in the Persian squirrel. In conclusion and

based on these findings, the vessels originating from the arcus aortae showed significant differences in number or origin point, especially for the branches of the arteria subclavia among different species. Our results offer a baseline for future detailed cardiovascular studies in the Persian squirrel and promote future investigations in this field.

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