

## CEREBRAL ARTERIAL CIRCLE IN GERMAN SHEPHERD DOGS RAISED IN TURKEY

İbrahim KÜRTÜL\*

Nejdet DURSUN\*\*

Özcan ÖZGEL\*\*\*

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**Summary:** Construction of the circulus arteriosus cerebri (circle of Willis) in the German shepherd dogs raised in Turkey was observed via injection of the latex through the left and right subclavian arteries. Although the formation is mostly similar to the data in the literature, the following results seem to vary; there is no rostral communicating artery, the caudal cerebral arteries divide into two nearly equal branches after leaving their origins, and the shape of the circle is triangle-like.

**Key words:** German shepherd dog, cerebral arterial circle.

### Türkiye'de Yetiştirilen Alman Çoban Köpeklerinde Circulus Arteriosus Cerebri

**Özet:** Bu çalışmada; Türkiye'de yetiştirilen Alman çoban köpeklerinde circulus arteriosus cerebri'nin oluşumu, a. (arteria) subclavia sinistra et dextra yolu ile latex verilmek suretiyle gözlemlendi. Çalışmanın sonuçları literatür ile çoğunlukla uyum göstermekle beraber aşağıda belirtilen farklılıklar dikkat çekti; a. communicans rostralis bulunmamaktadır, a. cerebri caudalis ayrıldıktan sonra yaklaşık iki eşit dala ayrılmaktadır, circulus arteriosus cerebri üçgen görünümündedir.

**Anahtar sözcükler:** Alman çoban köpeği, circulus arteriosus cerebri.

## INTRODUCTION

Arterial vascularization of the brain in mammals is supplied by a circle called circulus arteriosus cerebri (circle of Willis) formed by the terminal branches of the internal carotid and basilar arteries. Gross anatomy of the circle has been vastly documented in dogs<sup>1-5</sup> and in other animals<sup>6-10</sup> by researchers. These studies have observed the similarities and differences on the circle among the animals. To begin with these, studies have determined that 2/3 of the blood supply of the brain in dogs is provided by the basilar artery<sup>11,12</sup>.

Even though various studies on this subject have been performed in different species, they are few studies done on dogs raised in Turkey<sup>13,14</sup>. A study<sup>14</sup> done on Kangal shepherd dogs; patterns of the vessels constructing the circle that supplies the brain have been displayed, and the findings have been compared with the literature; thus, emphasizing that they are mostly similar in fashion.

In the present study, macroanatomy of the circle (origin, construction, anastomes, and the branches) in German shepherd dogs raised commonly in Turkey was aimed to be observed, and to compare the findings with the data.

## MATERIALS and METHODS

In the present study, a number of six German

shepherd dogs regardless of sex with the age of six months to one year were used as material. Four were provided from Gemlik Military Veterinary School and Education Center Commandership and two were obtained from a small animal clinic (Batikent Veteriner Hizmetleri Ltd. Ankara). The animals from the clinic had been brought to be euthanised since they were deadly ill. Thoracic cavities (cavum pectoris) of the dogs gently deeply anesthetized by xylazine-ketamine combination were opened, the hearts were cut off from the apex, and blood was emptied<sup>14,15</sup>. The vessels were cleaned with serum physiologic with 0.9% through the aorta as indicated in the literature. Colored latex (ZPG 582-G) was injected through the left and right subclavian arteries. The specimens were waited at room temperature in 10% formaldehyde for 2-3 days for the freezing of the latex. Dissection was performed and pictures were taken.

Nomina Anatomica Veterinaria<sup>16</sup> was used for the anatomical nomenclature.

## RESULTS

In the study circle of Willis (Figs. A,B) in the German shepherd dogs has been observed being triangle in shape. It was determined to be formed by, the junction of the internal carotid arteries (Figs. A,B-1) laterally, the termination of the basilar artery (Figs. A,B-2) caudally, and the internal ethmoidal

\* Department of Anatomy, Faculty of the Veterinary Medicine, Kafkas University, Kars-TURKEY

\*\* Department of Anatomy, Faculty of the Veterinary Medicine, Ankara University, Ankara-TURKEY

\*\*\* Department of Anatomy, Faculty of the Veterinary Medicine, Akdeniz University, Burdur-TURKEY



(Figs. A,B-3) and internal ophthalmic arteries (Figs. A,B-4) cranially.

Each of the internal carotid artery was shown to be emerging through the base of the brain, laterally to the optic chiasm and rostrolaterally to the hypophysis. They, later, were displayed ending by dividing into the rostral cerebral (Figs. A,B-5), middle cerebral (Figs. A,B-6) and caudal communicating (Figs. A,B-7) arteries.

The basilar artery during its rostral course on the ventral surface of the brain was determined sending bilaterally the following branches, respectively; the caudal cerebellar artery, the labyrinthine artery, and the pontine branches. It also was seen giving several small branches for the related tissues. These vessels were determined anastomosing with their counterparts or their branches. The basilar artery, then, was demonstrated joining the caudal communicating arteries at the border of the pons and mesencephalon.

At the cranial division of the circle, the internal ethmoidal and internal ophthalmic arteries were shown contributing bilaterally to the construction of it. They were observed giving several small branches for the related area as joining the rostral cerebral artery.

Each of the rostral cerebral artery was displayed running rostromedially dorsal to the optic nerve, giving off the internal ophthalmic and internal ethmoidal arteries, after leaving the internal carotid artery. They, later, were determined uniting directly. They, finally, were shown advancing nearly 0.5 cm. rostrally, dividing again, thus, supplying the rostral part of the brain.

Each of the middle cerebral artery which seems to be the continuation of the internal carotid artery was determined going laterally to the Sylvian fissure. They were shown distributing 4-5 branches in front of the piriform area before entering the fissure. Continuation of the vessel was observed proceeding dorsally in the fissure, and extending over the lateral surface of the brain.

The right and left caudal communicating arteries from each internal carotid arteries were displayed coursing caudomedially; thus, joining the terminal branches of the basilar artery in front of the pons. These caudal communicating arteries were seen constructing the lateral and caudal parts of the circle.

As running caudomedially, they were observed bilaterally giving the caudal cerebral and rostral cerebellar arteries, and numerous smaller branches.

The caudal cerebral artery (Figs. A,B-8) was seen arising bilaterally from the caudal communicating artery at the level of the caudolateral aspect of the pituitary gland. They were shown dividing into two main branches after running nearly 0,7 cm. while coursing dorsocaudally, to the lateral aspect of the thalamus. These branches consequently were displayed subdividing into several smaller branches, supplying the caudal aspect of the hemisphere.

Finally, the rostral cerebellar artery (Figs. A,B-9) was determined originating bilaterally from the caudal third of the circle. They, then, were seen giving off several smaller branches; thus, supplying the caudal midbrain and the rostral part of the cerebellum.

## DISCUSSION

In the present study performed on the German shepherd dogs, construction of the cerebral arterial circle (circle of Willis) that supplies the cerebral hemispheres was revealed. As documented in the literature<sup>1,17-20</sup>, the circle is formed by; caudally the basilar artery by joining the caudal communicating artery in front of the pons, laterally the internal carotid artery by giving the rostral cerebral artery rostrally and the caudal communicating artery caudally, the rostral cerebral arteries by uniting rostrally, and the internal ophthalmic and the internal ethmoidal arteries by joining the circle rostrally.

Several studies on various dog's breeds have searched the morphological features of the circle of Willis<sup>1-5</sup>. To begin with this, few similar studies have conducted on the dogs being raised in Turkey<sup>13,14</sup>. A research done on the Kangal shepherd dogs, a distinct breed of Turkey, has observed the macroanatomical appearance of the circle<sup>14</sup>. Outcomes of this study have also indicated high resemblance of the circle of the Kangal shepherd dogs to that in the literature.

The results of the present study carried out on the German shepherd dogs raised in Turkey have too showed high resemblance with the data in the literature. On the other hand, some differences that are thought to be related to the breed and species on the morphology of the circle have been observed. Shape of the circle on the German shepherd dogs was shown



to be triangle-like in this study while that has been indicated to be somewhat spherical in the various dog breed.

Several studies on different dog breeds have determined that communication of the right and left rostral cerebral arteries differs<sup>1-5</sup>. This communication occurs either directly without a communicating artery or via a rostral communicating vessel as seen in the Kangal shepherd dogs<sup>14</sup>. These vessels in the present study were observed uniting directly like in the Kangal shepherd dogs. Later, continuation of the vessel was displayed coursing nearly 1 cm. cranially, then, dividing again into two main branches supplying the rostral parts of the hemispheres.

Another finding which seems to vary from the literature in this study is that the caudal cerebral arteries divide into two nearly equal branches after leaving their origins. Although the study performed on the Kangal shepherd dogs mentions presence of a larger branch of the stated vessels, this branch in the present study seems to be as large as the main vessel. This is thought to be due to breed or species variation.

In the study, there are also several differences on the pattern of the small branches arising from both the vessels constructing the circle and the ones leaving it. This is also thought to be mainly breed or species variation which is not uncommon in the circulatory system.

In summary, the present study has observed the construction of the cerebral arterial circle supplying the hemispheres in the German shepherd dogs. The circle is constructed by; caudally the basilar artery by joining the caudal communicating artery, laterally the internal carotid artery by giving the rostral cerebral artery rostrally and the caudal communicating artery caudally, the rostral cerebral arteries by uniting rostrally, and the internal ophthalmic and the internal ethmoidal arteries by joining the circle rostrally. The shape of the circle is triangle-like and the formation is mostly similar to the data in the literature.

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**Figür A.** Formation of the circle of Willis in the German shepherd dogs raised in Turkey.  
1-Internal carotid artery, 2-basilar artery, 3-internal ethmoidal artery, 4-internal ophthalmic artery, 5-rostral cerebral artery, 6- middle cerebral artery, 7-caudal communicating artery, 8-caudal cerebral artery, 9-rostral cerebellar artery.

**Resim A.** Türkiye'de yetiştirilen Alman Çoban Köpeğinde circulus arteriosus cerebri'nin oluşumu.

1-arteria carotis interna, 2-arteria basilaris, 3-arteria ethmoidalis interna, 4-arteria aphtalmica interna, 5-arteria cerebialis rostralis, 6-arteria cerebialis media, 7-arteria comunicans caudalis, 8-arteria cerebialis caudalis, 9-arteria cerebellaris rostralis.



**Figure B.** Formation of the circle of Willis in the German shepherd dogs raised in Turkey (Slightly higher magnification of the Fig.A.).

1-Internal carotid artery, 2-basilar artery, 3-internal ethmoidal artery, 4-internal ophthalmic artery, 5-rostral cerebral artery, 6-middle cerebral artery, 7-caudal communicating artery, 8-caudal cerebral artery, 9-rostral cerebellar artery.

**Resim B.** Türkiye'de yetiştirilen Alman Çoban Köpeğinde circulus arteriosus cerebri'nin oluşumu (Resim A'nın büyütülmüş hali).

1-arteria carotis interna, 2-arteria basilaris, 3-arteria ethmoidalis interna, 4-arteria ophtalmic interna, 5-arteria cerebialis rostralis, 6-arteria cerebialis media, 7-arteria comunicans caudalis, 8-arteria cerebialis caudalis, 9-arteria cerebellaris rostralis.