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Arterial Supply of the Cranial Cervical Ganglion in Roe Deer (*Capreolus capreolus)*

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Abstract.- This study was performed to determine the arterial vessels of the cranial cervical ganglia of 7 adult roe deer. Latex coloured with a red dye was injected to blood vessels of the cranial cervical ganglion and these vessels were observed with detailed dissections. Especially, the occipital artery and branches that extended to the mandibular gland and to the medial retropharyngeal lenf node of the ascending palatine artery were responsible for the vascularization of the cranial cervical ganglion. Furthermore, the vessel that supplied muscles at the cervical region and separated from the common carotid artery, the ascending pharyngeal artery and middle meningeal artery also participated in the vascularization of the ganglion.

Keywords Anatomy, arterial supply, cranial cervical ganglion, roe deer.

INTRODUCTION

The cranial cervical ganglion is an important organ where cephalic sympathetic fibers make the last synapses. Postganglionic sympathetic fibers separated from this ganglion contribute into sympathetic innervation of smooth muscles and glands in the head (Getty, 1975; George *et al.*, 2008). Blood flow is greater in the nerve tissue where metabolic activity is more (gray matter of the brain, peripheral ganglions) than in the nerve tissue where metabolic activity is less (white matter of the brain, nerve axons) (Chunhabundit *et al.*, 1992; McManis *et al.*, 1997). There is more blood circulation in the cranial cervical ganglion according to peripheral nerve axons. Thus, this ganglion may stay unprotected against ischemia (McManis *et al.*, 1997). Damages occurred in the ganglion with cases such as trauma and neuroblastoma or ischemia that may appear in the cranial cervical ganglion for diseases such as diabetes (Cameron and Cotter, 2001; Kennedy and Zochodne, 2002) may lead to lack of sympathetic innervation in the head and neck areas (Zafeiriou *et al.*, 2006). Sympathetic innervation disorders may cause Horner's syndrome (Monteiro and Coppeto, 1988; Singh *et al.*, 2004; Zafeiriou *et al.*, 2006) as well as they are suppressed secretion of melatonin which is necessary for photo-periodcial stimulus of the reproduction function and synthesized from the pineal gland (Karasek *et al.*, 2002; Maurel *et al.*, 2002).

Recently, many studies related with localization of the ganglion and nerve branches separated from the cranial cervical ganglion on different species have been performed (Kabak *et al.*, 2005; Kabak, 2007; Arı *et al.*, 2010; Kabak and Onuk, 2010; Shao *et al.*, 2011). There are few studies about arterial vascularization of the ganglion and regulation of the blood flow on the ganglion in humans (Tubbs *et al.*, 2002), dogs (Chungcharoen *et al.*, 1952; Marcian and Jenkins, 1967) and rats (DePace, 1981; Santer and Owen, 1986; Chunhabundit *et al.*, 1992; Mikusek *et al.*, 1994; McManis *et al.*, 1997). However, no information could be detected about arterial supply of ganglion in the roe deer and other ruminants. The present study has been conducted to determine the vessels supplying the cranial cervical ganglion in the roe deer.

MATERIALS AND METHODS

This study was carried out with 31876 numbered permission slip taken from of the General Directorate of Nature Conservation and National Parks of the Ministry of Forestry and Water Affairs at 25.06.2012 date. Seven adult roe deer *(Capreolus*

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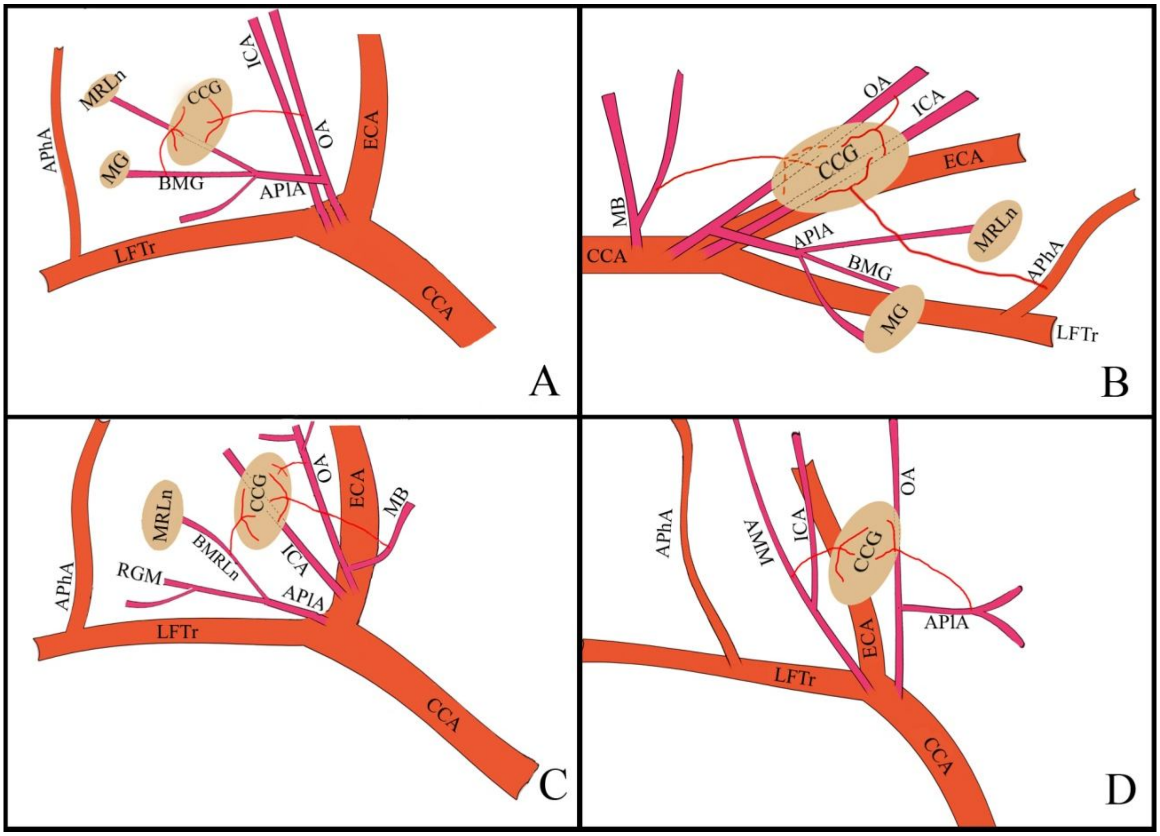

Fig. 1. Schematic representations of arterial vascularization of the cranial cervical ganglion in general vessels (A, B, C) separate and in rarely seen vessel (D). A, C and D shows medial view of the right cranial cervical ganglion, whereas B shows medial view of the left cranial cervical ganglion.
Abbreviations: APhA, ascending pharyngeal artery; APlA, ascending palatine artery; BMG, branch extended to mandibular gland; BMRLn, the branch extended to medial retropharyngeal lenf node; CCA, common carotid artery; CCG , cranial cervical ganglion; ECA, external carotid artery; ICA, internal carotid artery; LFTr, linguafacial trunctrunk; MB, the musculer branch extended to the muscles on cervical region and ramifying from the common carotid artery or occipital artery; MG, mandibular gland; MMA, medial meningeal arter. Red thin lines:, the vessels received to CCG; MRLn, medial retropharyngeal lenf node; OA, occipital artery.

capreolus) with a weight of 19 to 23 kg which referred to the clinics of our faculty because of traffic accident and firearm injury and could not be saved were formed to materials of the study. The vessels supplying totally 14 numbers on the right and left the cranial cervical ganglions were determined in the roe deer. These vessels were irrigated with 0.9% saline water through a catheter placed in the common carotid artery just after the death and latex injection coloured with red was performed through the same way. Materials were fixed in 10% formol solution and the vessels supplying the cranial cervical ganglion were studied with detailed dissections under Olympus SZ-61 TRC stereo-microscope. The photographs were taken by a Olympus C-5060 digital camera.

RESULTS

The arterial supply of the cranial cervical ganglion of all examined roe deer (Fig. 1) and numbers of these vessels which contribute to supplying of the ganglion were presented in Table I. The cranial cervical ganglion (GCC in Fig. 1 and a in Fig. 2) was supplied by the 2-4 vessels from 2 different origin in 8 of investigated ganglia and from 3 different origin in other 6 (Table I). One of the most important vessels which is responsible to

Table I.- The origin and number of arterial vessels of the cranial cervical ganglion in roe deer.

Material No	Material CCG	OA	APhA	APlA			MMA	CCA
				APlA	BMG	BMRLn		MB
I	Right	+	-	-	-	+	-	-
	Left	+	-	-	-	+	-	-
II	Right	-	-	+	-	-	+	-
	Left	+	-	-	+	-	-	+
III	Right	+	-	-	-	+	-	+
	Left	+	-	+	++	-	-	-
IV	Right	+	-	-	+	-	-	-
	Left	+	-	-	+	-	-	-
V	Right	+	-	-	-	+	-	+
	Left	++	-	-	+	-	+	-
VI	Right	+	-	-	-	+	-	-
	Left	+	-	-	+	-	-	-
VII	Right	+	+	-	-	-	-	+
	Left	+	-	-	+	-	-	-

For abbreviations see Figure 1. +, one number vessel; ++, two number vessels; -, no branch was observed.

blood supply of the cranial cervical ganglion was the occipital artery (AO in Fig. 1 and b in Fig. 2) and the other one was the ascending palatine artery (APIA in Fig. 1 and C in Fig. 2). The ascending palatine artery had two main branches. One of them was extended to the mandibular gland. The other one was extended to the medial retropharyngeal lymph node. It was observed that thin branches originated from these two main vessels were significantly contributed to supplying of the ganglion.

In all of the roe deer, occipital artery were contributed to arterial supply of the ganglion except one roe deer only. In the material that the occipital artery was not contributed to the supplying of the ganglion, 2 vessels were responsible from vascularization of the ganglion (Fig. 1D). These were thin vessels arose from the medial meningeal artery and ascending palatine artery. In the material where the ascending palatine artery was not contributed to supplying of the ganglion, 3 vessels were responsible from vascularization of the ganglion. These vessels were the occipital and ascending pharyngeal arteries and muscular branch which was originated from the common carotid arteries (Fig. 1B).

Another vessel which was important for supplying the ganglion, the ascending palatine artery was arose from the occipital artery (Fig. 1A, B, D) or bifurcation level of common carotid artery (Fig. 1C). The ascending palatine artery was ramified to branches extending to the mandibular gland and medial retropharyngeal lymph node which were contributed to supplying of the ganglion just after the initiation (Fig. 1A, C). It was observed that the branch extending to the mandibular gland was originated from common carotid artery (d in Fig. 2) in two materials. It was detected that the thin vessel ramified from the branch extending to the medial retropharyngeal lymph node was one number in five materials (Fig. 1C, Table I). Vessels ramified from the branch extending to the mandibular gland and contributed to supplying of the ganglion were determined as one vessel in six materials and two vessels in one material (Fig. 1A, B; Table I) The vessel ramified as one branch was supplied the medial side of the ganglion by entering from midlevel of the ganglion. In the material which was contributed to the ganglion supplying with 2 branches, it was observed that first branch was reached to the ganglion from midlevel of the ganglion (d' in Fig. 2) and the second branch was reached from distal end of the ganglion (d" in Fig. 2). The branch reaching to the ganglion from distal end was also ramified into three thin branches progression on medial (thin arrow in Fig. 2), lateral (thick arrow in Fig. 2) and dorsal (arrow head in Fig. 2) sides of the ganglion just after the initiation.

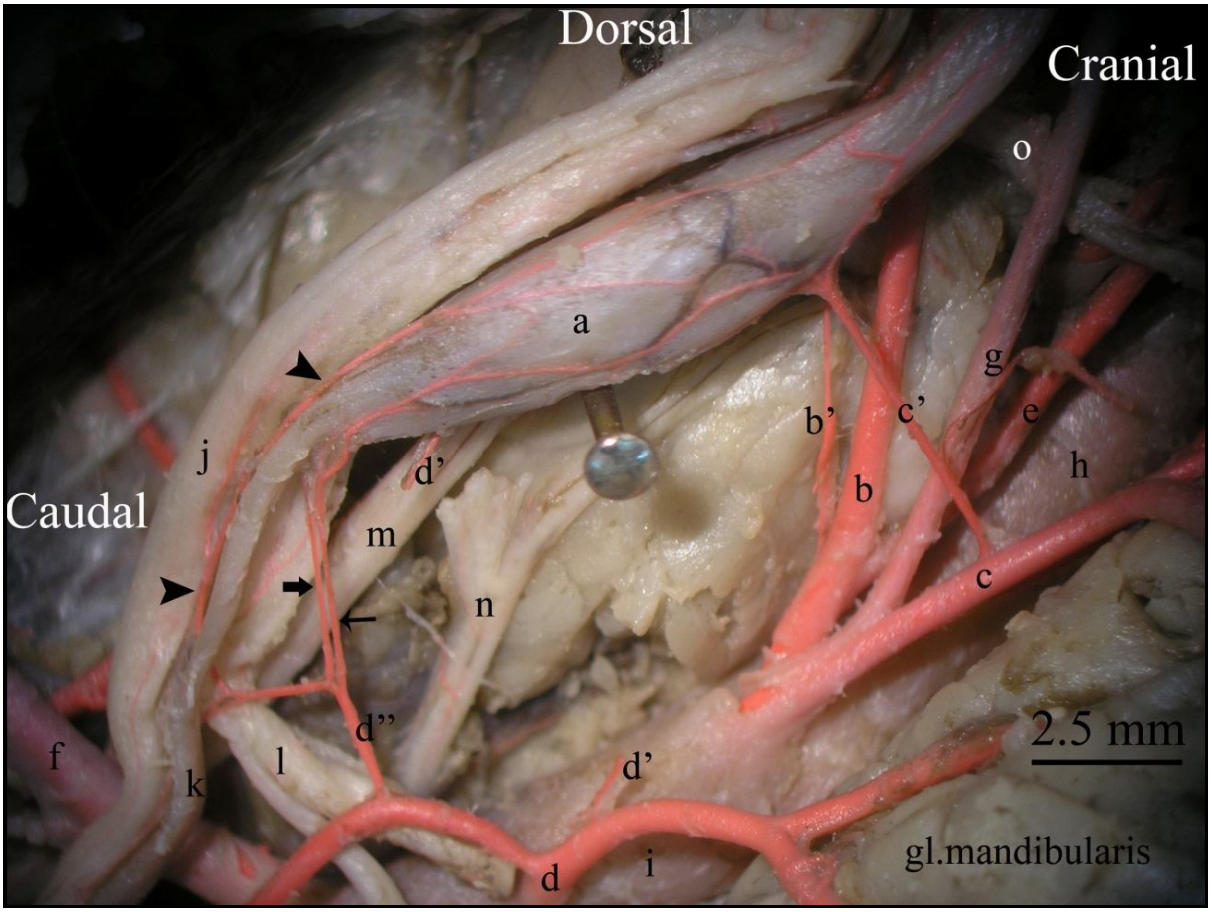

Fig. 2. Medial view of arterial vessels of the cranial cervical ganglion in the roe deer.
a, cranial cervical ganglion; b, occipital artery; b', the vessel reached to ganglion from occipital artery; c, ascending palatine artery; c', the vessel extented to ganglion from ascending palatine artery; d, the branch extented to mandibular gland; d', the branch (cutting) ramifying from the branch of the mandibular gland and reached to the ganglion from midlevel of the ganglion; d'', the branch (cutting) ramifying from the branch of the mandibular gland and reached to the ganglion from distal end of the ganglion; e, medial meningeal artery; f, the musculer branch extended to the muscles on cervical region and ramifying from the common carotid artery; g, internal carotid artery; h, external carotid artery; i, common carotid aretery; j, vagus nerve; k, sympathetic nerve; l, cranial laryngeal nerve; m, accessorial nerve n: hypoglossal nerve; o, pharyngeal ramus of vagus nerve; thin arrow, the vessel ramifying from d'' and extented to medial side of the ganglion; thick arrow, the vessel ramifying from d'' and extented to lateral side of the ganglion; arrow head, the vessel ramifying from d'' and extented to dorsal side of the ganglion.

Except abovementioned vessels, there were also the different vessels that were responsible from vascularization of the ganglion. These vessels were the muscular branch ramifying from the common carotid artery, medial meningeal and ascending pharyngeal arteries. Unilaterally in four roe deer, the branch which was initiated from the muscular branch originating from the common carotid artery and supplying the muscles on the cervical region (MB in Fig. 1D) was always one vessel and supply the distal half of the ganglion. It was determined that each branches which ramified from the medial meningeal artery (Fig. 1D) in two roe deer and from ascending pharyngeal artery (Fig. 1D) in one roe deer just unilaterally, supplied the dorsal half and medial side of the ganglion. It was detected that all branches supplying cranial cervical ganglion ramified into 2 or 3 or sometimes 4 subbranches after reaching to the ganglion and they were constituted an anastomosis between each other.

DISCUSSION

In the studies which have been conducted until today, it has reported that names of arteries supplying to the cranial cervical ganglion and number of branches given by these arteries for the ganglion are different in human, dog and laboratory animals (Chungcharoen *et al.,* 1952; Marcarian and Jenkins, 1967; DePace, 1981; Santer and Owen, 1986; Chunhabundit *et al.,* 1993; Hacein-Bey *et al.,* 2002; Tubbs *et al.,* 2002).

The cranial cervical ganglion is mainly supplied by 2 or 3 vessels originated from the ascending pharyngeal artery in human (Tubbs *et al.,* 2002; Hacein-Bey *et al.,* 2002), one branch from the ascending pharyngeal artery and 1 or 2 branches from occipital artery and cervical branch of the occipital artery in the dog (Chungcharoen *et al.,* 1952; Marcarian and Jenkins, 1967), 1 or 2 branches from the occipital and one branch from common carotid arteries in cat and rabbit (Chungcharoen *et al.,* 1952). It has stated that main arteries which are responsible to supply the ganglion in rats are 1 or 2 vessels originated from the common carotid artery (DePace, 1981; Chunhabundit *et al.,* 1993) and 2 or 3 branches from external carotid arteries (DePace, 1981; Santer and Owen, 1986; Chunhabundit *et al.,* 1993; Mikusek *et al.,* 1994). In the study, it was detected that the arterial supply of the cranial cervical ganglion was performed by branches of the occipital and ascending palatine arteries.

Nickel *et al*. (1981) have reported that the ascending palatine artery has ramified from the common carotid artery in the small ruminants and from the occipital artery in the bovine in accordance with expression of Getty (1975), as well. In roe deer, the ascending palatine artery was originated from the occipital artery in general and from the common carotid artery less.

There are vessels which contribute to ganglion supplying even less than abovementioned main vessels. These vessels have been stated as thin branches ramified from the cranial thyroid artery in human (Tubbs *et al.,* 2002), from the condylar (1 branch), common carotid and thyroid arteries (several branches) in dog (Chungcharoen *et al.,* 1952; Marcarian and Jenkins, 1967) and from the external carotid and thyroid arteries in cats (Chungcharoen *et al.,* 1952). One thin vessel ramified from the occipital artery and one branch from cranial thyroid artery in rat (Santer and Owen, 1986; Mikusek *et al.,* 1994), from the internal carotid and ascending pharyngeal arteries in rabbit (Chungcharoen *et al.,* 1952) are contributed to the ganglion supplying.

It is seen that the cranial thyroid artery contributes to ganglion supplying in all animals except rabbit. Not participating of the cranial thyroid artery to ganglion supplying in roe deer was similar to rabbit. In this study, it was determined that other vessels which were contributed to ganglion supplying except main vessels (the occipital and ascending palatine arteries) were the ascending pharyngeal and medial meningeal arteries and muscular branch which ramified from the common carotid artery and extended to the muscles of the cervical region. The medial meningeal artery which was contributed to ganglion supplying in two roe deer was ramified from the internal carotid artery in one roe deer and from the occipital artery as reported by Nickel et al. (1981) in the other one.

In roe deer, the cranial cervical ganglion was supplied by the 2-4 vessels from 2 or 3 different origins. It is remarkable that the number of vessels extending to the left cranial cervical ganglion more than the number of vessels to the right cranial cervical ganglion in 3 of 7 investigated roe deer. It is equal in 3. The vessels number of the right cranial cervical ganglion more than the number of vessels to the left cranial cervical ganglion in 1 of 7 roe deer.

Consequently, when main and assistant vessels which were contributed to ganglion supplying were compared with other species, some differences were observed. The most important differences were the ascending palatine (as main vessel) and medial meningeal arteries (as the assisting vessel) that were contributed to ganglion supplying. Contribution of these two vessels into ganglion supplying was reported first in this study.

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