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An Anatomical Study of the Cranial Cervical Ganglion of the Dromedary Camel (*Camelus dromedarius*)

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ABSTRACT:

The cranial cervical ganglion (CCG) of six adult dromedary camels of both sexes were dissected to investigate the weight, position and topography. The ganglion was located ventral to the atlas and dorsal to the pharynx on the rostrolateral surface of the longus capitis muscle. The cranial cervical ganglion was triangular or fusiform in shape and white in colour. The main branches of the cranial cervical ganglion were included in the internal and external carotid nerves in addition to the jugular nerve. It weighed about 0.5 g. The average length, width and thickness (Mean ± SE) of the right CCG were 16.33± 1.41 mm, 7.0± 1.03 mm and 3.03± 0.54 mm, respectively, whereas the left CCG had an average length, width and thickness of 16.65± 1.21 mm, 7.21±0.82 mm and 3.21± 0.37 respectively. In conclusion, the cranial cervical ganglion in dromedary camels were well developed structure. The number and course of the nerves ramifying from the ganglion, especially internal carotid nerves, were observed different than other species.

Keywords: Cranial cervical ganglion, Anatomical study, Camel.

INTRODUCTION:

The cranial cervical ganglion is the terminal end of the sympathetic cervical trunk, which is closely associated with the vagal nerve in the neck. The sympathetic cervical trunk contains the preganglionic fibers that convey messages to the cell bodies of the postganglionic neurons in the cranial cervical ganglion, which provide the sympathetic input to the head (Getty, 1975; Cui-Sheng, Wang and Xie, 1998; Cakir, 2001). The post-ganglionic axons of the cranial cervical ganglion form the internal and external carotid and jugular nerves in many animal species as had been reviewed by (Getty, 1975; Cui-Sheng *et al.*, 1998; Kabak, Orhan, and Hazırog˘lu, 2005; Kabak, 2007; Najafi, and Nejati, 2009; Najafi, Soltanalinejad and Dehghani, 2011), in addition to the laryngopharyngeal nerves in Angora goats (Ari, Soyguder and Cinaroglu, 2010).

Anatomical studies on the position, topography and ramifications of the cranial cervical ganglion and its relationship to the regional arteries and nerves were investigated in different animal species (Getty, 1975; De Lahunta, 1997; Cui-Sheng *et al.*, 1998; Cakir, 2001; Fioretto, Guidi, Oliveira and Ribeiro, 2003; Ozgel, Kurtul and Dursun, 2004; Kabak *et al*. 2005; Kabak, 2007; Shao, Ding, Xie, Yu, Saberi, and Wang, 2007; Najafi and Nejati, 2009; Kabak and Onuk, 2010; Ari *et al*. 2010; Shao, Ding and Wang, 2011; Najafi *et al.* 2011; Nourinezhad, Mazaheri and Saberifar, 2016). On the other hand, developmental (Maurel, Ben Saad, Roch and Siaud, 2002; Fioretto, Navarro de Abreu, Fernandes de Souza Castro, Guidi, and Ribeiro, 2007) and neurophysiological (De Lahunta, 1997) studies of the ganglion carried out in different species, concluded that the anatomy of the ganglion differed from species to another.

The fibers of the internal carotid nerve run to the trigeminal ganglion and the ophthalmic nerve. These branches carry the sympathetic input to the eye and its accessory organs (De Lahunta, 1997). In addition, the cranial cervical ganglion provides branches to the thyroid gland, the pharynx, and larynx (De Lahunta, 1997; Cui-Sheng *et al*., 1998; Cakir, 2001; Kabak, 2007), the common carotid artery (Cui-Sheng *et al*., 1998; Kabak, 2007), the cranial thyroid artery (Cui-Sheng *et al*., 1998), the ascending pharyngeal artery (De Lahunta, 1997) and the linguofacial trunk (Kabak, 2007). The cranial cervical ganglion also sends communicating branches to the spinal cervical nerves from the first to the fourth (De Lahunta, 1997; Cui-Sheng *et al*., 1998), the glossopharyngeal nerve (Karasek, Zielinska, Marek, and Swietoslawski, 2002; Ari, *et al.*, 2010), the vagal nerve (Cui-Sheng *et al*., 1998; Kabak, 2007; Ari, *et al.*, 2010), the accessory nerve (Cui-Sheng *et al*., 1998) and the hypoglossal nerve (Cui-Sheng *et al.*, 1998; Kabak, 2007).

An investigation of the cranial cervical ganglion in the Bactrian camels had been carried by Cui-Sheng *et al.* (1998). They described the general location, shape and the branches of the ganglion. They reported that there were no obvious differences in the anatomy of the ganglion and its associated nerves between the two sides of the head. On the other hand, Nourinezhad, Mazaheri and Biglari (2015) founded that the ganglion appeared as fusiform in the right side and oval in the left side in the dromedary camel.

Since little information is available on the macroscopic anatomy of the cranial cervical ganglion in the dromedary, the aim of the current study was to investigate the gross anatomy of the cranial cervical ganglion and provides basic data on its weight and linear measurements and branching pattern in dromedary camel.

MATERIALS AND METHODS:

Six apparently healthy adult dromedary camels of both sexes of different ages slaughtered at Assalam slaughter-house, Khartoum, Sudan were used to study the topography of the cranial cervical ganglion and its branches. A Canon digital camera (Canon Company, Tokyo, Japan) was used for photography.

The whole cranial cervical ganglia were carefully dissected out, weighed on a laboratory balance and then the length, width and thickness of the ganglia were measured with a ruler. Fresh specimens were used for the study of the colour and shape of the ganglion.

RESULTS:

In all dissected heads of the dromedary camels the cranial cervical ganglion was a well-developed structure disposed ventral to the caudal stylopharyngeal muscle and covered by the mandibular gland. It was lodged between the common carotid artery and the internal carotid artery rostrolateral to the longus capitis muscle (Figure 1). It was related laterally to the vagus nerve and medially to the retropharyngeal lymph node (Figure 2). It was triangular or fusiform in shape and white in colour. It weighed about 0.5 g.

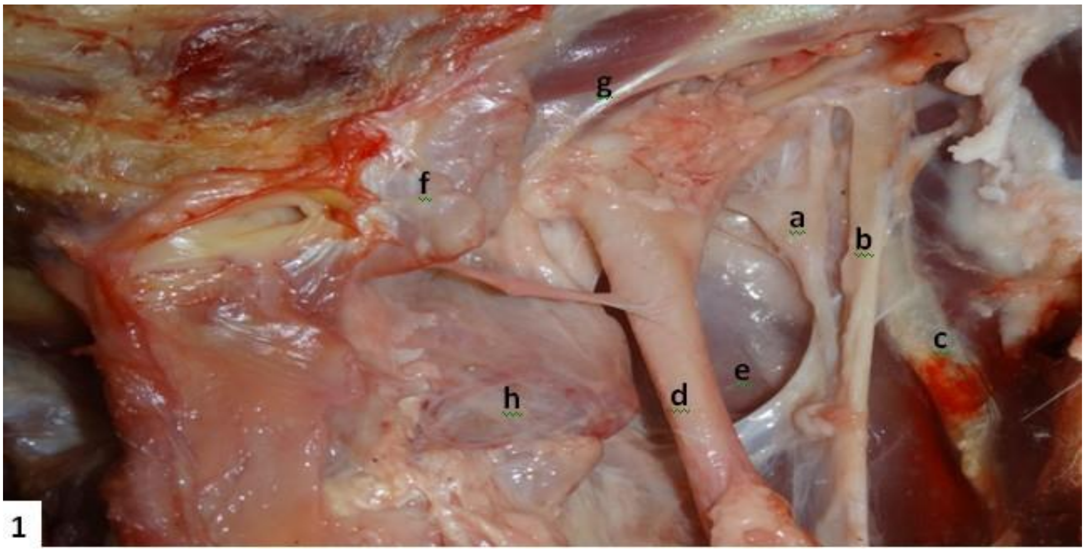

Figure 1: The cranial cervical ganglion in dromedary camel (a), vagus nerve (b), internal carotid artery (c), external carotid artery (d), longus captis muscle (e), mandibular gland (f), stylohyoid bone (g) and caudal stylopharyngeal muscle (h).

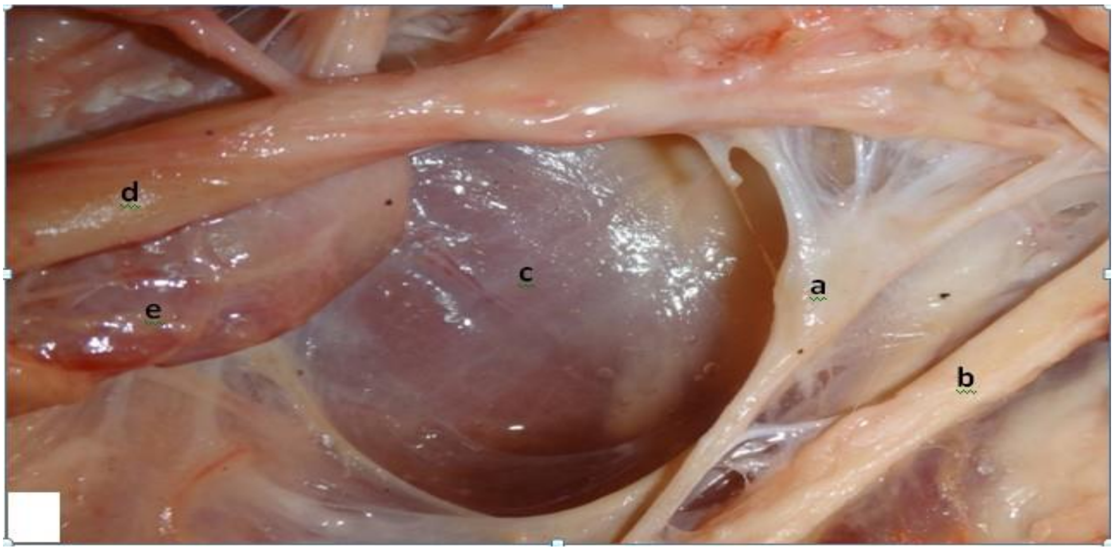

Figure 2: The cranial cervical ganglion in dromedary camel (a), vagus nerve (b). longus captis muscle (c), external carotid artery (d) and retropharyngeal lymph node (e).

The measurements of the length, width and thickness of the fresh samples of the right and left cranial cervical ganglia in the six dromedary camels were shown in Table 1. The length of the right cranial cervical ganglion ranged between 14.5 and 18.5 mm (the mean length was 16.33± 1.41 mm), whereas the length of the left cranial cervical ganglion ranged between 15.0 and 18.2 mm (the mean length was 16.65± 1.21 mm). The width of the right cranial cervical ganglion ranged between 5.8 and 8.5 mm (the mean width was 7.0 ±1.03 mm), while the width of the left cranial cervical ganglion ranged between 6.0 and 8.3 mm (the mean length was 7.21±0.82 mm). The thickness of the right cranial cervical ganglion ranged between 2.5

and 4.0 mm (the mean length was 3.03± 0.54 mm), whereas the thickness of the left cranial cervical ganglion ranged between 2.8 and 3.8 mm (the mean length was 3.21± 0.37 mm).

Table (1): Showing the length, width and thickness of fresh samples of right and left cranial cervical ganglion (CCG) in the dromedary camel.

Animal No.	length (mm)		Width (mm)		Thickness (mm)	
	Right	Left	Right	Left	Right	Left
1	17.3	16.5	7.5	6.7	3.2	3.0
2	15.5	17.9	6.2	7.8	2.6	3.5
3	18.5	18.2	8.5	8.3	4.0	3.8
4	15.9	16.4	6.5	7.0	2.9	3
5	14.5	15.0	5.8	6.0	2.5	2.8
6	16.2	15.9	7.7	7.5	3.0	3.2
Mean	16.33	16.65	7.0	7.21	3.03	3.21
SD	1.41	1.21	1.03	0.82	0.54	o.37

The cervical sympathetic trunk passed cranially from the stellate ganglion, joined the vagus nerve in a common sheath as the vagosympathetic trunk, then separated from the common trunk and terminated in the caudodorsal part of the cranial cervical ganglion (Figures 3 and 4).

The main branches of the cranial cervical ganglion comprised the internal carotid nerve and jugular nerve at the cranial half of the ganglion, the external carotid nerve at the caudal half of the ganglion (Figure 3).

The external carotid nerve emerged from the caudal half of the cranial cervical ganglion. It ran caudoventrally to the origin of the external carotid artery and reached its medial wall, where it formed the external carotid plexus (Figure 3).

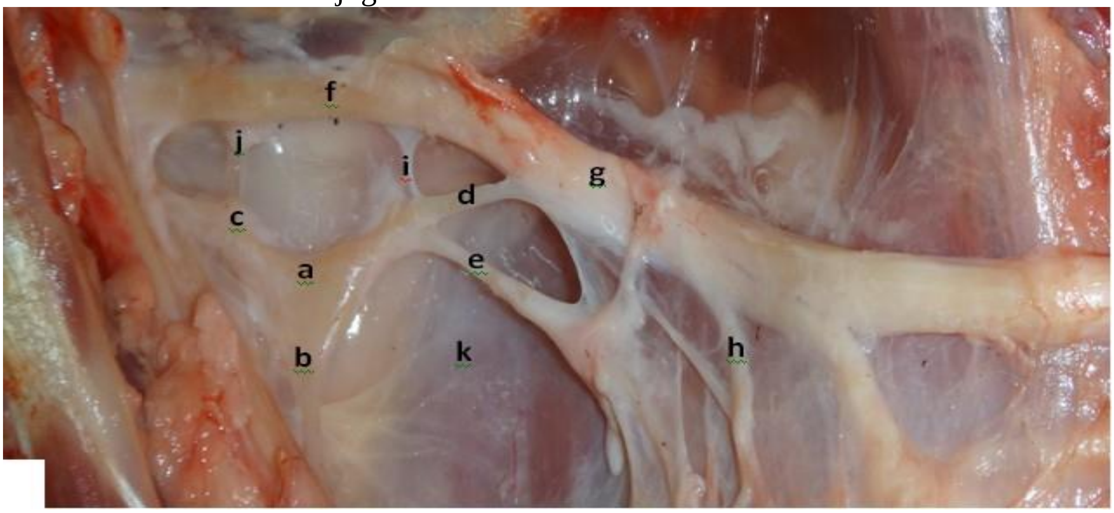

Figure 3: Medial view of cranial cervical ganglion in dromedary camel (a), internal carotid nerve (b), jugular nerve (c), sympathetic trunk (d), external carotid nerve (e), vagus nerve (f), vagosympathetic trunk (g), cranial laryngeal nerve of vagus nerve (h), communicating branch between the cranial cervical ganglion and the ventral branch of the first cervical nerve (i), Communicating branches to the vagus nerve (j) and longus captis muscle (k).

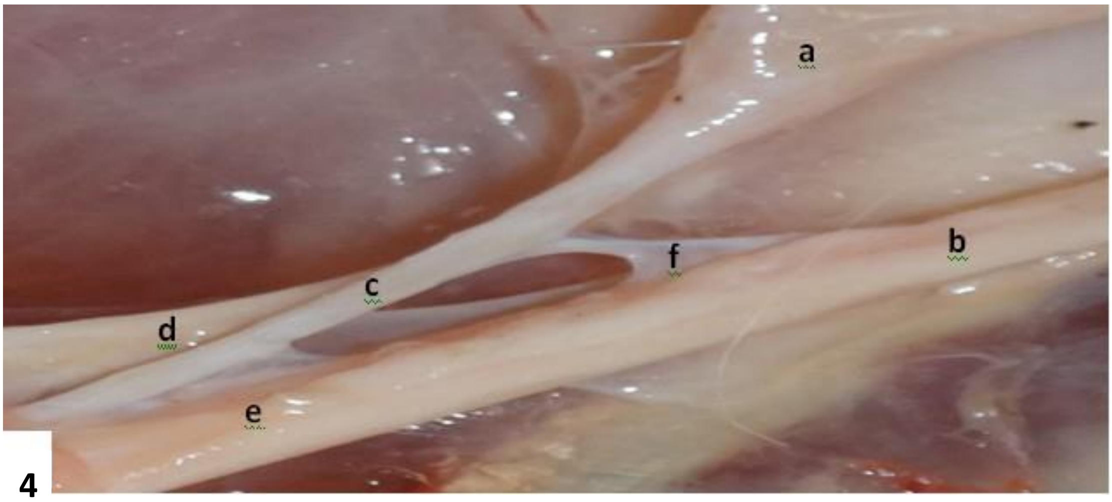

Figure 4: Medial view of the caudal half of the cranial cervical ganglion in dromedary camel (a), vagus nerve (b). sympathetic trunk (c), external carotid nerve (d), vagosympathetic trunk (e), the communicating branch between the cranial cervical ganglion and the ventral branch of the first cervical nerve (f).

The internal carotid nerve was subdivided into five branches which emerged from the rostrodorsal end of the cranial cervical ganglion. The branches were surrounded by a sheath and ran rostrally parallel to each other along the surface of the longus captis muscle, whereas the jugular nerve originated as a single branch from the dorsal border of the cranial half of the ganglion and near the jugular foramen it divided into two branches (Figure 5).

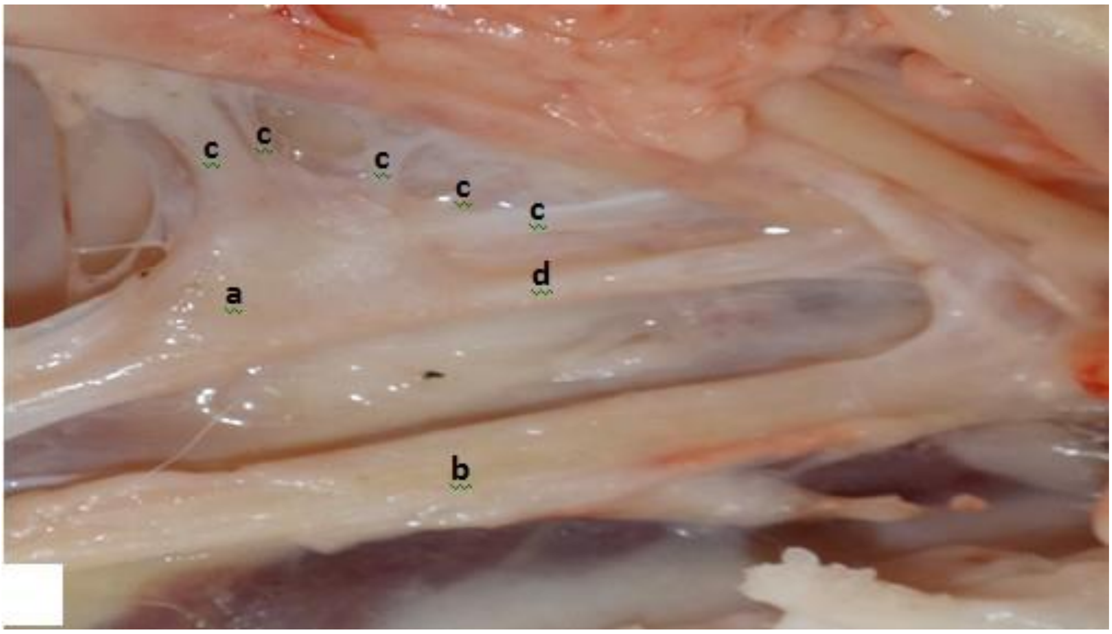

Figure 5: Medial view of the cranial half of the cranial cervical ganglion in dromedary camel (**a)**, vagus nerve (**b**), internal carotid nerve (**c**) and jugular nerve (**d**).

The cranial cervical ganglion gave two communicating branches from the caudodorsal border of the ganglion. The first communicating branch to the vagus nerve and the second communicating branch connected the cranial cervical ganglion to the ventral branch of the first cervical nerve (Figure 6).

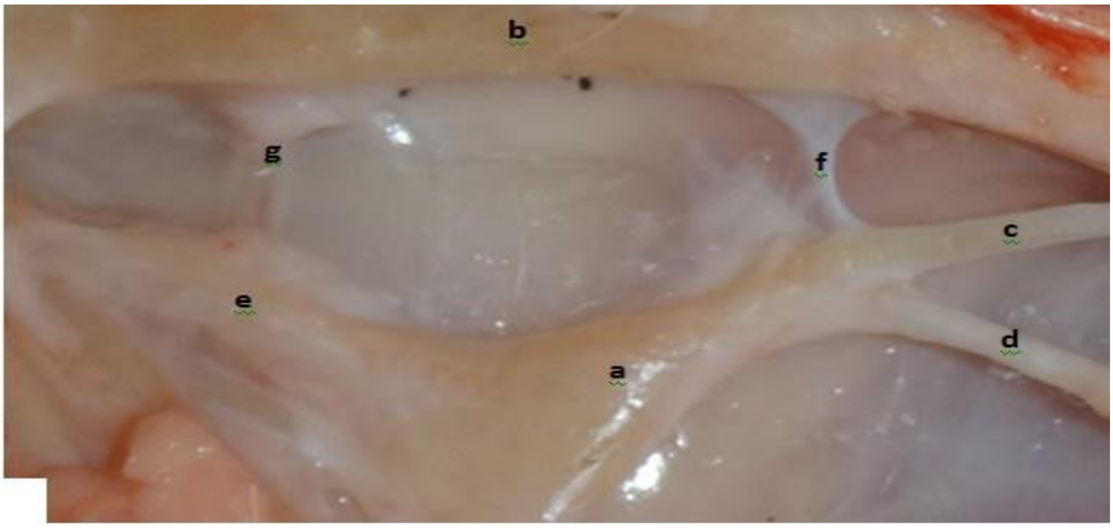

Figure 6: View of caudodorsal border the cranial cervical ganglion in dromedary camel (a), vagus nerve (b), sympathetic trunk (c), external carotid nerve (d), jugular nerve (e), communicating branch between the cranial cervical ganglion and the ventral branch of the first cervical nerve (f), communicating branches to the vagus nerve (g).

DISCUSSION:

In the present study, the cranial cervical ganglion was located ventral to the caudal stylopharyngeal muscle and covered by the mandibular gland. It was lodged between the common carotid artery and the internal carotid artery rostrolateral to the longus capitis muscle. It was related laterally to the vagus nerve and medially to the retropharyngeal lymph node. This position was similar to that observed by Cui-Sheng *et al***.** (1998) in the Bactrian camels and Nourinezhad *et al***.** (2015) in the dromedary camels. However, in the yak the cranial cervical ganglion was covered by stylohyoid muscle (Shao *et al.*, 2007).

The cranial cervical ganglion is either greyish in color (Shao et al., 2007), reddish in color (Ozgel *et al*., 2004; Najafi *et al.*, 2011) or white in colour (Fioretto *et al.*, 2007 and Ari *et al.*, 2010). The present study confirmed the findings of Fioretto *et al.* (2007) and Ari *et al.* **(**2010) that the cranial cervical ganglion was white in color.

The shape of the cranial cervical ganglion was either oval (Getty, 1975; Cui-Sheng *et al.*, 1998; Cakir, 2001; Ozgel *et al.*, 2004; Kabak *et al.*, 2005; Kabak, 2007; Kabak and Onuk, 2010), spindle-shaped (Fioretto *et al.*, 2007; Nourinezhad *et al***.**, 2016), fusiform (Fioretto *et al.*, 2003; shao *et al***.**, 2007; Najafi *et al.*, 2011), rectangular in shape (Ari *et al***.**, 2010), or triangular in shape (Najafi and Nejati, 2009). The present study agreed with the observation of the Najafi and Nejati (2009) that the cranial cervical ganglion was triangular in shape.

According to this study, the average length, width and thickness (Mean ± SE) of the right cranial cervical ganglion of the dromedary were 16.33± 1.41 mm, 7.0± 1.03 mm and 3.03± 0.54 mm, respectively, whereas the left cranial cervical ganglion had an average length, width and thickness (Mean ± SE) of 16.65± 1.21 mm, 7.21±0.82 mm and 3.21± 0.37 respectively, a value which was similar to that reported by Nourinezhad *et al.* (2015) which was14–18 mm in length and 6–8 mm in width in dromedary camel. Cui-Sheng *et al.* (1998) reported that there were no obvious differences in the measurements and topography of cranial cervical ganglion between left and right sides from animal within the same species.

However, Kabak (2007) stated that there was a positive correlation between body size and the length and width of the cranial cervical ganglion among different species of animals. Fioretto *et al.*, (2007) stated that the differences in relative CCG length, width, and thickness of different species of animals were correlated with body size and animal age.

The current study agreed with (Cui-Sheng *et al.* 1998**;** Ozgel *et al.*, 2004; Najafi and Nejati, 2009; Kabak and Onuk, 2010) who stated that the cranial cervical ganglion gave off three main branches. These were the external and internal carotid nerves and the jugular.

There were variations in the number of the branches of the internal carotid nerve in the different species of animals, one or two branches in the dromedary camel (Nourinezhad *et al.*, 2015), five branches in the bactrian camel (Cui-Sheng *et al.*, 1998) and five branches were currently observed in the dromedary camel. However, the branches of the internal carotid nerve in ox (Nourinezhad *et al.*, 2016) consists of seven to eight branches. In the sheep (Najafi and Nejati, 2009), Angora goats (Ari *et al.*, 2010), domestic pig (Kabak et al., 2005) and roe deer (Kabak and Onuk, 2010) the internal carotid nerve emerged as three branches from the cranial cervical ganglion.

The external carotid nerve composed of one branch which originated from the caudal end of the cranial cervical ganglion and formed the carotid plexus on the carotid artery (Ari *et al.*, 2010; Najafi *et al.*, 2011 and Nourinezhad *et al.*, 2015). Similar observations of the external carotid nerve were noted in this study.

Cui-Sheng *et al.* (1998) reported a communicating branch arising from the rostroventral margin of the cranial cervical ganglion and connected the ganglion with the glossopharyngeal nerve. In this study, this branch was not observed.

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