Macroanatomy of the cranial cervical ganglion in Angora goats

H.H. Ari, Z. Soyguder, S. Cinaroglu

Veterinary Faculty, University of Yuzuncu Yil, Van, Turkey

ABSTRACT: The cranial cervical ganglia (CCG) in the heads of six adult (three male and three female) Angora goats were dissected in detail. The ganglion was located on the ventral aspect of the tympanic bulla, cranioventral to the atlas, medio-ventral to the jugular process and lateral to the longus capitis muscle. The branches of the ganglion were the internal and external carotid nerves, the jugular and laryngopharyngeal nerves and the connecting branches to the vagus and glossopharyngeal nerve. The internal carotid nerve arose as three branches (cranial, caudal and medial) from the cranial region of the ganglion. The cranial branch, the profound petrosal nerve, entered the pterygoid canal. The caudal branch terminated at the trigeminal ganglion. The medial branch terminated at the cavernous sinus. The other cranial branch ramifying from the cranial region of the ganglion was the jugular nerve. The internal carotid and laryngopharyngeal nerves arose from the caudal region of the ganglion. In conclusion, compared with published data on other species, we found differences in the number and courses of the branches ramifying from the CCG of Angora goats and in the branches connected to the vagus, glossopharyngeal and hypoglossal nerves.

Keywords: anatomy; cranial cervical ganglion (CCG); Angora goat

Anatomical studies have demonstrated that the sympathetic innervations of the head and neck are effected by the neurons that ramify from the cranial cervical ganglion (CCG). The CCG is the end of the sympathetic cervical trunk, which runs with the vagal nerve during its cervical course. The sympathetic cervical trunk contains the preganglionic neurons that convey messages to the cell bodies of the postganglionic neurons in the CCG, which provide the sympathetic input to the head (De Lahunta, 1997; Cui-Seng et al., 1998; Cakir, 2001). The postganglionic axons of the CCG form the internal and external carotid and jugular nerves (De Lahunta, 1997; Cui-Seng et al., 1998; Dursun, 2000; Kabak et al., 2005; Kabak, 2007). The fibres 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 CCG provides branches to the thyroid gland, the pharynx, the larynx (De Lahunta, 1997; Cui-Seng et al., 1998; Cakir, 2001; Kabak, 2007), the common carotid artery (Cui-Seng et al., 1998; Kabak, 2007), the cranial thyroid artery (Cui-Seng et al., 1998), the ascending pharyngeal artery (De Lahunta, 1997) and the linguofacial trunk (Kabak, 2007). The CCG also sends branches to the spinal cervical nerves from the first to the fourth cervical nerves (De Lahunta, 1997; Cui-Seng et al., 1998), the glossopharyngeal nerve (Karasek et al., 2002), the vagal nerve (Cui-Seng et al., 1998; Kabak, 2007), the hypoglossal nerve (Cui-Seng et al., 1998; Kabak, 2007) and the accessory nerve (Cui-Seng et al., 1998). Anatomical studies on the location, dimensions and ramification of the ganglion and its relationship with the regional arteries and nerves (De Lahunta, 1997; Cui-Seng et al., 1998; Dursun, 2000; Cakir, 2001; Kabak et al., 2005; Kabak, 2007) and the development (Maurel et al., 2002; Fioretto et al., 2007) and neurophysiology (De Lahunta, 1997) of the ganglion have been carried out in different species. These studies have established that the anatomy of the ganglion differs from species to species. In the present study we investigated the macroanatomy of the CCG in Angora goats to provide a morphological basis for further research in comparative neuroanatomy.

MATERIAL AND METHODS

The study was performed on six adult Angora goats of both sexes (three male and three female) weighing 25–30 kg. The animals were being used as teaching materials in the Department of Anatomy of the Veterinary Faculty, University of Yuzucu Yil, Turkey. General anaesthesia was induced by intramuscular injection of xylazine (Rompun®, Mefar Ilac San, IST, 0.5 mg/kg body weight) and ketamin (Ketasol®, Richter Pharma Ag, Austria, 10 mg/kg body weight). After obtaining deep anaesthesia, the blood was drained through the external jugular vein and the animals were perfused with 10% paraformaldehyde for fixation. The CCG ganglion was dissected in each side of the heads, i.e., twelve ganglia were studied. The dimensions of the ganglia were measured by a calliper compass (The Rudolf®, Fridingen, Germany). The nerves of the ganglion and their relationship with the regional nerves or vessels were dissected under a dissection microscope (Euromex®, Holland) and photographed by a Canon 50D digital camera. The nomenclature introduced by ICVGAN (1994) was used in this study.

RESULTS

The cranial cervical ganglion (Figure 1-1) in the Angora goats was located ventrally to the tympanic bulla, cranioventrally to the atlas, ventromedially to the jugular process of the occipital bone and laterally to the longus capitis muscle. It was laterally adjacent to the vagal and hypoglossal nerves and the condylar artery, and medially adjacent to the glossopharyngeal nerve. The ganglion received the sympathetic trunk from the vagosympathetic trunk on the ventral aspect of the atlas (Figure 1-2, 7). The ganglion slightly resembled a rectangle in shape and was white in colour. The jugular and internal carotid nerves emerged from the cranial half of the ganglion (Figure 1-5, 6). The external carotid and laryngopharyngeal nerves (Figure 1-8, 9) emerged from the caudal half of the ganglion. Data on animal size and CCG dimensions (length, width and thickness) and the names of branches that originated from the CCG and their terminal places are given in Table 1.

In all cases, the jugular nerve emerged from the cranial half of the ganglion. After its origin, the jugular nerve coursed craniodorsally on the lateral aspect of the longus capitis muscle, reached the glossopharyngeal nerve (Figure 1-3) and gave off a branch to it. It then ran through to the jugular foramen, where it gave off a branch to the vagal nerves (Figure 1-2).

In all six animals studied, the internal carotid nerve (Figure 1-5) emerged as three branches (cranial, caudal and medial) from the cranial half of the ganglion. The branches were surrounded with a sheath and ran craniodorsally to the petrotympanic fissure. In all cases, the cranial branch (Figure 1-5^{I}) diverged cranially in front of the petrotympanic

Table 1. Measurements of the cranial cervical ganglion (CCG) of the Angora goat and nerve branches originated from the CCG

Dimensions of the CCG								Nerve branches originated from CCG				
Cadavers		lenght (mm)		width (mm)		thickness (mm)		regions of the CCG	nerve branches ramified from CCG	number of		termination
(*n*)	(kg)	reight	left	reight	left	reight	left			case	branch	
1	20	10	10	3	3	2.1	2	cranial half of the CCG	jugular N	12	1	VN-HN
2	22	11	14	4	4	3	3.2		internal carotid N	12	3 CrB	PC
3	19	9	9	3	3	2.2	2				CaB	TG
4	17	8	8	2	2	3	2.1				MB	CS
5	19	8	10	3	2.2	2.8	2.5	caudal half of the CCG	external carotid N	12	1	ECP
6	21	11	13	4	2.8	2.2	2.8		laryngoph aryngeal N	12	1	Pha-La-TGl
Average (mm)	19.6	9.05	10.6	3.16	2.83	2.55	2.43					

VN = vagus nerve, HN = hypogossal nerve, CrB = cranial branch, CaB = caudal branch, MD = medial branch, PC = pterygoid canal, TG = trigeminal ganglion, CS = cavernous sinus, ECP = external carotid plexus, TGl = throid gland, Pha = pharynx, La, Larynx

Figure 1. Lateral view of the cranial cervical ganglion of an Angora goat: (1) cranial cervical ganglion, (2) vagal nerve, (3) glossopharyngeal nerve, (4) hypoglossal nerve, (5) internal carotid nerve, (5^{I}) internal carotid nerve cranial branch, (5^{II}) internal carotid nerve medial branch, (5^{III}) internal carotid nerve caudal branch, (6) jugular nerve, (7) vagosympathetic trunk, (8) laryngopharyngeal nerve, (9) external carotid nerve, (10) cranial laryngeal nerve. (A) occipital condyle, (B) atlas, (C) axis, (D) external carotid artery, (E) M. longus capitis, (TG) trigeminal ganglion, (RPLnn) retropharyngeal lymph nodules

fissure. After diverging, the branch ran cranioventrally and reached the pterygoid canal. The caudal branch (Figure 1-5^{III}) gave off a ramification to the vagal nerve (in two cases) and entered the cranial cavity via the petrotympanic fissure. It then ran in the cranial cavity and reached the lateral side of the trigeminal ganglion. The medial branch (Figure 1-5^{II}), which was the thickest branch, made a cranial divergence at the level of the petrotympanic fissure into the cranial cavity, in which it ran cranially and ended in the cavernous sinus.

The external carotid nerve (Figure 1-9) emerged from the caudal half of the CCG in all cases. After its origin, it coursed caudoventrally to the origin of the external carotid artery and reached its medial wall, where it formed the external carotid plexus.

The laryngopharyngeal nerves (Figure 1-8) originated from the caudal half of the CCG. The nerve ran along the sympathetic trunk (Figure 1-7), then separated from it and gave off branches to the pharynx, larynx and thyroid gland. The laryngopharyngeal nerves also gave off a branch to the cranial laryngeal nerve (Figure 1-10). The cranial laryngeal nerve ramified from the vagal nerve and emerged between the oesophagus and larynx, where it ramified to cranial, caudal and two medial branches. The cranial branch ran craniodorsally and reached the dorsal aspect of the pharynx. The caudal branch ran caudoventrally on the dorsal aspect of the larynx and divided into dorsal and ventral branches on the border of the cricoarytenoid muscle. The dorsal branch ended on the ventral aspect of the oesophagus. The ventral branch ran caudoventrally and ended on the thyroid gland. One of the medial branches ran ventrocranially from its origin and ended on the ventral border of the cricoarytenoid muscle. The other medical branch ran ventrolaterally and ended on the cricothyroid muscle.

DISCUSSION

Anatomical studies have indicated that sympathetic innervations of the head and neck are effected by the postganglionic neurons of the CCG. From a clinical point of view, studies have also demonstrated that infection of the ganglion affects the reproductive system by causing a reduction in melatonin secretion from the pineal gland (Maurel et al., 2002) and damaging the sympathetic fibres of the CCG. The latter causes some neuropathies which can be clearly seen in Horner's syndrome (Collins, 1991; Boydell, 1995; Melian, 1996; Lembo et al., 2001; Panciera et al., 2002). From a surgical point of view, it can be useful to know the macroanatomy and dimensions of the CCG, its exact location and the course of its branches. Therefore morphologists are working to produce more descriptive and comparative data on the CCG in different species.

The ganglia were rectangular in shape in the Angora goats studied here. This has not been observed in other species (Turkmenoglu and Dursun, 2003; Ozgel et al., 2004; Kabak et al., 2005). The location of the ganglion in Angora goats is reported to be similar to that in sheep (Turkmenoglu and Dursun, 2003), donkeys (Ozgel et al., 2004), pigs (Kabak et al., 2005), guinea pigs (Kabak, 2007), camels (Cui-Seng et al., 1998) and rabbits (Cakir, 2001). The morphometrical dimensions of the CCG in the Angora goats studied here correlated with body size and CCG size (see Table 1).

In the present study, it was observed that the cranial cervical ganglion gave off four main branches. These were the external and internal carotid nerves and the jugular and laryngopharyngeal nerves. The ganglion also had communication branches with the vagal and glossopharyngeal nerves. Except for the jugular nerve, similar findings have been reported for rabbits (Cakir, 2001), guinea pigs (Kabak, 2007), pigs (Kabak et al., 2005), camels (Cui-Seng et al., 1998) and donkeys (Ozgel et al., 2004). However, there was a numerical difference in the branching of the CCG between the Angora goats and those other species. For example, no data have been reported for the laryngopharyngeal nerve, which originated from the caudal region of the ganglion in the Angora goats.

It has been reported that the jugular nerve courses towards the jugular foramen after its origin and gives off a branch to the vagal nerve (Cui-Seng et al., 1998; Cakir, 2001; Turkmenoglu and Dursun, 2003; Ozgel et al., 2004; Kabak et al., 2005; Kabak, 2007). A similar finding was made in the present study. However, the studies cited also report that a branch arises from the jugular nerve and communicates with the glossopharyngeal nerve, but this branch was not found in the Angora goats.

Kabak et al. (2005) reported that the internal carotid nerve emerges as three branches from the CCG in the domestic pig. Similar ramification of the internal carotid nerve was found here for the Angora goats, where the course of the branches of the internal carotid nerve between the ganglion and tympanic fissure was similar to that of camels (Cui-Seng et al., 1998), pigs (Kabak et al., 2005), carnivores (Getty, 1975) and donkeys (Ozgel et al., 2004).

In the present study, the cranial branch of the internal carotid nerve was found to be the profound petrous nerve. This branch coursed via the occipitotympanic and petrotympanic fissures and ended in the petrotympanic canal, as previously described in the literature (De Lahunta, 1997). The medial branch of the internal carotid nerve ended in the cavernous sinus in the Angora goats. It has been reported that the nerve ending in the cavernous sinus is the internal carotid nerve itself in donkeys (Ozgel et al., 2004) and in pigs (Kabak et al., 2005), but a branch of the internal carotid nerve in camels (Cui-Seng et al., 1998). In the Angora goats, the caudal branch of the internal carotid nerve terminated in the trigeminal ganglion. This branch has been called the internal carotid nerve in dogs and cats (Getty, 1975)

The external carotid nerve originated from the CCG in the Angora goats and formed the carotid plexus on the carotid artery. This supports findings in the literature (Cui-Seng et al., 1998; Dursun, 2000; Ozgel et al., 2004; Kabak et al., 2005; Kabak, 2007).

In conclusion, the results of the present study generally support the findings of previous neuroanatomical studies. However, the variations observed in the course of the internal carotid nerve and the presence of the laryngopharyngeal nerve that originated from the caudal half of the ganglion in Angora goats are important novel results of this study.

Acknowledgement

We thank the Veterinay Faculty of University of Yuzuncu Yıl for providing the research materials for this study.

REFERENCES

Boydell P (1995): Idiopatic Horner's syndrome in the golden retriever. Journal of Small Animal Practice 36, 381–392.

Cakir A (2001): The morphology of the cranial cervical ganglion in the New Zealand rabbit. Journal of Veterinary Medicine, Ankara University 48, 83–87.

Collins SL (1991): The cervical sympathetic nerves in surgery of the neck. Otolaryngology-Head and Neck Surgery 105, 544–555.

Cui-Seng, Wang JL, Xie ZM (1998): The gross anatomy of the cranial cervical ganglion and ıts branches the Bacterian camel (*Camelus bacterianus*). Veterinary Research Comminications 22, 1–5.

De Lahunta A (1997): Veterinary Neuroanatomy and Clinical Neurology. W.B. Saunders Company, Phidelphia, London, Toronto. 112–113.

Dursun N (2000): Veteriner Anatomi III. 1st ed. Medisan Yayinevi. Ankara. 131–134.

Fioretto ET, Navarro de Abreu R, Fernandes de Souza Castro M, Guidi WL, Ribeiro AACM (2007): Macro and microstructure of the superior cervical ganglion in dogs, cats and horses during maturation. Cells Tissues Organs 186, 129–140.

Getty R (1975): Sisson and Grosman's The Anatomy of the Domestic Animals. Vol. 2. W.B. Saunders, Phidelphia. 1151–1155.

ICVGAN (1994): Nomina Anatomica Veterinaria. 4th ed. International Committee on Veterinary Gross Anatomical Nomenclature, Zurich and Ithaca, NY. 126–127.

Kabak M (2007): The gross anatomy of the cranial cervical ganglion in the quine pig (*Cavai porcellus*). Veterinary Research Communications 31, 1–7.

Kabak M, Orhan IO, Haziroglu RM (2005): Macro anatomical investigations of the cranial cervical ganglion in domestic pigs (*Sus scrofa domesticus*). Anatomy, Histology, Embriology 34 199–202.

Karasek M, Zielinska A, Marek K, Swietoslawski J (2002): Effect of superior cervical ganglionectomy on the ultrastructure af pinealocytes in the Djungarian hamster (*Phodopus sungorus*): Quantative study. Neuroendocrinology Letters 23, 443–446.

Lembo TM, Wright KC, Cromeens DM, Price RE (2001): Iatrogenic Horner's syndrome in an experimental pig. Contemporary Topics in Laboratory Animal Science 40, 333–335.

Maurel DL, Benn Saad MM, Roch G, Siaud P (2002): Testicular activity is restored by melatonin replacement after suprachiasmatic nucleus lesion on superior cervical ganglionectomy in mink. Journal of Pineal Research 32, 15–20.

Melian C, Molares M, Espinosa de los Monteros A, Peterson ME (1996): Horner's syndrome associated with a functional thyroid carsinoma in a dog. Journal of Small Animal Practice 37, 591–593.

Ozgel O, Kurtul I, Dursun N (2004): On the gross anatomy of the cranial cervical ganglion of the donkey (*Equus asinus*) in Turkey. Veterinary Research Communications 28, 261–266.

Panciera RJ, Ritchey JW, Baker J, DiGregorio M (2002): Trigeminal and polyradiculoneuritis in a dog presenting with masticatory muscle atrophy and Horner's syndrome. Veterinary Pathology 39, 146–149.

Turkmenoglu I, Dursun N (2003): Koyunda ganglion cervicale craniale uzerine makroanatomik calismalar. Turkish Journal of Veterinary and Animal Sciences 27, 1019–1021.

Received: 2010–07–05
Accepted after corrections: 2010–08–10

Corresponding Author:

Prof. Dr. Zafer Soyguder, Yuzuncu Yil University, Faculty of Veterinary Medicine, Department of Anatomy, 65080 Van, Turkey
Tel. + 90 5358807535, Fax + 90 432 2151127, E-mail: zsoyguder@hotmail.com