

TOPOGRAPHIC ANATOMY, COURSE AND DISTRIBUTION OF VAGUS NERVE IN CAMEL (*CAMELUS DROMEDARIUS*)

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ABSTRACT

Six adult dromedary camels of either sex were used to investigate the origin, course and distribution of the vagus nerve. Its topographic position in the head, neck, thorax and abdomen were also studied by gross and subgross dissections with the naked eye and hand lens to establish their anatomical relations. The study revealed that the vagus nerve arose by several rootlets from the ventrolateral aspect of the medulla oblongata in between the glossopharyngeal nerve in front and the medullary roots of the spinal accessory nerve behind. It gained the company of the sympathetic nerve to form the vagosympathetic trunk at the level of atlantoaxial joint. The vagosympathetic trunk descended on the dorsomedial aspect of the common carotid artery in the cervical region. It gave off the pharyngeal branches, common stem for the cranial laryngeal nerve and recurrent laryngeal nerve, oesophageal branches and tracheal branches in the cervical region. At the level of the thoracic inlet, the vagus and the sympathetic nerves separated from each other. The vagus nerve in the thorax gave off cardiac branches and then continued over the base of the heart giving off small branches to the bronchi and lungs. The vagus nerve then divided into the dorsal and ventral branches. These dorsal and ventral branches of the corresponding sides joined to form the dorsal and ventral oesophageal nerve trunks, respectively. These nerve trunks traversed on the dorsal and ventral aspects of the oesophagus and pierced into the abdominal cavity through the hiatus oesophagi where they supplied the abdominal viscera.

Key words: Topographic anatomy, vagus nerve, camel

All body systems are necessary to support life but the nervous system is the most important among them as it governs and coordinates the operation of all the tissues and organs. The beating of heart, secretion from glands, breathing and the process of digestion, are all triggered, monitored and adjusted by nervous signals. The nervous system is of primary importance in another way and is the physical basis of all the mental activities and properties without which the life would be of no interest, consciousness, sensation, thought, memory, emotion, character, speech and skill. The peripheral nervous system in general comprises all the nervous tissue outside the brain and spinal cord and functions to keep other tissues of the body in communication with the central nervous system. Vagus nerve contains a number of functional components, the most important of which is the general visceral efferent division which controls the visceral organs in the body. Therefore vagus nerve plays

an important role in controlling all activities of the visceral organs in the body.

MATERIALS AND METHODS

The study was conducted on six apparently healthy adult camels of either sex. They were embalmed by injecting 10 per cent formalin solution through the common carotid artery as per Grossman's technique (1959). The origin, course and distribution of the vagus nerve were examined by careful and fine dissection. A close search was made with naked eye and a hand lens to examine the fine branches of the vagus nerve and their ramifications.

RESULTS AND DISCUSSION

The vagus nerve was the longest of the cranial nerves. It was remarkable for its wide distribution and connection with the other nerves including the sympathetic nerve. It originated with several rootlets from the ventrolateral

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aspect of the medulla oblongata which were in a series with 9th in front and 11th behind. The filaments converged to form a trunk which passed outward pierced the duramater. It emerged out of the cranial cavity along with the caudal margin of the foramen lacerum and coursed downward and backward towards the neck. The nerve at its emergence possessed an elongated flattened jugular ganglion (g. jugulare) on its lateral aspect. The vagus nerve in ox possessed a jugular ganglion and a nodosal ganglion (g. nodosum). The latter occurred at the point of origin of the anterior laryngeal nerve and might be as small as a pea (Getty, 1975) then it was crossed laterally by the hypoglossal nerve slightly below the level of ganglion. The vagus nerve in camel there after coursed for a short distance caudal to the internal carotid artery. It was related to the jugulohyoideus and stylohyoideus muscles and crossed the medial aspect of the origin of the occipital artery. At the level of the atlantoaxial joint the nerve was joined by the cervical part of the sympathetic trunk in a dense fibrous sheath forming a vagosympathetic trunk. This trunk then traversed for a short distance medial to the mandibular salivary gland to gain the dorsolateral aspect of the pharynx, there after it descended on the dorsomedial aspect of the common carotid artery up to the level of cranial margin of the seventh cervical vertebra. Here the dense fibrous sheath became loose and the sympathetic trunk separated itself from the vagus nerve. The vagus nerve during this course issued the following branches in the head and neck region:

Pharyngeal branches (Rami pharyngi)

The pharyngeal branches of the vagus nerve were 2-3 in number, a larger and 1-2 smaller branches. The larger branch arose from the ventral border of the vagus nerve about 3.5-4.0 cm caudal to its emergence from the foramen lacerum. It traversed backward and downward crossing the lateral aspect of the cervical sympathetic ganglion and medial aspect of the internal carotid artery towards the dorsal aspect of the pharynx. At this point, it divided into two unequal twigs viz. cranial and caudal twig. The cranial twig coursed towards the lateral aspect of pharynx where it contributed to the formation

of the pharyngeal plexus. The caudal branch was distributed into 9-10 smaller twigs which ramified into the muscles of the pharynx. Some of these branches also contributed to the formation of the pharyngeal plexus. However, Smuts and Bezuidenhout (1987) reported only one pharyngeal branch in camel. The small pharyngeal branch also arose from the ventral aspect of the vagus nerve about 1.0 cm caudal to the level of origin of the large branch. It coursed backward and downward and distributed in the musculature and wall of the pharynx and contributed to the formation of the pharyngeal plexus (Fig 1).

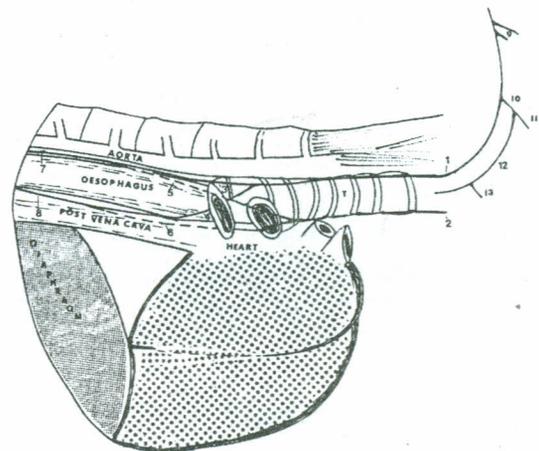


Fig 1. A composite diagram showing the course, distribution and relations of vagus nerve in camel (Left lateral view).

1, left vagus nerve; 2, right vagus nerve; 3, dorsal branch of left vagus; 4, ventral branch of left vagus; 5, dorsal branch of right vagus; 6, ventral branch of right vagus; 7, dorsal oesophageal nerve trunk; 8, ventral oesophageal nerve trunk; 9, rami pharyngi; 10, common stem for cranial laryngeal and recurrent laryngeal nerves; 11, cranial laryngeal nerve; 12, recurrent laryngeal nerve; 13, caudal laryngeal nerve.

Common stem for cranial laryngeal nerve (N. laryngeus cranialis) and recurrent laryngeal nerve (N. laryngeus recurrens)

The vagus nerve at the level of caudal end of the cervical sympathetic ganglion gave off a common stem for the cranial laryngeal nerve and the recurrent laryngeal nerve (Fig 1). Similar finding has been reported earlier in this species (Lesbre, 1903, Tayeb, 1957, El-Shaieb and El-Hadi, 1977). However, this common stem was

named as laryngo-oesophageal trunk by Lesbre (1903) and laryngo-tracheal trunk by Tayeb (1957).

The cranial laryngeal nerve after its origin traversed downward and slightly backward on the lateral wall of the pharynx. It crossed the medial surface of the common carotid artery and entered the larynx where it was ramified in the mucous membrane and musculature of the cranial part of the latter. The recurrent laryngeal nerve after its origin coursed on the lateral aspect of the pharynx and larynx in its initial course and then descended in the neck region in between the oesophagus and trachea. Similar description had been given in this species earlier (El-Shaieb and El-Hadi, 1977). The recurrent laryngeal nerve during its course in the cervical region issued the caudal laryngeal, tracheal and oesophageal branches. The nerve on entering the thoracic cavity traversed between the oesophagus and brachiocephalic trunk. It terminated at the level of aortic arch by forming a plexus along with the sympathetic fibers originating from the third, fourth and fifth thoracic sympathetic ganglia. This plexus supplied several twigs to the oesophagus, trachea, lungs and heart. Anastomosis between the left and right recurrent laryngeal nerves were also observed in the middle and caudal parts of the neck and also in the thoracic cavity. Sisson and Grossman (1953) in ox stated that the recurrent laryngeal nerve was also termed as inferior laryngeal or posterior laryngeal nerve and it arose from the vagus nerve but it differed on the two sides in its point of origin. They further said that the right nerve was given off opposite the second rib, turned around the cost-cervical artery and ran forward on the right part of ventral surface of trachea. The left nerve arose at the level of arch of aorta. It passed over the ligamentum arteriosum and ran forward on the ventral part of the left face of trachea. They further added that the recurrent laryngeal nerve innervates all the intrinsic muscles of the larynx except crico-thyroideus.

The caudal laryngeal nerve in camel arose from the recurrent laryngeal nerve at the level of the cranial margin of the thyroid gland. It entered the caudal part of the larynx and ramified in the mucous membrane and musculature of

the latter. It received communicating branches (rami communicans) from the cranial laryngeal nerve within the larynx. The recurrent laryngeal nerve also issued 3-4 tracheal branches and 3-4 oesophageal branches during its course in the cervical region which innervated the trachea and oesophagus, respectively. Similar observations have been reported in camel by El-Shaieb and El-Hadi (1977). Miller *et al.* (1964) described in dog that the recurrent laryngeal nerve arose from the vagus nerve at thoracic inlet. They further stated that the left one ran cranially on the dorsolateral aspect of trachea while the right one between the oesophagus and trachea, both nerves terminated as the caudal laryngeal nerve to all the intrinsic muscles of the larynx. The vagus nerve in camel separated from the sympathetic nerve at the thoracic inlet. The right vagus nerve entered the thoracic cavity medial to the right subclavian artery and traversed caudally and upward on the right side of trachea to reach its dorsal aspect at the bifurcation of trachea, where it divided into dorsal and ventral branches. The left vagus nerve entered the thorax ventrolateral to the left subclavian artery. It coursed backward in the lateral aspect of the aortic arch and oesophagus. At the level of left bronchus it divided into the dorsal and ventral branches (Fig 1). Both the right and left vagus nerves during their course in the thoracic cavity issued several twigs to the heart, lungs, large blood vessels, trachea, oesophagus and bronchi. The dorsal branches of both the vagus nerves united together to form a dorsal oesophageal nerve trunk on the dorsal aspect of oesophagus at the level of 8th intercostal space. Similar finding had been reported earlier in this species (El-Shaieb and El-Hadi, 1977). This union occurred at the level of 7th thoracic vertebra in cow (Habel, 1956). However, Moustafa *et al.* (1968) reported in buffalo that this union took place in the mid way between the aortic arch and diaphragm. Similarly the ventral branches of the left and right sides on the bifurcation of trachea and ventral aspect of oesophagus at the level of 6th rib united together to form the ventral oesophageal nerve trunk. Moustafa *et al.* (1968) reported in buffalo that the ventral oesophageal nerve trunk began at the level cranial to the dorsal

oesophageal nerve trunk. However, it began immediately caudal to the bifurcation of trachea in cow, sheep and kid (Habel, 1956). El-Shaieb and El-Hadi (1977) named these trunks as dorsal and ventral vagal nerve trunks. The dorsal and ventral oesophageal nerve trunks traversed on the corresponding dorsal and ventral aspects of the oesophagus and pierced the hiatus oesophagi to enter into the abdominal cavity. These trunks along with their course detached several oesophageal branches to the oesophagus and 3-4 ramus communicans to each other. The dorsal oesophageal nerve trunk coursed along the abdominal part of oesophagus up to the level of ventricular atrium where it divided into the several branches. These branches were described as the dorsal group, intermediate group and a single ventral branch.

(i) The nerves of dorsal group coursed backward along with the right dorsal aspect of rumen and they were described as following branches (Fig 2)

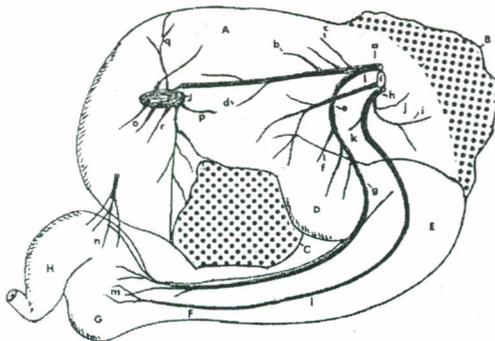


Fig 2. A composite diagram of right side of stomach showing the distribution of dorsal and ventral oesophageal nerve trunks of the vagus nerve.

A, rumen; B, craniodorsal glandular sac area of rumen; C, ventral glandular sac area of rumen; D, reticulum; E, omasum (wide part); F, omasum (tubular part); G, abomasum; H, duodenal ampulla; I, oesophagus; J, coeliacomesenteric ganglion; a, dorsal oesophageal nerve trunk; b, rami ruminales dorsales; c, rami atriales ruminales; d, rami coeliaci; e, rami gastrici viscerales; f, rami reticulares of the dorsal oesophageal nerve trunk; g, ramus omasoabomaseales viscrales; h, ventral oesophageal nerve trunk; i, rami gastrici parietals; j, rami atriales ruminales of ventral oesophageal nerve trunk; k, rami reticulare craniales of ventral oesophageal nerve trunk; l, rami omaseales; m, rami abomaseales; n, rami duodenales; o, hepatic plexus; p, gastric plexus; q, left ruminal plexus; r, ruminal plexus.

a) Dorsal ruminal branches (Rami ruminales dorsales): These branches were 2-3 in number and ramified in the right dorsal wall of rumen. A small twig coursed backward and joined the coeliaco-mesenteric ganglion (Fig 2). Nearly similar description has been given earlier in this species (El-Shaieb and El-Hadi, 1977). Moustafa *et al.* (1968) in buffalo, Foust (1929) and Sisson and Grossman (1953) in bovines and Habel (1956) in cow, sheep and kid stated that the corresponding nerves were also distributed to the dorsal wall of the rumen.

b) Ruminal atrial branches (Rami atriales ruminales): The ruminal atrial branches were 2-3 in number. They coursed backward toward the ventricular atrium after their origin and distributed there to form a plexus along with the 2-3 branches of the ventral oesophageal nerve trunk. This plexus supplied many twigs to the ventricular atrium in addition to one branch to the cranio-dorsal glandular sac and one branch to the left ventral wall of the rumen (Fig 2). The ruminal atrial branches have also been described by El-Shaieb and El-Hadi (1977).

c) Coeliac branches (Rami coeliaci): The coeliac branches were 3-4 in number. They traversed caudally along the dorsal aspect of the rumen. They issued several twigs during this course which constituted the nerve supply to the rumen and finally terminated by joining the coeliaco-mesenteric ganglion. However, one of these branches also contributed to the nerve supply to the liver.

d) Visceral gastric branches (Rami gastrici viscerales): The visceral gastric branches were generally two in number. They coursed backward and downward along with the gastric artery and ramified in the wall of craniodorsal glandular sac of rumen, reticulo-omasal junction and the wide part of omasum along with the branches from the coeliaco-mesenteric ganglion. The visceral gastric branches have also been described earlier in bovines (Foust, 1929) and in cow, sheep and kid (Habel, 1956).

(ii) The intermediate group of nerves comprised of the following branches:

a) Caudal reticular branches (Rami reticulares caudales): These branches were 3-4 in number and all these branches traversed

backward and downward on the right side of the caudal part of reticulum. They ramified in the wall of reticulum and the adjacent part of rumen including ventral glandular sac.

b) Omaso-abomasal branch (Ramus omaso-abomasalis): This branch coursed on the right side of the rumen during its initial course, it took a slight downward course and then ran along the cranial part of the lesser curvature of reticulum. At the level of reticulo-omasal junction, it curved backward and continued its course along the lesser curvature of the wide and tubular part of omasum first and then the abomasum. The omaso-abomasal nerve finally ramified into the duodenal ampulla (ampulla duodeni). The omaso-abomasal branch during its course gave off reticular branches (Rami reticulares) to the reticulum and reticulo-omasal junction, omasal branches (rami omasiales) to the wide and tubular part of omasum, abomasal branches (rami abomasiales) to the abomasum and the duodenal ampulla (Fig 2).

(iii) The ventral group comprised of a single branch which coursed at first on the right side of the rumen then along the cranial part of the lesser curvature of the reticulum, on reaching the reticulo-omasal junction it curved backward and continued along the lesser curvature of the omasum and abomasum and ends at the duodenal ampulla (ampulla duodeni). It gave reticular branches to the cranial part of the reticulum and the reticulo-omasal junction, (rami reticulare omaseales) omasal branches to omasum, (rami omaseales) and visceral abomasal branches (rami abomaseales viscerales) to the abomasum and duodenal ampulla (Fig 2).

Ventral oesophageal nerve trunk

The ventral oesophageal nerve trunk coursed backward and downward in the abdominal cavity. It issued the following branches:

i) Parietal gastric branches (Rami gastrici parietales): These branches were 2-3 in number and distributed to the cranio-dorsal glandular sac area and the left ventral aspect of rumen. Similar description has been given in this species (El-Shaieb and El-Hadi, 1977).

ii) Ruminal atrial branches (Rami atriales ruminis): These branches were also 2-3 in number and distributed into the atrium ruminis. After issuing these branches, the ventral vagal trunk passed cranioventrally on the cranio-dorsal part of the lesser curvature of the reticulum, the reticulo-omasal junction and the parietal surface of the omasum and abomasum and finally terminated into the duodenal ampulla. The ventral oesophageal nerve trunk during its course gave off several branches such as reticular branches such as (r. reticulares), omasal branches (r. omasiales), abomasal branches (r. abomasiales), duodenal branches (r. duodenales) and hepatic branches (r. hepatici) (Fig 2). These branches innervated the corresponding organs.

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