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Study of the formation and distribution of the ansa cervicalis and its clinical significance

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SUMMARY

The ansa cervicalis is a neural loop in the neck. It is formed by the union of two main nerve roots -i.e., superior and inferior- derived from the ventral rami of the cervical nerves. The aim of this study was to explore the anatomical variations of the ansa cervicalis with a view to preventing accidental injury during surgical procedures. Fifty formalin-fixed cadavers were dissected bilaterally for the ansa cervicalis, in which abnormalities were observed in three cadavers. In one cadaver, the ansa cervicalis was absent and the strap muscles of the neck received their innervations from the vagus nerve. Two cadavers displayed an ansa cervicalis formed by the superior root, which branched out from the vagus nerve instead of the hypoglossal nerve. In recent years, there has been an abundance of techniques utilizing the ansa cervicalis to reinnervate the paralyzed larynx. Because of its proximity to major nerves and vessels of the neck, a good understanding of the topography and morphology of this loop is essential. Any variation in the course, contributing roots or branching pattern of the ansa cervicalis, potentially modifies and complicates the course of procedures relating to this nerve.

Key words: Ansa cervicalis – Hypoglossal nerve – Vagus nerve – Carotid sheath – Infrahyoid muscle – Anatomical variation

INTRODUCTION

The ansa cervicalis is a loop of nerves that is a part of the cervical plexus. Normally, the ansa cervicalis is formed by a superior root arising from the ventral ramus of C_1 which joins the hypoglossal nerve. Some of the C_1 fibres leave the latter as the superior root of ansa cervicalis and part of it continues with the hypoglossal nerve. The inferior root is formed by the union of fibers from the ventral rami of C_2 and C_3. Both roots typically join in the anterior wall of the carotid sheath to form the loop of the ansa cervicalis, and distribute branches to infrahyoid muscles (Chhetri and Berke, 1997; Williams, 1995).The internal jugular vein and carotid arteries, being the contents of the carotid sheath, lie in close proximity to the ansa cervicalis (Williams, 1995).

In recent years, reinnervation of the paralyzed larynx with the ansa cervicalis is practiced quite frequently. Esophageal cancer surgery may lead to inadvertent injury to the recurrent laryngeal nerve, leading to paralysis.

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Nerve-muscle transplantation to the paraglottic space with the ansa cervicalis has recently become the method of choice after resection of the recurrent laryngeal nerve (Loukas et al., 2007). In unilateral vocal cord paralysis, an artificially created anastomosis between the ansa cervicalis and the recurrent laryngeal nerve will result in improved phonatory function of the affected vocal cord (Brondbo et al., 1992; Crumley, 1991; Green et al., 1991). Because of its proximity to the major nerves and vessels of the neck, surgeons should be aware of the ansa cervicalis and its relationships to the great vessels of the neck in order to avoid injury during surgical procedures of the neck. Any variation in the course, contributing roots or branching pattern of the ansa cervicalis, may potentially alter and complicate the course of the procedures relating to this nerve, such as neurorrhaphy, skull base surgery, neck dissection, and the anterior cervical spinal approach (Khaki et al., 2006). Recent advances in reconstructive surgery involving the use of infrahyoid muscles means that information about variations of the ansa cervicalis must be collected. The aim of this study was to explore the anatomical variations of the ansa cervicalis with a view to avoiding accidental injury to it during surgical procedures.

Materials and Methods

The study involved dissection of 50 formalin-fixed South Indian cadavers of both sexes with an age range of 40 to 60 years. During routine dissection, the necks were dissected bilaterally to trace the ansa cervicalis in all subjects. The nerve roots forming the ansa were traced. Branches coming out from the ansa cervicalis were traced up to their termination into the strap muscles. Any anomalies in the formation of the ansa cervicalis were noted and photographs were taken to record the findings.

Results

In 47 of the cadavers dissected, the ansa cervicalis was embedded on the anterior wall of the carotid sheath. It was formed by the ventral ramus of C_1 which joined the hypoglossal nerve to leave the latter as the superior root and an inferior root formed by the union of fibers from the ventral rami of C_2 and C_3. The superior belly of the omohyoid was supplied by the superior root. The other infrahyoid muscles -i.e sternothyroid, sternohyoid and inferior belly of the omohyoid- were supplied by branches from the loop of the ansa cervicalis.

Three cadavers had variants of the ansa cervicalis. In one cadaver, the contributing roots and loop of the ansa cervicalis were absent. The vagus and hypoglossal nerves were connected for a short distance after they emerged from the skull. Just superior to this union, fibers from the ventral ramus of C_1 joined the vagus nerve (Fig. 1). The ventral rami of C_2 and C_3 did not unite and hence the inferior root was not formed. The contributions from ventral rami of C_2 and C_3 joined the vagus nerve separately at different levels (Fig. 2). The infrahyoid muscles (sternothyroid, sternohyoid, superior and inferior bellies of omohyoid) received their nerve supply directly from the vagus.

In the two cadavers, the superior root of the ansa cervicalis was found to leave the vagus nerve as it descended between the internal jugular vein and the common carotid artery in

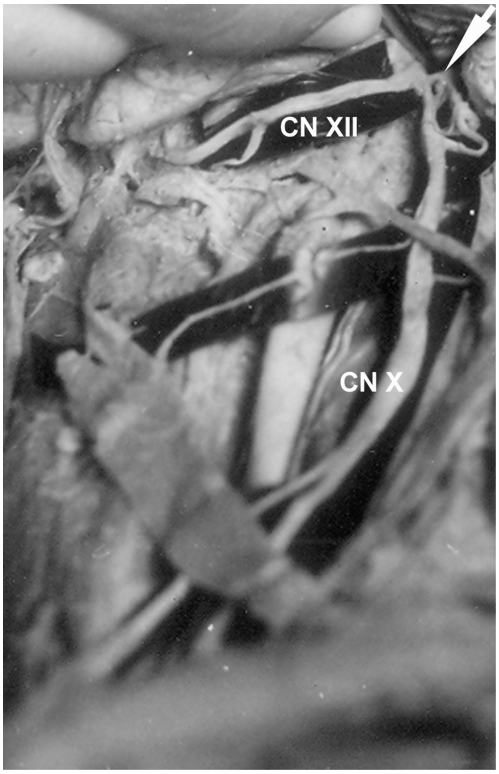

Fig. 1. The vagus (CN X) and hypoglossal nerves (CN XII) are connected for a short distance after they emerge from the skull. Just posterior to this union, fibers from the ventral ramus of C1 (arrow) join the vagus nerve. The contributions from the ventral rami of C2 and C3 join the vagus nerve separately at different levels. The infrahyoid muscles receive their nerve supply directly from the vagus (to sup-OH, to ST, SH). The loop and superior and inferior roots of the ansa cervicalis are absent.

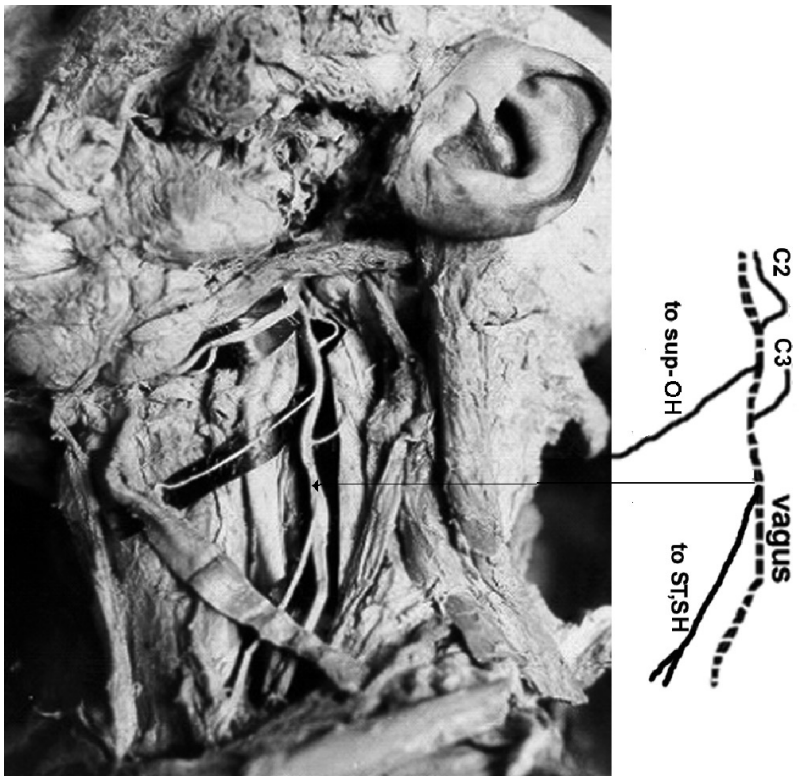

Fig. 2. The vagus (CN X) and hypoglossal nerves (CN XII) are connected for a short distance after they emerge from the skull. Just posterior to this union, fibers from the ventral ramus of C1 (arrow) join the vagus nerve.

the carotid sheath (Fig. 3). This root joined the inferior root, formed by the union of the contributions from the ventral rami of C_2 and C_3 to form the ansa cervicalis, which then innervated the infrahyoid muscles through its branches.

Discussion

Interest in the anatomy of the ansa cervicalis has been rekindled after five to six decades of apparent unconcern. Two abnormalities were mentioned in *Anatomy for Surgeons* by Hollinshead (1968) reported by Taguchi in 1888 and von Lippmann (1910). In 1968, Caliot et al. described the ansa cervicalis as a loop of nerves formed by the descending branch of hypoglossal nerve and the descending branch of the cervical plexus (Banneheka, 2008). This renewed interest may be due to the adoption of reconstructive surgical techniques involving the tongue and laryngeal musculature.

Banneheka (2008) reported that the ansa cervicalis derived from a combination of C_1-C_4 spinal segments, with C_1-C_3 being the most frequent pattern (87.5%) in 106 cadavers (Khaki et al., 2006). In the present study, the ansa cervicalis was contributed by then C_1-C_3 routes in all cases except for one variant case, in which the superior route was derived from the vagus nerve. Khaki et al. (2006) described a variant inferior root of the ansa cervicalis formed by the joining of two rootlets: one originating from the spinal accessory nerve and the other from a branch of the cervical plexus to the sternocleidomastoid muscle. The fibers traversing the branch of spinal accessory nerve were derived from the first segments of the cervical spinal cord.

Loukas et al. (2007) reported that the inferior root of the ansa cervicalis was derived from the ventral rami of C_2 and C_3 in 38%, from C_2, C_3 and C_4 in 10%, from C_3 in 40% and from C_2 in 12% of the cases (Brondbo et al., 1992). In the present study, the inferior route was derived from the C_2 and C_3 spinal segments in all cases.

An ansa cervicalis innervating the sternocleidomastoid along with the infrahyoid muscles has been observed (Koizumi et al., 1993). Meguid and Agawany (2009) reported variations of the ansa cervicalis innervating the infrahyoid muscles and a double nerve supply to the sternohyoid. In 57.1% of cases, the superior part of the sternohyoid was innervated by the nerve to the superior belly of the omohyoid muscle and its inferior part received branches from the ansa. In 35.7% of cases, its superior part received direct branches from the

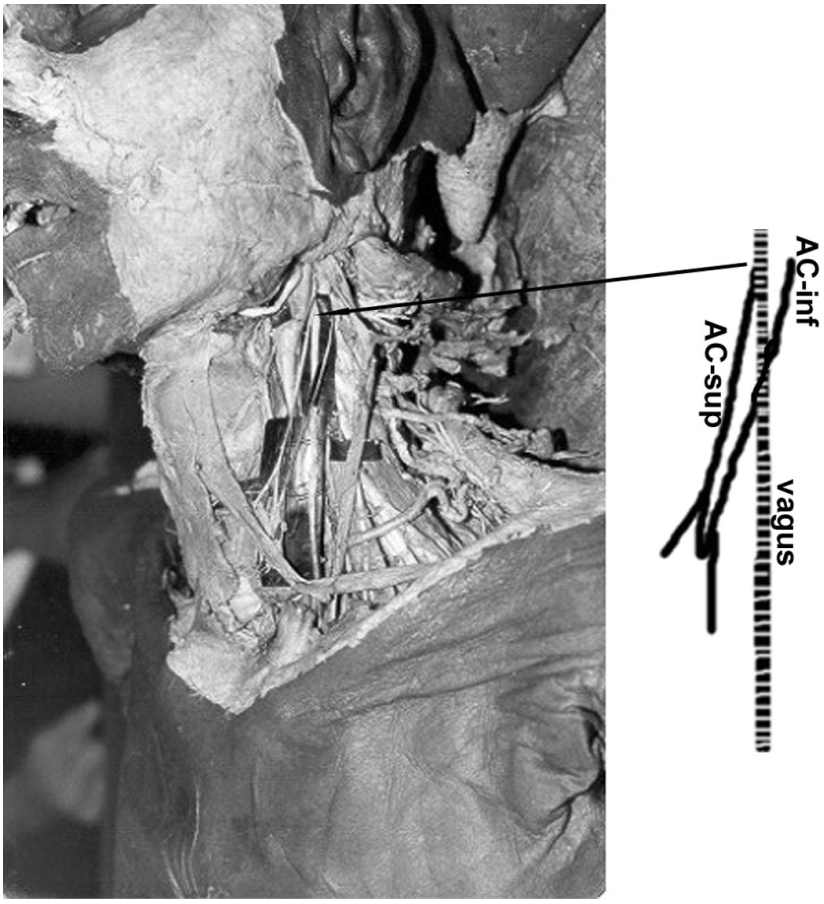

Fig. 3. The superior root (AC-sup) of the ansa cervicalis leaves the vagus nerve. This root join the inferior root (AC-inf) to form the ansa cervicalis, whose branches then innervate the infrahyoid muscles.

ansa. In 71.4% of cases, a common trunk arose from the loop and supplied the inferior parts of both the sternohyoid and sternothyroid. The nerve supply to the superior belly of the omohyoid originated from the loop of the ansa cervicalis in 64.3% of cases. In the present study, the superior belly of the omohyoid received a nerve supply from the superior route of the ansa cervicalis, whereas the inferior belly of the omohyoid and rest of the strap muscles of neck received nerves from the inferior route.

The constituent fibers of the ansa cervicalis are derived from the ventral rami of C_1, C_2 and C_3 spinal nerves. However, O'Reilly and Fitzgerald (1990) demonstrated that both the cervical spinal nerves and the hypoglossal nucleus contribute to the formation of the ansa cervicalis. The only variation observed in this study displayed C_1 fibers joining the vagus nerve (Figs. 1, 2). Two cases showed the superior root leaving the vagus nerve. Similar observations were reported by Taguchi and von Lippmann in *Anatomy for Surgeons* by Hollinshead (1968).

The absence of the ansa cervicalis and its replacement by the vagocervical complex has been reported. This complex was formed by the vagus nerve with the C_1 and C_2 components from the cervical plexus, giving off a descending branch to supply the infrahyoid muscles of the neck (Abu-Hijleh, 2005; Rath and Anand, 1994). Chhetri and Berke (1997) mentioned that the superior root of the ansa, although apparently coming out of the vagus nerve, in fact had its true origin in the cervical plexus. Similarly, in the present study in two cadavers the superior root of the ansa cervicalis was found to leave the vagus nerve (Fig. 3). In the first case, the fibers from the ventral rami of C_2 and C_3, instead of joining to form the inferior root of the ansa cervicalis, joined the vagus nerve independently at different levels (Fig. 2). During evolution, the hypoglossal nerve, which was originally a spinal nerve, became incorporated into the cranium (Kent, 1978). It communicates with the upper cervical nerves to form the hypoglossocervical plexus, which innervates the suprahyoid and infrahyoid muscles (Kikuchi, 1970; Kitamura et al., 1986). The musculature of the neck is

derived from the differentiation of the branchial arch mesenchyme and cervical somites. The hypaxial portions of these myotomes give rise to scalene, prevertebral, geniohyoid and infrahyoid muscles. Because of their somatic origin, the infrahyoid muscles are innervated by the hypoglossocervical plexus (Kikuchi, 1970; Kitamura et al., 1986). Early on embryonic development, the infrahyoid muscle mass is closely associated with the diaphragmatic muscle mass. This helps to explain the origin of the innervations of the infrahyoid muscles and diaphragm from the cervical nerves.

According to the observations made by Ranval et al. (1994), stenosis of the internal carotid artery could be due to the effects of a transverse neurofascial band between the vagus and hypoglossal nerves or a large cervical contribution to the ansa cervicalis. Thus, the present report may benefit reconstructive surgery. In addition, it would be worth studying whether during surgical procedures, the handling of the muscular branches arising from the vagus to the infrahyoid muscles, as observed in the present study, would lead to vasovagal shock.

In cases of unilateral vocal cord paralysis, anastomoses between the ansa cervicalis and the recurrent laryngeal nerve have resulted in excellent to normal function in the vocal cord affected (Brondbo et al., 1992; Crumley, 1991; Green et al., 1991). Furthermore, it has been suggested that this technique is the one of choice in younger patients or in those who use their voice professionally.

During surgically exposure of the thyroid gland, the sternohyoid and sternothyroid muscles are frequently cut, often damaging the nerve branches of the ansa cervicalis that enter the upper part of the muscles at the level of the thyroid cartilage (Chhetri and Berke, 1997). In patients with thyroid cancer, the vocal cords may be paralysed at the time of presentation, or the recurrent laryngeal nerve may need to be sacrificed because of the invasion of cancer, even if the vocal cords had functioned properly before surgery (Loukas et al., 2007). Following lymphadenectomy along the recurrent laryngeal nerve in patients with oesophageal cancer, recurrent laryngeal nerve paralysis is also commonly observed. In carotid endarterectomy, hypoglossal nerve injuries, ansa cervicalis resection and injuries to the sternocleidomastoid vessels are common complications. The intimate association of the ansa cervicalis to the common carotid artery and the internal jugular vein demand a good understanding of the clinical anatomy of the ansa cervicalis in order to avoid injury to these vessels during recurrent laryngeal nerve neurotisation procedures. Iatrogenic injuries to the ansa cervicalis have been reported in surgical procedures, such as thyroplasty, arytenoids adduction, Teflon injection and nerve-muscle pedicle implantation (Loukas et al., 2007).

Three variations out of the 50 dissections reported in this study suggest the need for studies involving larger populations from different parts of the world for a better understanding of the origin, formation, variations, and distribution of the ansa cervicalis.

References

Abu-Hijleh MF (2005). Bilateral absence of ansa cervicalis replaced by vagocervical plexus: case report and literature review. *Ann Anat*, 187: 121-125

Banneheka S (2008). Morphological study of the ansa cervicalis and the phrenic nerve. *Anat Sci Int*, 83: 31-44.

Brondbo K, Jacobsen E, Gjellan M, Refsum H (1992). Recurrent laryngeal nerve - ansa cervicalis nerve anastomoses: A treatment alternative in unilateral recurrent nerve paralysis. *Acta Otolaryngol*, 112: 353-357.

Caliot P, Dumont D, Bousquet V, Midy D (1968). A note on the anastomoses between the hypoglossal nerve and the cervical plexus. *Surg Radiol Anat*, 8: 75-79.

Chhetri DK, Berke GS (1997). Ansa cervicalis nerve: review of the topographic anatomy and morphology. *Laryngoscope*, 107: 1366-1372.

Crumley RL (1991). Update; Ansa cervicalis to recurrent laryngeal nerve anastomoses for unilateral laryngeal paralysis. *Laryngoscope*, 101: 384-388.

Green DC, Berke GS, Graves MC (1991). A functional evaluation of ansa cervicalis nerve transfer for unilateral vocal cord paralysis: Future directions for laryngeal reinnervation. *Otolaryngol - Head Neck Surg*, 104: 453-456.

Hollinshead WH (1968). *Anatomy for Surgeons*. Vol. 1, 2nd Ed. Harper and Row, Hagerstown, Maryland, pp 562-563.

Kent GC (1978). *Comparative Anatomy of the Vertebrates* (4th ed). Mosby Co., Saint Louis pp 352.

Khaki AA, Shokouhi G, Shoja MM, Farahani RM, Zarrintan S, Khaki A, Montazam H, Tanoomand A, Tubbs RS (2006). Ansa cervicalis as a variant of spinal accessory nerve plexus: a case report. *Clin Anat*, 19: 540-543.

Kikuchi T (1970). A contribution to the morphology of the ansa cervicalis and the phrenic nerve. *Acta Anat Nippon*, 45: 242-281.

Kitamura S, Nishiguchi T, Okubo J, Chen K, Sakai A (1986). An HRP study of the motoneurons supplying the rat hypobranchial muscles: central localization, peripheral axon course and soma size. *Anat Rec,* 216: 73-81.

Koizumi M, Horiguchi M, Sekiya S, Isogai S, Nakano M (1993). A case of human sternocleidomastoid muscle additionally innervated by the hypoglossal nerve. *Okajimas Folia Anat Jpn*, 69: 361-367.

Loukas M, Thorsell A, Tubbs RS, Kapos T, Louis RG Jr, Vulis M, Hage R, Jordan R (2007). The ansa cervicalis revisited. *Folia Morphol*, 66: 120-125.

Meguid EA, Agawany AE (2009). An anatomical study of the arterial and nerve supply of the infrahyoid muscles. *Folia Morphol*, 68: 233-243.

O'reilly PM, Fitzgerald MJ (1990). Fiber composition of the hypoglossal nerve in the rat. *J Anat*, 172: 227-243.

Ranval TJ, Solis MM, Barnes RW, Vitti MJ, Gagne PJ, Eidt JF, Barone GW, Harshfield DL, Schafer RF, Read RC (1994). Isolated symptomatic midcervical stenosis of the internal carotid artery. *Am J Surg*, 168: 171-174.

Rath G, Anand C (1994). Vagocervical complex replacing an absent ansa cervicalis. *Surg Radiol Anat*, 16: 441-443.

Von Lippmann R (1910). Abnormer Ursprung des Ramus descendens n. Hypoglossi aus dem N. Vagu. *Anat Anz*, 37: 1.

Williams PL (1995). *Gray's Anatomy. The Anatomical basis of Medicine and Surgery*. 38th Ed. Churchill Livingstone, London, pp 1257-1258.