Case Report

An Ansa Cervicalis with Vagohypoglossal Anastomosis, Absent Inferior Root and Unusual C1 Contribution

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Abstract

The authors present a unique and unreported variation of the ansa cervicalis, which was found during upper neck microdissection on an isolated cadaveric neck. The C1 contribution to the hypoglossal nerve was found to take its origin from the suboccipital nerve. This branch pierced the dura along with the vertebral artery to enter the intradural space and join the spinal accessory nerve. These fibers then left the spinal accessory nerve and entered the vagus nerve through an anastomosis at the level of the jugular foramen. Subsequently, they departed from the inferior vagal ganglion at the origin of its pharyngeal branch to transiently join the hypoglossal nerve before leaving it as the descendens hypoglossi. The descendens hypoglossi then fused with the vagus nerve to form a common nerve trunk approximately at the level of common carotid artery bifurcation and superior border of the thyroid cartilage. The common nerve trunk coursed anterior to the common carotid artery. The inferior root of the ansa cervicalis, which normally joins the descendens hypoglossi, was absent.

Keywords: Anatomical variation, Carotid, Cranial, Neck, Nerve

Introduction

The anatomy of the ansa cervicalis – a neural loop located in the vicinity of the common carotid artery – and its branches in the neck is of importance as the nerve is often used for laryngeal reinnervation procedures. Although the variations in the cervical spinal fiber composition and location of the ansa cervicalis are not uncommon [1,2], the origin of its roots from the lower cranial nerves has seldom been reported in the literature. The variant ansa cervicalis may or may not give off muscular branches to the infrahyoid muscles. Some authors have referred to the latter as a pseudo-ansa cervicalis [3]. Herein, we report a neural anastomosis between the descendens hypoglossi and vagus nerve, which replaced the ansa cervicalis. The method of dissection, details of anatomical observation and relevant images are presented. To the best of our knowledge, this variant is unique in the literature.

Methods

The dissection procedure was conducted in three stages under a surgical microscope (Zeiss, Germany): first, the anterolateral neck was explored to isolate the carotid sheath, external carotid artery and its branches, hypoglossal nerve, internal carotid artery, glossopharyngeal, vagus and accessory nerves and their branches and the sympathetic trunk. Next, the left mastoid process and half of the occipital bone posterior to the foramen magnum and a portion of the squamous occipital bone were removed to explore the jugular foramen posterolaterally. Loose, fatty and fascial tissues were removed in very small pieces under the microscope to preserve the neural connections at the level of or below the jugular foramen. Superficial and intermediate layers of the posterior neck muscles were removed to reach the suboccipital triangle. The posterior arch of the atlas was carefully fragmented, and the suboccipital nerve and V3 segment of the vertebral artery isolated. Subsequently, the ligamentum nuchae, spinous process of the upper three cervical vertebrae, and their intervening ligamentous elements, and part of the transverse processes were removed to explore the first to third cervical spinal nerve roots with the dorsal root ganglia. The spinal dura mater was opened in the midline. All dissections were recorded under the surgical microscope. Neural anastomoses were isolated, fixed in 10% buffered formalin and submitted for Luxol fast blue with hematoxylin-eosin staining.
Results

Travelling posterolateral and in close vicinity to an S-shaped internal carotid artery (ICA), the hypoglossal nerve turned around the inferior border of the occipital artery to pass medially while crossing the internal and external carotid arteries and the origin of the lingual artery anteriorly. Just behind the occipital artery and posterolateral to the ICA, the hypoglossal nerve gave off the descendens hypoglossi. Initially, the descendens hypoglossi traveled downward over the posterolateral surface of ICA. Next, it turned posteroomedially to cross the posterior surface of the ICA at the level of hyoid bone. At this place, the descendens hypoglossi came near but lateral to the vagus nerve. Both nerves were covered by the posterior layer of the carotid sheath, and fused together at the inferior vago hypoglossal anastomosis (Figure 1) approximately at the level of the common carotid artery (CCA) bifurcation and superior border of the thyroid cartilage. The common nerve trunk turned over the lateral border of the CCA to appear on its anterior wall. Then, it passed downward anterior to the CCA (within the carotid sheath). No branches from the vagus or descendens hypoglossi were noted at the lower necks far as examination was feasible in the studied specimen. As the specimen was isolated and its distal portion transected during preparation, it was not possible to examine the distal part of the strap muscles.

On tracing the vagus nerve upward, the nerve was found to course between the sympathetic trunk/ganglia (posteriorly) and ICA (anteriorly) on the upper neck. A few millimeters below the tip of the mastoid process, the vagus nerve gave off the superior laryngeal nerve, which passed posterior to the ICA and ECA (external carotid artery). The pharyngeal branch of the vagus originated from the lower portion of inferior vagal ganglion (below the jugular foramen) and travelled between the ICA (posteriorly) and ECA (anteriorly). The pharyngeal branch of the vagus nerve was joined by a branch from the glossopharyngeal nerve on the lateral surface of the pharynx. The hypoglossal nerve was traced upward. There was an anastomotic connection between the hypoglossal nerve and pharyngeal branch of the vagus at its origin form the inferior vagal ganglion below the jugular foramen (superior vago hypoglossal anastomosis) (Figure 2). By gently isolating the descendens hypoglossi from the hypoglossal nerve, it was noted that the descendens hypoglossi was the continuation of the neural fibers of the superior vago hypoglossal anastomosis (Figure 2). The neural fibers belonging to the descendens hypoglossi were subsequently traced upward within the vagus nerve (above the origin of its pharyngeal branch). The trunks of the accessory and vagus nerves were blended at about the level of the jugular foramen. Under the surgical microscope, the two nerves were isolated. It was noted that the vagal neural fibers belonging to the descendens hypoglossi ultimately enter the spinal accessory nerve trunk at this level. Figure 3 is a schematic representation of the course of the descendens hypoglossi described.

At the level of the jugular foramen, there was a communication between the accessory and vagus nerves (Figure 2). The accessory nerve was traced into the upper cervical spinal canal. A recurrent branch from the suboccipital nerve was found to travel underneath the vertebral nerve and pass the foramen magnum to join the accessory nerve before it entered the jugular foramen (Figure 4). The dorsal rootlet of C1 was absent. Although the spinal accessory nerve rootlets had connections with the dorsal rootlets of C2 and C3 spinal nerves, no gross communications were noted between them and the ventral rootlets.

Histological examination (Figure 5) revealed that the descendens hypoglossi had two large and several small nerve fascicles. A cluster of ganglion cells was noted inside the perineurium of the descendens nerve. The aberrant connection between the suboccipital and spinal accessory nerves contained one nerve fascicle with meningoeipithelial cells attached at one end.
Discussion

In the present specimen, it was noted that the C1 contribution to the hypoglossal nerve passed from the suboccipital nerve intradurally to join the accessory nerve. These fibers then left the spinal accessory nerve and entered the vagus nerve at the level of the jugular foramen. Subsequently, they exited the inferior vagal ganglion at the origin of its pharyngeal branch to transiently join the hypoglossal nerve before leaving the latter as the descendens hypoglossi. The descendens hypoglossi fused with the vagus nerve to form a common nerve trunk, which coursed anterior to the common carotid artery. The inferior root of the ansa cervicalis, which normally joins the descendens hypoglossi, was absent.

The communications between the lower cranial nerves and first cervical spinal nerves are often inconsistent and show high inter-individual variability [4]. Notably, among these anastomoses, the ansa cervicalis is considered in textbooks as a consistent anastomosis between the descending branch of the hypoglossal nerve and another contributory root from the cervical spinal nerves. Having said this, it is necessary to mention that several variations, albeit rare, have been reported for the origin of the roots of the ansa cervicalis [2]. The anastomosis between the lower cranial nerves and first cervical spinal nerves is sometimes referred to as the spinal accessory nerve plexus [4]. The anatomy of this plexus still needs to be fully explored. Several studies have attempted to explore the communications between these individual nerves.

Pertinent to the present discussion, it would be useful to overview the pattern and variability of communications between the hypoglossal nerve and nearby nerves in the upper neck. Saraswathi reported anastomoses between the vagus and hypoglossal nerves at the level of the skull base [5]. The most common patterns were a vagal-to-hypoglossal limb from below the superior vagal ganglion or a conjoined inferior vagal ganglion-proximal hypoglossal nerve [5]. The presence of dense connective tissue within and below the jugular foramen often necessitates microdissection in order to distinguish the tiny neural connections from the fibrous tissue strands. Banneheka et al. claimed that most of the connections between the proximal hypoglossal and vagus nerves are pseudo-anastomosis as “no fiber exchange takes place at these regions” [6]. Such a remark is relevant; based on our experience, the dense connective tissue, as reported by Banneheka et al. [6], represents a challenge for the dissection of nerves in the upper neck. Thus, pseudo-anastomosis should be distinguished from a true anastomosis on the grounds of histological examination. In our specimen, the smallest anastomosis was the aberrant connection between the suboccipital and spinal accessory nerves; on histological examination this contained one nerve fascicle. The descendens hypoglossi nerve contained two nerve fascicles. Grossly, the latter was a branch of the vagus, which joined the hypoglossal nerve below the jugular foramen. The connections between the C1 and accessory nerves and the accessory and vagus nerves might have transmitted the nerve fibers from the upper cervical spinal cord segments to the descendens hypoglossi. No other direct or indirect connections between the cervical spinal cord and hypoglossal nerve were present in the examined specimen.

Several connections have been described between the hypoglossal nerve and other cranial and cervical spinal nerves. Jackson mentioned communications between the hypoglossal nerve and superior cervical sympathetic ganglion, inferior vagal ganglion, the loop between the first and second cervical nerves and lingual nerve [7]. Gray described connections between the hypoglossal nerve and pharyngeal plexus [8]. Bergman et al. described anastomosis between the hypoglossal and glossopharyngeal nerves below the hypoglossal foramen [9]. In Chimpanzee, Saberton noted that fibers from the C1 nerve joined the hypoglossal nerve through a communication between the latter and first loop of the cervical plexus [10]. He also noted...
connections between the vagus and descendens hypoglossi passing between the internal jugular vein and common carotid artery. The vagus nerve and its branches have also been reported to have extensive and variable communications with nearby nerves [9]. Although the C1 ventral root to the spinal accessory nerve connection (Mackenzie’s nerve) has been reported in 2.5% of neck sides [11], as far as we are aware, a connection between the suboccipital and accessory nerves as noted in the present specimen has not been described previously.

Several variants of the ansa cervicalis have been reported. Cunningham mentioned cases where the two roots remained separate throughout their course [12]. The origin of the superior root from the vagus nerve alone [9,13,14], both the vagus and hypoglossal nerves [15] or superior cervical sympathetic ganglion [3], and origination of the inferior root from the spinal accessory nerve [1] have been described. Ayyoubian and Koruji reported a variant of the ansa cervicalis in which the C1 contributory root passed from the suboccipital nerve to the accessory nerve to the hypoglossal nerve. The descendens hypoglossi originated from the latter, and then joined the vagus nerve again as the inferior root of ansa cervicalis was absent. The variations in the morphology and origin of ansa cervicalis are of clinical significance as this neural loop is used for laryngeal reinnervation procedures.

**Conclusion**

An unreported variant of the ansa cervicalis is presented in this paper. In this variant, the C1 contributory root passed from the suboccipital nerve to the accessory nerve to the hypoglossal nerve. The descendens hypoglossi originated from the latter, and then joined the vagus nerve again as the inferior root of ansa cervicalis was absent. The variations in the morphology and origin of ansa cervicalis are of clinical significance as this neural loop is used for laryngeal reinnervation procedures.

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