Vagus nerve

see Vagus nerve section.

see Vagus nerve stimulation.

Function

The vagus nerve, historically cited as the pneumogastric nerve, is the tenth cranial nerve or CN X, and interfaces with parasympathetic control of the heart and digestive tract.

The vagus nerve is a major component of the autonomic nervous system, has an important role in the regulation of metabolic homeostasis, and plays a key role in the neuroendocrine-immune axis to maintain homeostasis through its afferent and efferent pathways.

Structure

Upon leaving the medulla oblongata between the olive and the inferior cerebellar peduncle, the vagus nerve extends through the jugular foramen, then passes into the carotid sheath between the internal carotid artery and the internal jugular vein down to the neck, chest, and abdomen, where it contributes to the innervation of the viscera, reaching all the way to the colon. Besides giving some output to various organs, the vagus nerve comprises between 80% and 90% of afferent nerves mostly conveying sensory information about the state of the body's organs to the central nervous system.

The right and left vagus nerves descend from the cranial vault through the jugular foramina, penetrating the carotid sheath between the internal and external carotid arteries, then passing posterolateral to the common carotid artery. The cell bodies of visceral afferent fibers of the vagus nerve are located bilaterally in the inferior ganglion of the vagus nerve (nodose ganglia).

The right vagus nerve gives rise to the right recurrent laryngeal nerve, which hooks around the right subclavian artery and ascends into the neck between the trachea and esophagus. The right vagus then crosses anterior to the right subclavian artery, runs posterior to the superior vena cava, descends posterior to the right main bronchus, and contributes to cardiac, pulmonary, and esophageal plexuses. It forms the posterior vagal trunk at the lower part of the esophagus and enters the diaphragm through the esophageal hiatus.

The left vagus nerve enters the thorax between left common carotid artery and left subclavian artery and descends on the aortic arch. It gives rise to the left recurrent laryngeal nerve, which hooks around the aortic arch to the left of the ligamentum arteriosum and ascends between the trachea and esophagus. The left vagus further gives off thoracic cardiac branches, breaks up into the pulmonary plexus, continues into the esophageal plexus, and enters the abdomen as the anterior vagal trunk in the esophageal hiatus of the diaphragm.

The sternocleidomastoid muscle has been removed to expose the external and internal carotid artery. The omohyoid muscle defines the inferior border of the carotid triangle.

After the carotid artery bifurcation, the internal carotid artery travels without branches to the skull base, where it enters the carotid canal of the petrous temporal bone. The internal carotid nerve is associated with several cranial nerves: the glossopharyngeal nerve and hypoglossal nerves cross the artery while the vagus nerve continues to follow it. A branch of the glossopharyngeal nerve supplies the carotid sinus.

The vagus nerves are paired, however, they are normally referred to in the singular.

Brain tumors, traumatic head injury, and other intracranial processes including infections can cause increased intracranial pressure and lead to overstimulation of the vagus nerve. As a result, increased secretion of gastric acid may occur which leads to gastro-duodenal ulcer formation known as Cushing's ulcer.

A review of the original records of Dr. Harvey Cushing's patients suffering from gastro-duodenal ulcers

was performed followed by a discussion of the available literature. We also reviewed the clinical records of the patients never reported by Cushing to gain his perspective in describing this phenomenon. Dr. Cushing was intrigued to investigate gastro-duodenal ulcers as he lost patients to acute gastrointestinal perforations following successful brain tumor operations. It is indeed ironic that Harvey Cushing developed a gastro-duodenal ulcer in his later years with failing health.

Clinically shown by Cushing's Yale Registry, a tumor or lesion can disrupt this circuitry, leading to gastroduodenal ulceration. Cushing said that it was “reasonable to believe that the perforations following posterior fossa cerebellar operations were produced in like fashion by an irritative disturbance either of fiber tracts or vagal centers in the brain stem.”

Harvey Cushing's pioneering work depicted in his Yale registry serves as a milestone for continuing research that can further discern this pathway [1].

The 10th cranial nerve (CN X) is at risk during surgery in the lower cerebellopontine angle (CPA).

To evaluate endotracheal surface electrodes for assessment of CN X motor function during CPA surgery.

Twenty patients were enrolled. Electrophysiological recordings were analyzed and retrospectively correlated with clinical, imaging, and intraoperative data.

Recordings from endotracheal surface electrodes were reliable and eligible for analyses in 17 patients; in 3 patients, no surface electrode compound motor action potentials (CMAPs) could be obtained. Those patients with sufficient recordings underwent surgery in the CPA for tumors in 14 patients and for nontumor pathologies in 3 patients. In 12 patients, bipolar stimulation of motor rootlets in the CPA resulted in simultaneous CMAPs recorded from both surface electrodes and needle electrodes placed in the soft palate. Coactivation was particularly seen in patients with an intricate relationship between lower cranial nerves and tumor formations (n = 9/10). Amplitudes and latencies of vocal cord CMAPs showed high interindividual but low intraindividual variability. Parameters were not well correlated with the type of surgery (tumor vs nontumor surgery) and lower CN anatomy (displaced vs undisplaced). In 2 patients, vocal cord CMAPs were lost during tumor surgery, which was associated with postoperative dysphagia and hoarseness in 1 patient.

Endotracheal surface electrodes allow identification of vocal cord motor rootlets in the CPA. Worsening of CMAP parameters might indicate functional impairment. These aspects support the use of endotracheal surface electrodes in selected patients in whom the vagus nerve might be at risk during CPA surgery [2].

Monitoring

see Vagus nerve monitoring

References

1)
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