The glossopharyngeal and vagus nerves arise from the posterior aspect of the superior third of the olive anterior to the choroid plexus, extending from the foramen of Luschka and traveling laterally to enter the jugular foramen. The jugular foramen is divided into an anteromedial pars nervosa and posterolateral pars venosum compartment by the jugular spine (intrajugular process). In this foramen, the nerves traverse with a sheath of connective tissue that extends from the dura to the pericranium. The glossopharyngeal and vagus nerves are often separated in the jugular foramen by a fibrous crest (dural septum), thereby separating the jugular foramen into a glossopharyngeal and vagal meatus. This septum varies in width from 0.5 to 4.9 mm. Linn et al. termed the glossopharyngeal meatus a “small internal auditory canal.” The inferior petrosal sinus travels with the glossopharyngeal nerve in one canal or each travels separately in its own bony canal.

During the formation of the skull, no rigid separation of the fibers of the glossopharyngeal, vagus, accessory, and hypoglossal nerves exists. Additionally, the lower cranial nerves merge during development through a common ganglion crest. Therefore, it is not surprising that these nerves may communicate along their length.

To our knowledge, intracranial connections between the glossopharyngeal and vagus nerves have not been previously reported. Since these connections may have relevance during microvascular procedures of this area, the present study aimed at observing such connections.

Methods

During a microvascular decompression for hemifacial spasm, the senior author (A.C.G.) noted a connection between the glossopharyngeal and vagus nerves. To
investigate this further, prospective observations were made during 16 consecutive posterior fossa microvascular decompressive procedures for glossopharyngeal/geniculate neuralgia and hemifacial spasm regarding the presence of any interneural connection among the lower cranial nerves. This cohort was composed of 4 male and 12 female adult patients. Of these, 6 underwent exploratory posterior fossa surgery on the left side and 10 on the right side.

To further investigate the approximate incidence and significance of such an interneural connection, we studied 80 sides from 40 cadavers (23 male and 17 female) aged 39–88 years old (mean 73.5 years) at death. Twenty-five of the cadavers were formalin-fixed and 15 were unembalmed; none harbored any sign of an intracranial pathological condition. After the bone over the posterior fossa was removed with a drill (Midas Rex, Medtronic), brain retractors were positioned to retract the cerebellum medially, and the arachnoid membranes over the lower cranial nerves were dissected using microsurgical techniques. These nerves were then inspected from their exit zone to the jugular foramen and interconnections among them were investigated. Specifically, we sought any neural connections between the glossopharyngeal and vagus nerves using a surgical microscope (Zeiss). When seen, histological analysis (H & E staining) of these connections was performed.

Results

Our initial surgical patient was observed to harbor a connection between the glossopharyngeal and vagus nerves during a posterior fossa exploration for hemifacial spasm on the left side. This connection was more oblique than those subsequently identified in the cadavers that we studied and traveled from the glossopharyngeal nerve medially to join the vagus nerve laterally (Fig. 1). No other such connections were observed between the glossopharyngeal and vagus nerves in any of the other 16 patients included in this study.

Among the cadavers, 2 sides (2.5%) were found to have neural connections between the intracranial intracisternal segments of the glossopharyngeal and vagus nerves (Fig. 2). These were identified on the right side of an embalmed male cadaver and the left side of an unembalmed female cadaver. Both of these connections were more or less vertical in nature and occurred as the nerve began to traverse the jugular foramen. The length and width of these connections were approximately 9 mm and 1 mm, respectively. Histological analysis of these connections verified their neural content.

We classified these 2 forms of glossopharyngeal nerve to vagus nerve connections as Types I (occurring in 66% of the observed instances) and II (occurring in 33%). Type I designates the more vertical connecting fibers and Type II the more oblique connecting fibers (Figs. 1 and 2). Two of the 3 intraneural connections were seen on the left side.

Discussion

We found that intracranial connections between the glossopharyngeal and vagus nerves exist and are seen as potentially two types, one more vertical and the other more oblique. The neural anastomotic network between the lower cranial nerves shows individual variability, and knowledge of the anatomy, including such neural connections as reported herein, may be important during skull base surgery such as microvascular decompression and various nerve transfer procedures, as well as for understanding the pathophysiology of skull base and neck disorders. Of note, upper fibers of the vagus nerve are often transected for surgical treatment of glossopharyngeal neuralgia. However, the significance of such neural interconnections is unknown and warrants further investigation. We would hypothesize that such connections represent embryologically misguided fibers from the glossopharyngeal nerve to the vagus nerve or vice versa.

Extracranial connections between the glossopharyngeal and vagus nerves have been described. Such extracranial connections have been referred to as the ansa of van Haller or the glossopharyngeo–pneumogastric...
Intracranial vagus–glossopharyngeal nerve interconnections

This anastomosis is formed by the joining of a small branch of the glossopharyngeal nerve (ramus communicans cum nervo glossopharyngo) with the auricular branch of the vagus nerve. Such communication may also be seen at the level of the tympanic plexus where branches of the glossopharyngeal and vagus nerves come into contact.

Rhoton stated that a large glossopharyngeal nerve diameter may be associated with a small diameter of the upper vagus nerve rootlets or vice versa as these two nerves arise from the same nuclei and have similar functions. We have found that stimulation of the glossopharyngeal nerve gives results comparable to those of vagus nerve stimulation in aborting seizures in an animal model. Such findings lend credence to alternative pathways to the nucleus tractus solitarius via glossopharyngeal nerve to vagus nerve connections.

The intracranial intracisternal interconnections between the glossopharyngeal and vagus nerves described herein may be more common than previously described because small connections among intracisternal segments of the cranial nerves may be underappreciated and missed during removal of the embalmed brain from the cranial vault. We do not believe that our findings regarding these interconnections were due to fixation of soft tissues because both fixed and unfixed specimens were found to have these interconnections.

Conclusions

Although apparently uncommon and having an unknown function, knowledge of neural interconnections between the glossopharyngeal and vagus nerves might prove useful to surgeons who operate in the posterior cranial fossa so that they may avoid inadvertent traction or transection of these connections.

Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

Author contributions to the study and manuscript preparation include the following. Conception and design: Cohen-Gadol, Tubbs. Acquisition of data: all authors. Analysis and interpretation of data: all authors. Drafting the article: Cohen-Gadol, Tubbs. Critically revising the article: Cohen-Gadol, Tubbs. Reviewed final version of the manuscript and approved it for submission: all authors. Study supervision: Cohen-Gadol.

References


Fig. 2. Upper: Intraoperative photograph demonstrating a Type II connection in a patient undergoing microvascular decompression for left hemifacial spasm as reported herein. Lower: Schematic drawing of the Type II connection.