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Does the ganglion of Ribes exist?

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Abstract

Some have included the ganglion of Ribes (Francois Ribes, 1765-1845), lying on the anterior communicating artery, as the most superior ganglion of the sympathetic nervous system. To verify the presence of this structure, the anterior communicating artery was harvested from 40 fresh adult cadavers and histological analysis and immunochemistry performed. Grossly and with magnification, no ganglion-like structures were found in or around the anterior communicating artery in any specimen. However, scattered neuronal cell bodies were found in the adventitia of the anterior communicating artery with histological immunochemical analysis. Based on the lack of vasoactive intestinal peptide staining and the positive reaction to tyrosine hydroxylase, these neurons are most likely sympathetic in nature. Based on our findings, a grossly visible ganglion of Ribes does not exist. However, neuronal cell bodies were found in the adventitia of the anterior communicating artery although the function of such cells remains speculative.

Key words: *anatomy, brain, vasculature, autonomic nervous system.*

Introduction

There are questions in the literature as to whether the ganglion of Ribes exists. The ganglion of Ribes (Francois Ribes, 1765-1845, French physician and army surgeon of Toulouse, Paris and Rome) has been cited in the anatomical literature as lying upon the anterior communicating artery. With the ganglion impar (coccygeal ganglion of Luschka) representing the most caudally located ganglion of the sympathetic chain, some have included the ganglion of Ribes as the most superior ganglion of the sympathetic nervous system [14]. The present study was performed in order to verify the existence of such a collection of neuronal cell bodies on the anterior communicating artery.

Materials and methods

In the supine position, forty consecutive fresh adult cadavers (twenty-six male and fourteen female; aged 55 to 99 years old (mean 77 years)) underwent removal of their calvaria with a standard bone saw. Next, a subfrontal approach was undertaken with retraction of the frontal lobes and sequential transection of the olfactory tracts and

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cranial nerves II through IV and the internal carotid artery as it exited the cavernous sinus. No specimen was noted to have any obvious pathology of the intracranial compartment. Retraction was next made in the longitudinal fissure and the anterior communicating artery identified at the skull base. An operative microscope (Zeiss, Germany) was then used for magnification of the anterior communicating artery and observations made. Following the removal of the brain, the anterior communicating artery was harvested by cutting 0.5 to 1 cm proximal and 0.5 to 1 cm distal to its connections to the anterior cerebral artery with microscissors. Gross examination was made of all specimens using the above-mentioned microscope. Following gross examination, these arterial specimens underwent histological analysis with 5 ?m. slices Antibody staining of specimens was performed using the neuronal markers Vimentin, Chromogranin, Synaptophysin, and S-100 protein (DakoCytomation, Carpinteria, CA, USA), all prediluted with HIER-Tris-EDTA at 98°C at a pH of 9.0 for 20 minutes. Detection reagents included dual endogenous enzyme block S2003, Target Retrieval S1700, Envision Dual Link, LSAB 2 System HRP, DAB+K34568, and hematoxylin counterstain, all from DakoCytomation (Carpinteria, CA, USA). Additional immunochemistry was used to further elucidate the sympathetic or parasympathetic nature of any cells located on the anterior communicating arteries. This was done with vasoactive intestinal polypeptide (VIP) (LSAB/Envision), tyrosine hydroxylase, and neuropeptide Y (Biogenex, San Ramon, CA, USA). The antigen retrieval method for this substance was with Steamer-Tris-EDTA at a pH of 9.0. Standard controls for the above stains were used.

Results

Grossly and with a surgical microscope, no ganglion-like structures were found in or around the anterior communicating artery in any specimen. Histologically however, scattered neuronal cell bodies were found in the adventitia of the anterior communicating artery (Figs. 1 and 2). There were no specific areas of greater concentration of neuronal cell bodies on the anterior communicating artery specimens (i.e. these were found in multiple sites around the circumference of this artery). None of the ganglion cells or nerve fibers stained significantly with VIP, neuropeptide Y, or Vimentin. However, these cells stained positively for tyrosine hydroxylase. Controls for stains reacted appropriately.

Discussion

Almost one hundred years ago, Robinson [15] stated that "I must confess that my searches for Ribes' ganglion have not been fully successful". It is not clear, however, if this author did observe this ganglion. It is interesting that this structure is not commented upon more frequently in the literature, specifically the neurosurgical literature, as the anterior communicating artery is one of the most frequently involved sites for intracranial aneurysms [11]. In fact, in a twenty-three page chapter on the anterior communicating and anterior cerebral arteries, Grand and Hopkins [7] do not mention any structure that resembles the ganglion of Ribes. Gray [8] stated that the terminal filaments from the carotid and cavernous plexuses are prolonged along the internal carotid artery and send branches along the divisions of this vessel. This author further stated that filaments prolong along the anterior communicating artery to communicate with the small ganglion of Ribes which serves to connect the sympathetic nerves from the right and left sides. However, and as a footnote, Gray [8] stated that the existence of this ganglion is doubted by some observers. Interestingly, some have referenced the ganglion of Ribes as lying at a comparable point to the concentration region known as ajna chakra to some practitioners of yoga (http://swamij.com/kundalini-awakening-3.htm). A small internal carotid ganglion, in the carotid canal at the junction of the greater petrosal and deep petrosal nerves, may also exist [1]. In rats, Hara and Kobayashi [10] found VIP positive cell bodies in the nerves close to the internal carotid artery and cerebral arterial wall at the skull base.

Cassot et al. [4] postulated that the anterior communicating artery has a significant role in maintaining cerebral hemodynamics and its diameter is a major determinant in blood collateralization from the unilateral carotid arterial system to the distal bed of a contralateral occluded internal carotid artery. Branches of this anterior communicating artery originate in the lamina terminalis cistern and supply the: (1) lamina

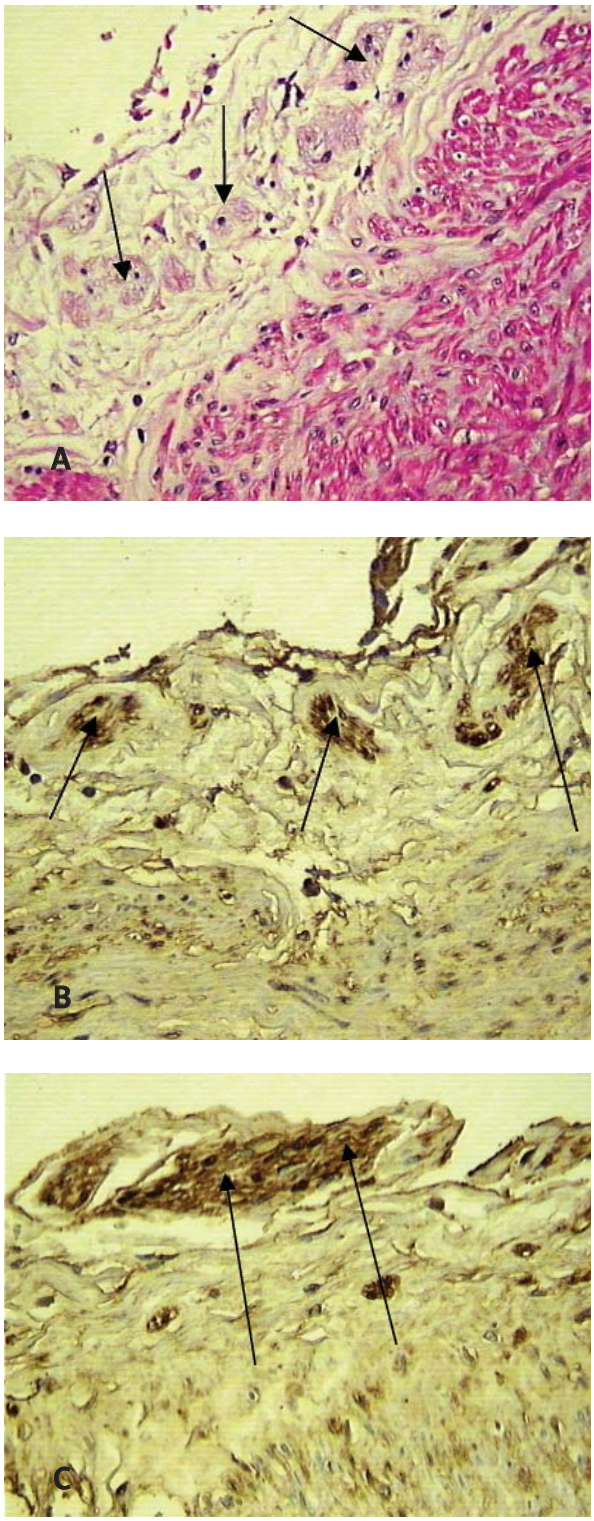

Fig. 1. Small peripheral nerves (arrows) along the adventitia of the anterior communicating artery (1**A**, H&E, x132) stain with S-100 protein (1**B** and 1**C**, x132)

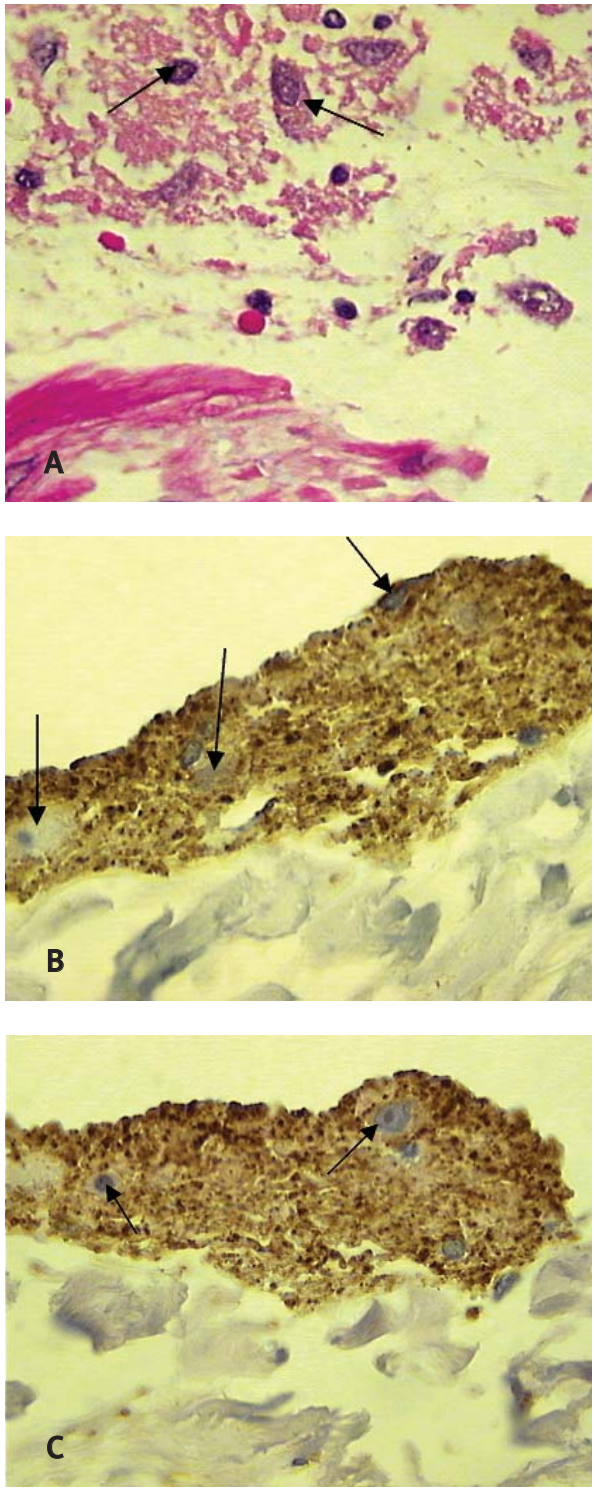

Fig. 2. Rare ganglia (arrows) are encountered within the adventitia of the anterior communicating artery (2**A**, H&E, x330). The ganglion cells stain with chromogranin (2**B**, x330), and synaptophysin (2**C**, x330)

terminalis, chiasmatic area and hypothalamus; (2) anterior commissure, trigone, septum pellucidum paraolfactory gyrus; (3) subcallosal region, anterior part of the cingulated gyrus; and (4) the territory beyond the corpus callosum [7, 11]. Complications following repair of anterior communicating artery aneurysms include memory deficits, confabulation, and personality changes but no autonomic dysfunction that is clinically appreciated. These aforementioned complications are attributed to infarctions of basal forebrain structures following injury to branches of the anterior communicating artery [11].

Based on our findings, a grossly visible ganglion of Ribes does not exist. However, neuronal cell bodies are found in the adventitia of the anterior communicating artery. The function of such cells remains speculative and would presumably have similar functions as do the cell bodies located in the superior cervical ganglion. Interestingly, Handa et al. [9] performed unilateral excision of the superior cervical ganglion in the rat and demonstrated reinnervation of ipsilateral cerebral vessels like the anterior cerebral artery by anterior communicating artery sympathetic fibers. However, no mention was made of fibers sprouting from any neuronal cell bodies located on the anterior communicating artery.

In the rat, Bleys et al. [1] identified small ganglia in the lateral wall of the cavernous sinus. Five years later, these same authors found small ganglia in the lateral cavernous sinus of humans and speculated that they may be involved with regulation of the cerebral arteries. In our study, all neuronal cell bodies were found to be negative for VIP. VIP has been used as a marker for parasympathetic neurons [12, 13]. For example, VIP has been found in the human pterygopalatine ganglion [13]. As sympathetic neurons stain positive with antibodies to tyrosine hydroxylase except for sudomotor cells, the neurons found scattered along the anterior communicating artery in our study are most likely sympathetic in nature.

The sympathetic nervous system plays an important role in vasomotion and vascular smooth muscle differentiation [6]. It has been shown that arterial sympathetic innervation protects against stroke, blood-brain barrier leakage, and hypertensive encephalopathy [16, 17]. Coutard et al. [5] demonstrated that low levels of arterial sympathetic innervation (controlled by the BN gene in rats) may make a cerebral aneurysm prone to rupture. Buki et al. [3] also found that human cerebral arteries possess a system of peptidergic neural fibers on the adventitia that is absent in the wall of saccular aneurysms. Interestingly, Tsai et al. [18] revealed that norepinephrine containing neural fibers are denser in the rostral than caudal segment of the circle of Willis in rats.

Further studies are now necessary to identify the possible origin of the neuronal cell bodies observed in our study and the specific neurotransmitters utilized by them as well as to distinguish what occurs when these cells are disrupted in isolation.

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