5-2022

The Origin of Sympathetic Postganglionic Fibers in the Cervical Region of the Vagus Nerve

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Recommended Citation

Wallace C, Glueck E, Kuhnert S, Brauer P, Lemmons C, Kilmer M, Barry A. The Origin of Sympathetic Postganglionic Fibers in the Cervical Region of the Vagus Nerve. *The FASEB Journal*. 2022; 36(S1). doi: 10.1096/fasebj.2022.36.S1.R3076.

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The FASEB Journal

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First published: 13 May 2022

https://doi.org/10.1096/fasebj.2022.36.S1.R3076

Abstract

Introduction

The vagus nerve (VN) is a cranial nerve that is mainly known for its parasympathetic function. Although a communication between the VN and sympathetic ganglia was described as early as 1858 by Henry Gray, the existence of sympathetic fibers within the VN is still under debate. Studies utilizing immunohistochemical verification with anti-Tyrosine Hydroxylase (TH) antibody have found variable distribution of catecholaminergic activity in the cervical and thoracic trunks of the VN, ranging from 0% to 21.63%. We aimed to elucidate the presence and distribution of the postganglionic sympathetic element within the cervical region of the VN using immunohistochemical analysis with anti-TH antibody. We evaluated macroscopic neural communications between cervical sympathetic chain ganglia (SCG) and the cervical VN as a potential source of intravagal catecholaminergic fibers.

Methods

Dissection of the VN, cervical chain ganglia, and any communicating branches was performed bilaterally on 20 fully embalmed cadavers (male n=11, female n=9) using standard dissection tools. All communications were histologically validated to confirm neural tissue and cervical VN samples were collected bilaterally in two locations. Tissue sections were stained with anti-TH antibody and Luxol Fast Blue. Histological slides were viewed and photographed with a Leica DM 500 compound microscope. All images underwent quantitative analysis with ImageJ software to measure effective surface area (ESA) and TH-positive areas.

Results

Twenty pairs of VN and SCG with associated neural communications were identified. Interconnections were found in 11 donors (55%), resulting in 13 total neural anastomoses between the VN and either the superior, middle, or inferior cervical ganglia. All measurements are reported as mean ± SEM. When comparing the right and left superior cervical vagus nerve ESA, the right side had a larger ESA than the left

(2.27±0.26mm^2 and 1.82±0.15mm^2; p=0.039). TH Immunoreactivity was detected in all donors bilaterally. We observed TH positive fibers in three distribution patterns (Figure 1). There was a significant interaction of location and gender on the percentage of TH-positive fibers. Females expressed a higher percentage of TH-positive fibers on the right side (3.0 ±1.22% in females and 1.2 ±0.37% in males; p=0.044). The average ESA of communications on the right side was 0.15±0.07 mm^2 and 0.04±0.009 mm^2 on the left (p>0.05). The number of fascicles within each communication varied from one to seven (2.77±0.4956). Most fibers stained positive for TH, occupying 91.86% ±4.1% of the total ESA. Presence or size of communications did not influence number of TH positive fibers within the VN. We identified ganglion cells within the superior and inferior samples of the cervical VN (Figure 2).

Conclusion

TH-positivity within the cervical VN and its communications with the SCG suggests a ganglionic sympathetic source. However, identification of ganglion cells within the VN suggests a postganglionic source that warrants further study. Investigating sympathetic activity of the VN and its source, aids in understanding its physiologic role.

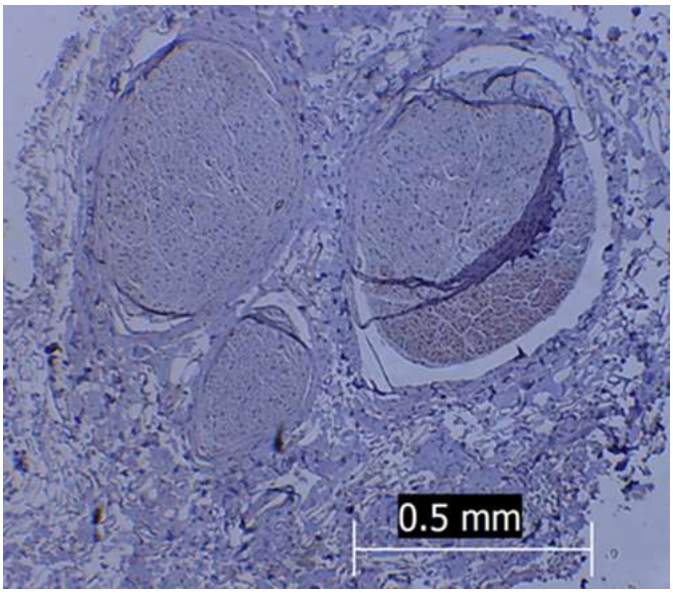

Figure 1
Distribution patterns: diffusely spread throughout the fascicles, clusters of axons within the fascicle, or entire independent fascicle. The percentage of TH-positive fibers varied from 0% (0.0mm2) to 23% (0.56mm2) of the total ESA.

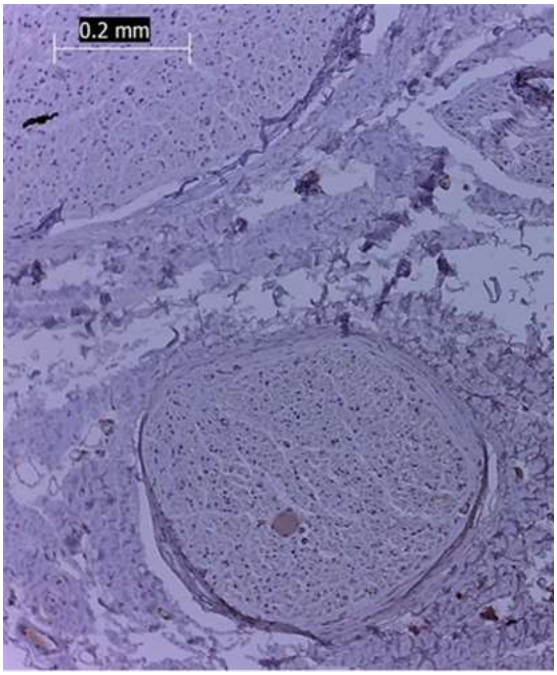

Figure 2
A higher presence of ganglion cells was observed in the superior sample. The maximum number of ganglionic cells were found in the locations with the highest quantity of TH-positive fibers. One large ganglion cell in the field of view possesses TH-positive cytoplasm. Note a single layer of satellite cells surrounds the neural body.