



Review article

The vertebral nerve: A comprehensive review of its form and function



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ABSTRACT

The literature is littered with variable and scant reports of the vertebral nerve. The present paper reviews the literature regarding this nervous structure of the neck and attempts to clarify a number of issues surrounding its form, function, and implications of surgical manipulation. The nerve may arise from the stellate ganglion or the ansa subclavia, amongst a number of other structures. Additionally, the terminal insertion of the vertebral nerve varies in the reported literature, with authors observing various terminations. Animal models of the vertebral nerve have limited value, as variations between species and with species have been observed. This review also indicates that contradictory evidence exists regarding the clinical implications of vertebral nerve damage. Although irritation may result in ocular disturbance, hearing loss, headaches, and dizziness, a high degree of incongruity exists around whether or not any clinical findings will actually be observed. Based on our review of the available literature and recent cadaveric research, it appears it may be more logical to classify the vertebral nerve as a variable ramus communicans that connects the stellate or inferior cervical ganglia to the lower cervical spinal nerves and not a structure that ascends entirely with the vertebral artery to enter the cranium.

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1. Introduction

Despite being extensively studied, the termination and communications of the vertebral nerve have left many uncertainties. There has been debate regarding its classification as a true nerve versus a ramus communicans. Moreover, there have been conflicting clinical and surgical reports regarding compromise of this nerve [28,1,25,21,8,24,11,20,12,27,26,7,36,37,39,33]. The clinical importance of the vertebral nerve in relation to the vertebral artery has been described as coursing within the bony canals of the cervical vertebrae, anterior to the cervical nerve roots, encircled by veins and nerve elements [36]. Due to the variations in anatomical descriptions, the vertebral nerve may be compromised during surgical procedures such as foraminotomy, anterior cervical fusion with discectomy, removal of extra-axial tumors, isolation or occlusion of the proximal vertebral artery, root repair of the brachial plexus, and scalenotomies or cervical rib resection for thoracic outlet syndrome [3]. The compromise or irritation of this nerve has been implicated as the cause of post-surgical and post-traumatic complications including hearing loss or tinnitus following cervical spine injury, cervical migraine, vertigo, dizziness, fainting, visual disturbances (i.e., blurred vision, diplopia and transient

amblyopia), myalgia, positive Romberg test, vertical or diagonal nystagmus and Horner's syndrome [3,9,19,23].

The purpose of the present paper was to review prior literature on the vertebral nerve regarding its relation to anatomical location and function.

2. Historical background

The vertebral nerve has had many descriptions and depictions (Fig. 1). One of the earliest researchers to study the vertebral nerve was v.d. Broeck in 1908 [30]. He described the vertebral nerve as running medial to the vertebral artery in the foramina transversarium and crossing the dorsal side of the subclavian artery and being formed primarily by communicating rami from the 6th, 7th, and 8th cervical nerves [30]. However, in 1931, Siwe described the vertebral nerve as the only nerve in the foramina transversarium connected below with the inferior cervical ganglion. Furthermore, he described it as crossing the vertebral artery dorsally from the lateral to medial side to join the sixth or seventh cervical nerve, and found that it divided and branched in very few cases [30]. Despite this difference in description, Siwe believed that he and Broeck were referring to the same nerve because he thought of Broeck's vertebral nerve as analogous to the cranial contribution of the nerve he had described and included a caudal portion formed by the ramus from nerve root C6 to the inferior cervical

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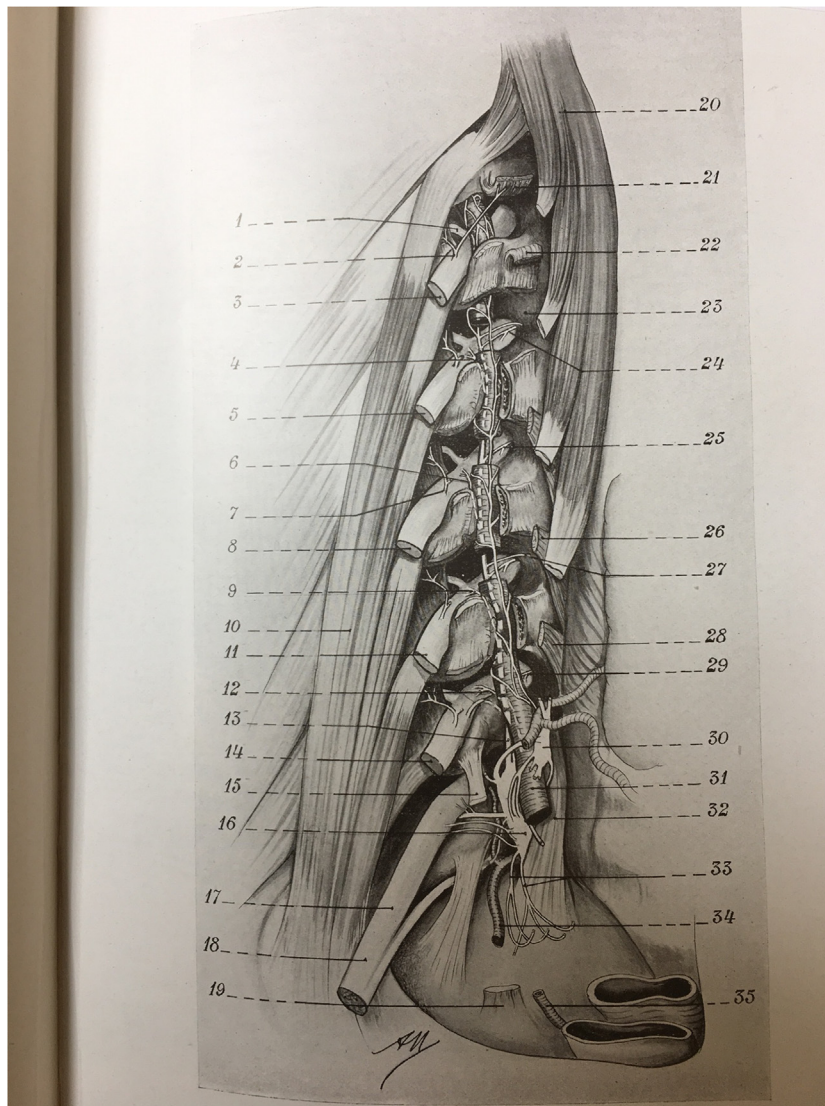


Fig. 1. Holeveque's depiction of the vertebral nerve.

ganglion [30]. He also demonstrated that all the cervical rami communicans, with the exception of the vertebral nerve, ran ventral or lateral to the vertebral artery to join the stellate ganglion and that the vertebral plexus has very little to do with the vertebral nerve [30].

Due to variations in the description of the vertebral nerve, it has been excluded from most anatomical textbooks. One of the few textbooks to mention the vertebral nerve was published in 1982 [14]. The description was taken from the research of Kimmel in 1959, which described the vertebral nerve as the gray rami communicantes leaving the inferior cervical-stellate complex directed toward the first thoracic and the lower cervical nerves as they emerge from the intervertebral foramina [17]. The nerve is currently described as the vertebral branch of the stellate ganglion in Gray's Anatomy ([34]). However, prior research concerning the vertebral nerve tends to lack any uniform interpretation and is generally sparse [3].

3. Anatomy

Macroscopic and microscopic research has attempted to find the most correct neurological classification of the vertebral nerve.

Previous studies reported that the vertebral nerve originated from the cervical portion of the stellate ganglion [5,13,31]. Skoog [31] also described the vertebral nerve as a gray ramus. Kimmel [17] stated that the vertebral nerve actually is a gray communicating ramus, and that it contributes sympathetic nerve fibers to more than one spinal nerve. The vertebral nerve branches into deep communicating rami, provides filaments to the vertebral plexus, and provides innervation to the spinal meningeal branches [19,17,35]. A difference in origin of the vertebral nerve among fetal and adult cadavers was noted. The rami of the vertebral nerve originate from the stellate ganglion in fetuses and in adults they originate from the middle and inferior cervical ganglia [17,35]; however, Stillwell's studies were performed in monkeys.

In the 1980's, Bogduk and colleagues [3] studied both human and monkey cadavers (*Macaca nemestrina*) and indicated that the vertebral nerve is conventionally regarded as a macroscopically discernable nerve and is distinct from any microscopic adventitial plexus of the vertebral artery. He reported there is no individual nerve, which may be referred to as the vertebral nerve. Rather the second part of the vertebral artery (within the foramina transversaria) is accompanied by a repeating system of neural arcades which are intersegmental communications between gray rami and ventral rami or ventral rami and ventral rami [3]. He

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