Dorsal Roots and Associated Ganglia from the First Cervical Spinal Segment in Humans

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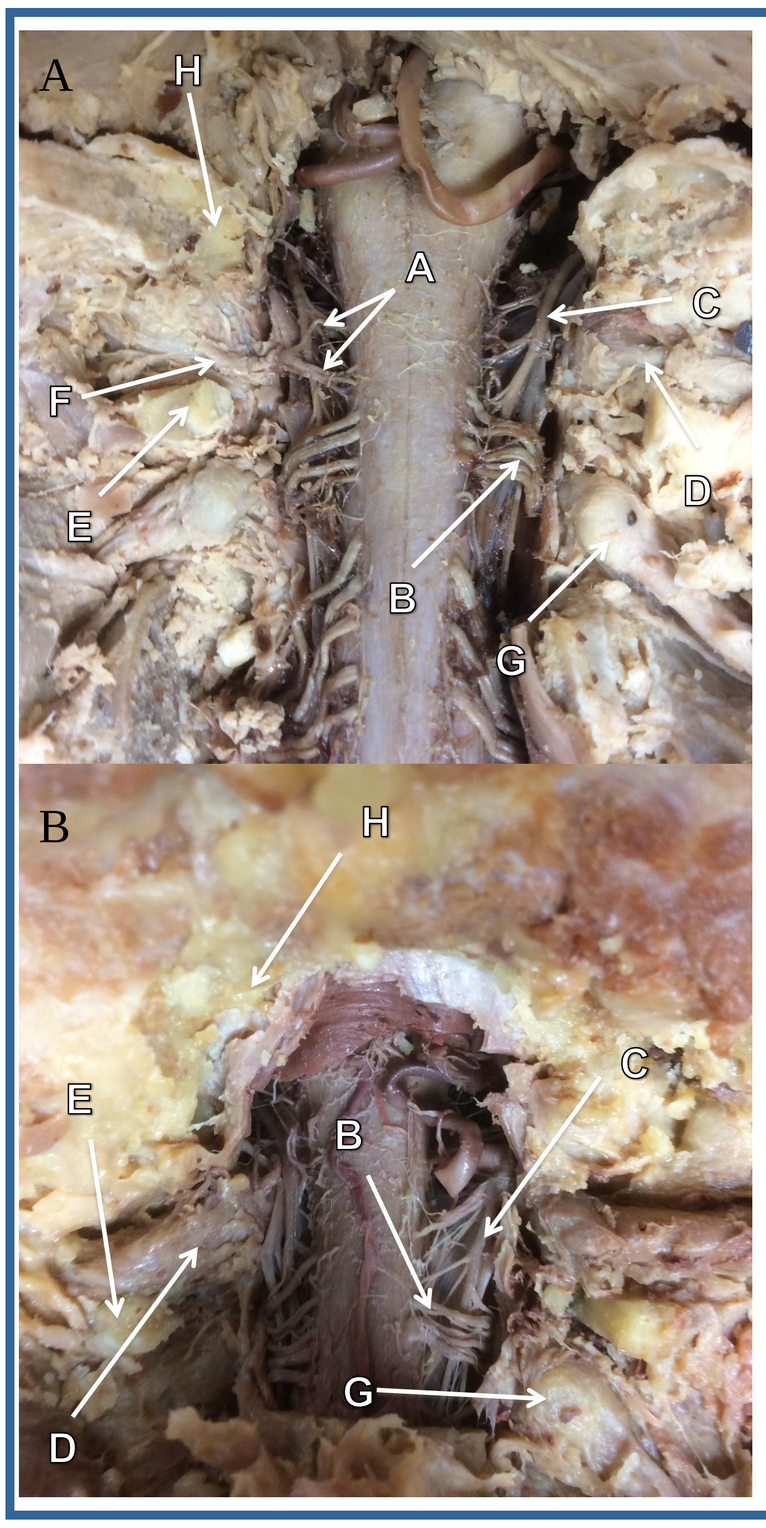
Introduction

Pain is a debilitating sensory experience that affects everyone at some point in his or her lives. In the United States alone unrelieved pain results in decreased quality of life, losses in productivity adding up to hundreds of billions of dollars annually, increased hospital stays, increases out patient visits all adding up to hundred of billions of dollars in increased health care costs[1]. One in four Americans over the age of 20 report having had issues with chronic pain. Thirty-four percent of those reported having either severe headaches (15%), neck pain(15%) or facial pain (4%).[1] Despite the tremendous burden on society pain mechanisms are still not completely understood. There is a great deal of knowledge and research devoted to the somatosensory systems, including pain systems, of the head and neck yet there is still much more that remains to be elucidated. For instance, current dogma describes the first cervical nerve (C1) as being purely motor in function. This is the most common description given in medical textbooks and reports and is being taught this way to current health professional students. Despite what is being taught anatomical reports of sensory roots coming off the first spinal segments have been observed (2). We suggest that presence of C1 dorsal roots, and a corresponding dorsal root ganglia, would have significant implications on the distribution of pain sensation in the head. The *long-term goal* of this project is to investigate the role of sensory roots of the C1 spinal segment in pain sensation of the head and neck.

Purpose

To determine whether a subset of the population possesses dorsal roots and associated ganglia exiting the C1 segment of the spinal cord.



Results

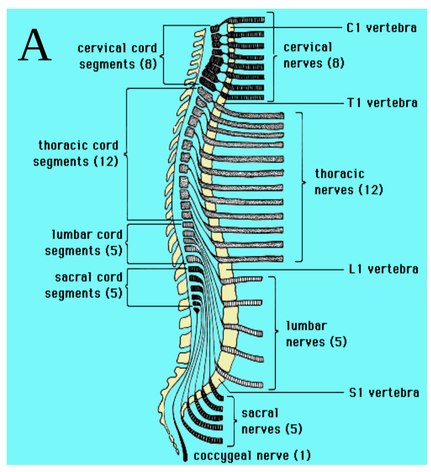
A. Human cervical spine with four visible dorsal roots on the left side (A) traveling dorsal to the spinal accessory nerve. The C1 dorsal root ganglia (F) can be observed in the vertebral sulcus between the arch of the C1 vertebra and the occipital bone. On the right side no dorsal roots and no dorsal root ganglia are evident.

B. On a second human specimen dorsal roots of C1 are absent bilaterally.

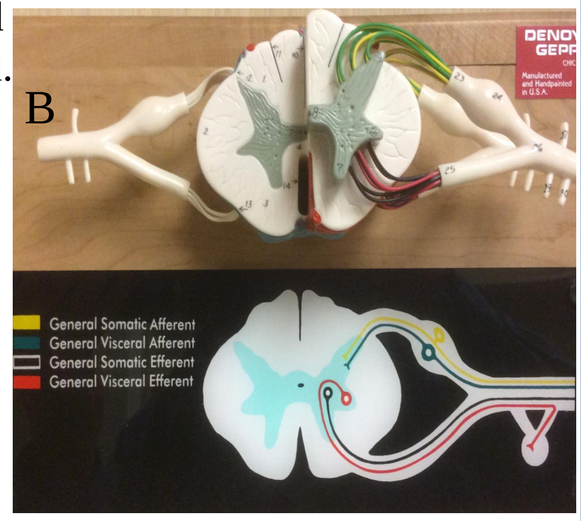
Arrow Legend

A-Dorsal roots of C1
B-Dorsal roots of C2
C-Spinal Accessory Nerve
D-Vertebral Artery
E- Arch of C1 Vertebrea
F- Dorsal Root Ganglion of C1
G- Dorsal Root Ganglion of C2
H– Occiptial bone

Figure 1

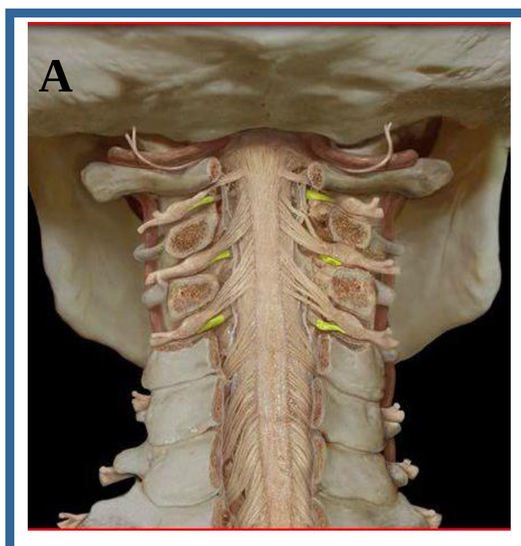


A. A typical human spinal cord develops 31 pairs of spinal nerves, 8 in the cervical region, 12 in the thoracic region, 5 lumber 5 sacral and 1 coccygeal.

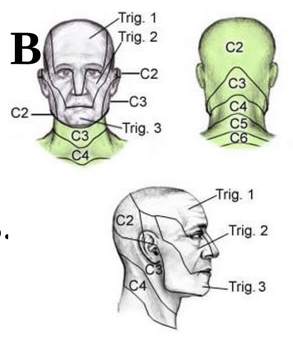


B. A typical spinal nerve has both dorsal and ventral roots comprised of multiple rootlets attached to the spinal cord. Ventral rootlets contain mostly axons from motor neurons located in the ventral horn of the spinal cord. The dorsal rootlets contain axons from mostly sensory neurons located in dorsal root ganglia and enter the spinal cord at the dorsal horn.

Figure 2



A. The C1 spinal nerve is considered an atypical nerve. It exits the vertebral column between the skull and its respective vertebrae and it is widely reported to only have ventral rootlets and lacks a dorsal root ganglia (suggesting it has only a motor and not a sensory function).



B. Cutaneous sensory innervation of the head is thought to be from the 2nd and 3rd Cervical nerves. This is demonstrated by the dermotome map.

Discussion

Anatomical variations such as altered routes of nerves, arteries and veins, are relatively common in humans. Generally these variations have minimal clinical relevance in that relevant tissues remain innervated and supplied with blood despite By contrast we are investigating a anatomical variant that may prove to be highly relevant in the diagnosis and treatment of cervicogenic headaches. While it is generally accepted that cutaneous innervation of the scalp and neck arises from nerves coming off of the C2 and C3 spinal segments, sensory innervation of deeper structures (muscle tendons, ligaments, spinal dura and deep blood vessels) are only hypothesized. Being able to predict and localize the presence of a C1 sensory nerve may bring us that much closer to being able to diagnosis and treat deep cervical pain.

References

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2. Tubbs, R., Loukas, M., Slappey, J., Shoja, M., Oakes, W., & Salter, E. (2007). Clinical anatomy of the C1 dorsal root, ganglion, and ramus: A review and anatomical study. *Clinical Anatomy, 20*(6), 624-627.