Do Grossly Identifiable Ganglia Lie Along the Spinal Accessory Nerve? A Gross and Histologic Study with Potential Neurosurgical Significance

R. Shane Tubbs[1], Jeffrey R. Lancaster[1], Martin M. Mortazavi[1], Marios Loukas[2], Mohammadali M. Shoja[3], Eyas M. Hattab[4], Aaron A. Cohen-Gadol[5]

Key words
- Innervations
- Nerve supply
- Neurosurgery
- Sternocleidomastoid
- Trapezius

Abbreviations and Acronyms
SAN: Spinal accessory nerve

OBJECTIVE: **To elucidate further the anatomy of focal enlargements that have been observed along the spinal accessory nerve (SAN) as it courses within the posterior cranial fossa.**

METHODS: **Dissection of the posterior cranial fossa was performed on 27 adult cadavers with attention to the SAN and any focal enlargements associated with it.**

RESULTS: **Grossly, four specimens (14.8%) were found to have focal enlargements associated with the SAN within the posterior cranial fossa. These structures were in intimate contact with the dorsal aspect of the spinal portion of the SAN in all specimens and measured a mean diameter of 1.9 mm. One right-sided male specimen had two focal enlargements. All focal enlargements were found within 1 cm of the foramen magnum. Histologically, no ganglion or neuronal cells were identified within these focal enlargements in any specimen. These focal enlargements are best described as *ectopic glial nests* or *heterotopias* within the leptomeninges around the SAN.**

CONCLUSIONS: **The focal enlargements located along the SAN should not be termed ganglia. These structures do not contain neural structures and should not be mistaken for pathology of the posterior fossa.**

INTRODUCTION

Because focal enlargements may be seen during various approaches to the posterior cranial fossa and may be mistaken for tumors or other pathology (5), we aimed to understand the true nature of these structures better through an anatomic study. Some authors (11) have encountered head pain as a response to intraoperative stimulation of the spinal accessory nerve (SAN). Some investigators have reported occasional grossly visible ganglia associated with the SAN (4, 5). However, the literature on this subject is very scarce, and a general consensus regarding the significance of such focal enlargements is not readily available. This lack of consensus is evidenced by the fact that popular anatomy and physiology textbooks still report that the SAN is a purely motor nerve, and the presence of SAN ganglia is usually ignored. However, the presence of ganglia (nerve cell bodies located outside of the central nervous system) along a nerve suggests that the nerve contains a sensory function (9).

Based on investigations of the SAN and its musculature, some authors have concluded that there is a strong phylogenetic inclination for the SAN to lose its sensory cells by their migration into the dorsal roots of adjacent cervical nerves (12). Streeter (13) found that there are more sensory cells in the SAN of a fetus than the SAN of an adult (3, 10, 16). Fahmy (3) mentioned that ganglion cells were more "abundant and conspicuous" in a 3-month-old infant compared with an adult but based this on a single specimen. Further support for the sensory hypothesis comes from another study in rats that concluded that the "architectural features of neurons within the [SAN] ganglion are similar to those of neurons in other sensory ganglia" (16).

METHODS

We dissected the posterior cranial fossa in 27 adult cadavers (54 sides) aged 39–78 years at the time of death. Of these specimens, 18 were formalin-fixed, and 9 were unembalmed; 12 specimens were male, and 15 were female. The bone over the posterior fossa was removed with a drill (Midas Rex; Medtronic, Fort Worth, Texas, USA), and the cerebellum was carefully removed. Brainstem retraction allowed identification of the SAN. No pathology was observed in the area of dissection of any specimen. The SAN was traced from its entrance into the posterior cranial fossa until its exit via the jugular foramen. Observations were made for grossly identifiable focal enlargements along this nerve. When identified, measurements of these structures were made with microcalipers, and the focal enlargements were submitted for histologic analysis (hematoxylin and eosin staining).

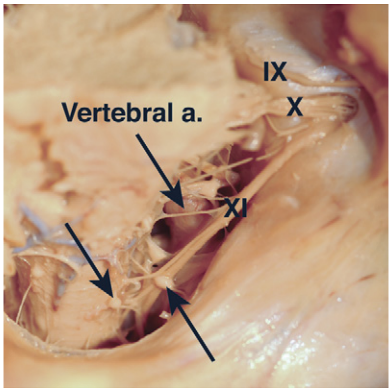

Figure 1. Spinal accessory nerve ganglia (*arrows*) seen on the right side of a male cadaveric specimen. The brainstem has been dissected to show the lower cranial nerves near the foramen magnum. Vertebral a., vertebral artery; IX, glossopharyngeal nerve; X, vagus nerve; XI, accessory nerve.

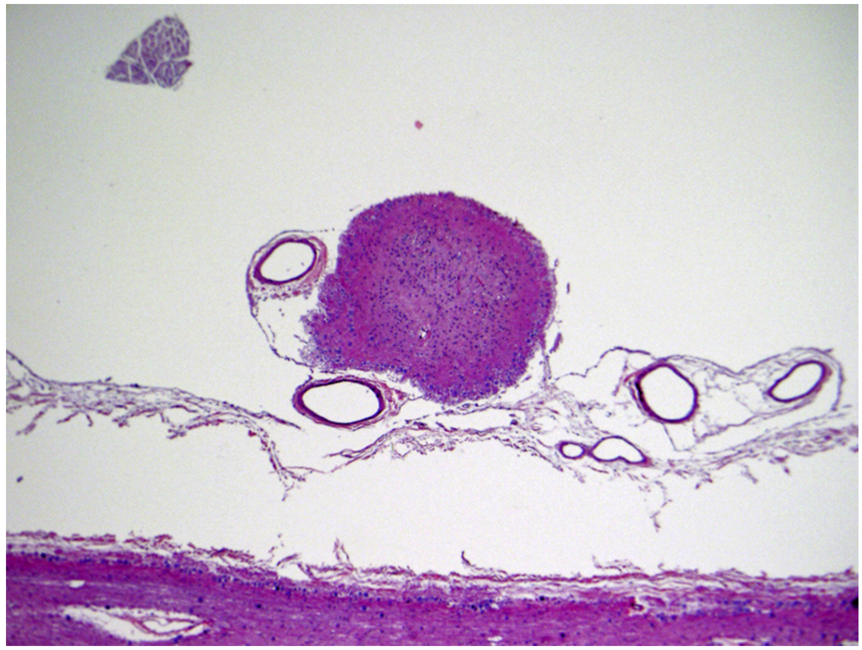

Figure 2. Left-sided spinal accessory nerve (SAN) ganglia (hematoxylin and eosin, ×5) in the center with surrounding blood vessels. The SAN is in the lowest part of the field and is traveling longitudinally. Histologically, the ganglia are not in contact with the nerve.

Statistical analysis between sides and genders was performed using Statistica for Windows (StatSoft, Tulsa, Oklahoma, USA) with significance set at $P < 0.05$.

RESULTS

Grossly, four specimens (14.8%) were foundto have focal enlargements associated with the SAN within the posterior cranial fossa (**Figure 1**). Focal enlargements were found on two left sides in one male and one female specimen, one right side in a male specimen, and bilaterally in one female specimen. These structures were in intimate contact with the spinal portion of the SAN in all specimens and measured 1–2.2 mm (mean 1.92 mm) in diameter. All focal enlargements were found dorsal to the spinal portion of the SAN. One right-sided male specimen was seen to have two focal enlargements: one dorsal to the spinal portion of the SAN and one smaller focal enlargement adjacent to the cranial root of the SAN. All focal enlargements were found within 8.5 mm of the foramen magnum.

Grossly, these focal enlargements were associated with the SAN but did not appear to be embedded within it. Histologically, no ganglion or neuronal cell was identified within these focal enlargements in any specimen. These focal enlargements were best described as *ectopic glial nests* or *heterotopias* within the leptomeninges around the SAN (**Figure 2**). Additionally, pale blue structures were noted at the periphery, and these represented polyglucosan bodies (corpora amylacea) (**Figure 3**). No statistical significance was observed for an increased frequency of these focal enlargements between left or right sides or between genders.

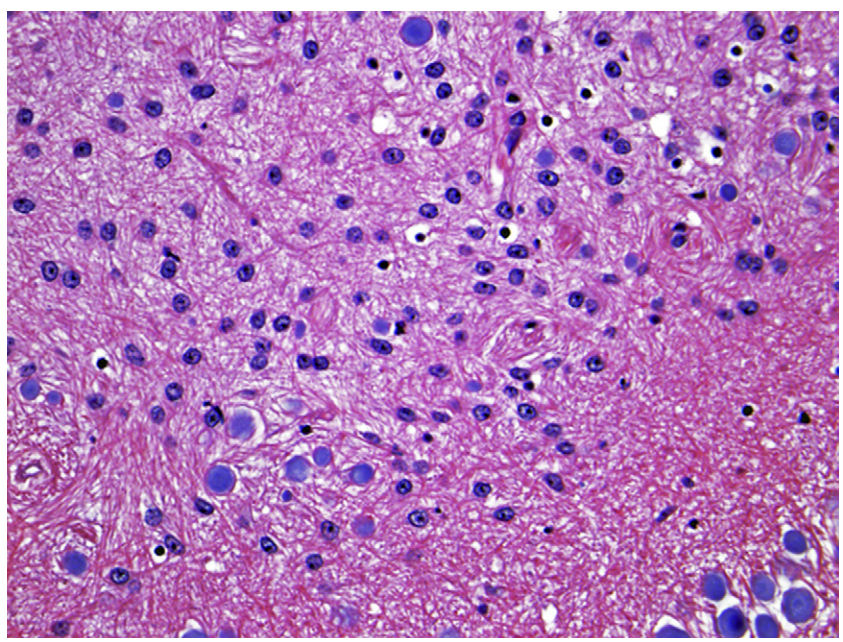

Figure 3. Left-sided spinal accessory nerve ganglia shown in **Figure 2** now at ×50 magnification. The corpora amylacea (large blue-colored cells) at the periphery indicate chronicity.

DISCUSSION

None of the ganglia found along the SAN in our study contained neural structures. The term *ganglion* should not be used to describe these structures. The polyglucosan bodies (corpora amylacea) seen in these focal enlargements signify the chronicity of these focal enlargements, which also should not be mistaken for tumors. Corpora amylacea are small hyaline structures of unknown significance that are derived from degenerate cells and occur more frequently with advancing age. Some authors have suggested that such ganglia along the SAN are responsible for various clinical findings. Ray and Wolff (11) directly stimulated the SAN in neurosurgical patients. Patients reported pain ". . . low in the back of the head and in the upper cervical regions of the same side." The conclusion of these authors was that the SAN transmits nociception from the musculature it innervates. In a related study, researchers examined the SAN and described its complicated anatomy, which involves adhesions, or anastomoses, between the SAN and the cervical plexus (1).

Because the SAN innervates the sternocleidomastoid and trapezius muscles in humans, it is a logical extension to assume that the nerve could also carry proprioceptive signals from these same muscles (6, 16). Windle (17), in a study of the same subject in cats and monkeys, added that although there is likely proprioception from the sternocleidomastoid and trapezius muscles, it is doubtful that the SAN alone carries proprioception for these muscles. To support this idea, Corbin and Harrison (2) identified a proprioceptive function of the SAN in cats. Sensory microganglia transmitting proprioception in the SAN as anastomotic connections of the dorsal roots of upper cervical nerves have been reported (4, 5, 14, 15).

The way in which the afferent sensory pathways travel to their final location makes understanding of such pathways difficult. One of the problems faced when studying the SAN is its two-part anatomy. This particular nerve has the unique feature of consisting of a cranial and a spinal root (16). To add to the intricacy, Ouaknine and Nathan (8) and Oh et al. (7) reported four various types of anastomotic connections in which the SAN fuses with the posterior roots of C1. Another confounding issue is that the ganglia cells of the SAN have been reported to have a "migrating anatomy" throughout fetal growth. Fahmy (3) reported that "[t]he ganglion crest is at first continuous, but subsequently becomes subdivided . . . [and that it is] conceivable that these cells have a tendency for distal migration."

Although we did not identify neural cells within these structures, it is possible that such cells may have migrated during development to other sites (eg, dorsal root ganglia). All of our specimens were adults; a larger study of specimens from children or fetuses is in order to verify this idea. Nonetheless, and based on our study, these focal enlargements in adults should not be mistaken for pathology.

CONCLUSIONS

Although no ganglion cells were identified in the spinal accessory ganglia, it remains to be seen if any sensory fibers may traverse such structures.

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