Research Paper

A Cadaveric Study of the Accessory Phrenic Nerve: Assessment of Prevalence, Origin, and Clinical Significance

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ABSTRACT

Introduction: Phrenic nerve injury is a common complication during cardiovascular surgeries. Therefore, a precise understanding of its anatomy and branches is crucial. The accessory phrenic nerve (APN) is a related branch of the phrenic nerve. This study aimed to assess the prevalence of the APN and its anatomical variations.

Methods: Twenty-six adult male cadavers were dissected using Grant's method, yielding 52 nerve specimens. The phrenic nerve branches were examined for the presence or absence of APNs. All parameters were documented bilaterally and recorded in pre-designed tables.

Results: The total prevalence of APN was 30.77% (8 of 26 cadavers). In five cases, APN was bilateral, while in three cases, it was unilateral (two left-sided and one right-sided). In five cadavers, the APN originated from the root of the fifth cervical nerve, while in three cases, it branched from the nerve to the subclavius.

Conclusion: The frequency and variable origin of APNs provide valuable insights for clinicians and surgeons performing thoracic surgeries.

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Introduction

The diaphragm is the primary muscle of inspiration, with the phrenic nerves serving as its sole motor innervation [1]. Many complications following cervical and thoracic surgeries are associated with phrenic nerve damage and its branches. Therefore, an accurate anatomical description of the phrenic nerve and its branches is clinically significant [2].

The accessory phrenic nerve (APN) typically originates from the fifth cervical nerve and connects to the phrenic nerve via the nerve to the subclavius [3, 4]. It runs lateral to the phrenic nerve, descending behind or, in some cases, anterior to the subclavian vein, usually joining the phrenic nerve near the first rib [5, 6]. However, variations have been reported, including junctions near the lung hilum [5, 6]. Previous studies have demonstrated significant variability in the prevalence and origin of APNs [7, 8]. Despite its importance, anatomical textbooks often provide limited information on the APN, and no data on its incidence in the Iranian population exist. Therefore, this study aimed to evaluate the prevalence and anatomical variations of the APN.

Materials and Methods

This study involved the dissection of 26 adult male cadavers (aged 20–65 years), yielding 52 nerve specimens. Dissections were conducted using Grant's standard method to examine the phrenic nerve branches and the presence, course, and origin of APNs. A stereomicroscope was used to visualize small branches. Dissections were performed at the Afzalipour Faculty of Medical Sciences and the forensic hall in Kerman, Iran. Written consent was obtained from the cadavers' families prior to the study. Data were recorded in pre-prepared tables and analyzed using SPSS software, version 16.

Results

The total prevalence of APN was 30.77% (8 of 26 cadavers). In five cases, APN was bilateral, while in three cases, it was unilateral (two left-sided and one right-sided) (Table 1). In five cadavers, the APN originated from the root of the fifth cervical nerve, while in three cases, it branched from the nerve to the subclavius. In four cadavers, the APN joined the phrenic nerve at the thoracic inlet, while in one cadaver, the junction occurred near the lower part of the lung hilum. In the remaining three cases, the junction was located between the thoracic inlet and the upper part of the lung hilum. In all eight cases, the APN traversed posterior to the subclavian vein.

The anatomical variations observed in this study were consistent with previous reports. In all cadavers, the phrenic nerve was formed by the anterior branches of the third, fourth, and fifth cervical nerves. Additionally, the anatomical relationships of the phrenic nerve in the cervical (Figure 1) and thoracic (Figure 2) regions were examined, showing no deviations from prior studies.

Discussion

A thorough understanding of nerve, muscle, and vascular variations is essential in surgery to prevent iatrogenic injuries [9-13]. Phrenic nerve injury in the cervical region can lead to unilateral diaphragmatic paralysis [14]. However, in cases where an APN is present, it may preserve some diaphragmatic function even if the phrenic nerve is compressed or severed [14, 15].

Our study revealed an APN prevalence of 30.77%, lower than the 45% reported by Talbot et al. [16]. The APN commonly originates from the nerve to the subclavius, a pattern observed in three cases in our study. However, in five cadavers, the APN arose from the root of the fifth cervical nerve. Loukas et al. found that this type of APN origin occurred in only 2% of cases [5].

APNs may also arise from spinal nerves C4 or C6, the ansa cervicalis, or the nerve to sternohyoid (Figure 3) [5, 7, 17], but these variations were absent in our study. In some studies, the APN has been reported to traverse through a loop formed by the subclavian vein [8]. Our findings indicated that in all cases, the APN passed posterior to the subclavian vein. Loukas et al. found that in 45.5% of cases, the APN was posterior to the subclavian vein, whereas in 22.2% of cases, it was anterior [5]. Furthermore, they reported that in 9.1% of cases, the APN was medial to the phrenic nerve, while in our study, the APN was lateral to the phrenic nerve in all cases.

Previous studies have reported the absence of C3 and C5 contributions to the phrenic nerve [18-20]. However, in our study, all examined cadavers showed phrenic nerve formation from C3, C4, and C5. Understanding phrenic nerve anatomy and its variations is crucial during cervical and thoracic surgeries to prevent iatrogenic injuries [21-23]. Another clinical implication of APN arises during nerve blocks in the lower cervical region, as transient diaphragmatic paralysis has been reported, possibly due to phrenic nerve or APN involvement [24-26].

Table 1. Prevalence of APN

Total Prevalence	Bilateral APN	Unilateral APN
8/26 (30.77%)	5/8 (62.5%)	3/8 (37.5%) (2 left-sided, 1 right-sided)

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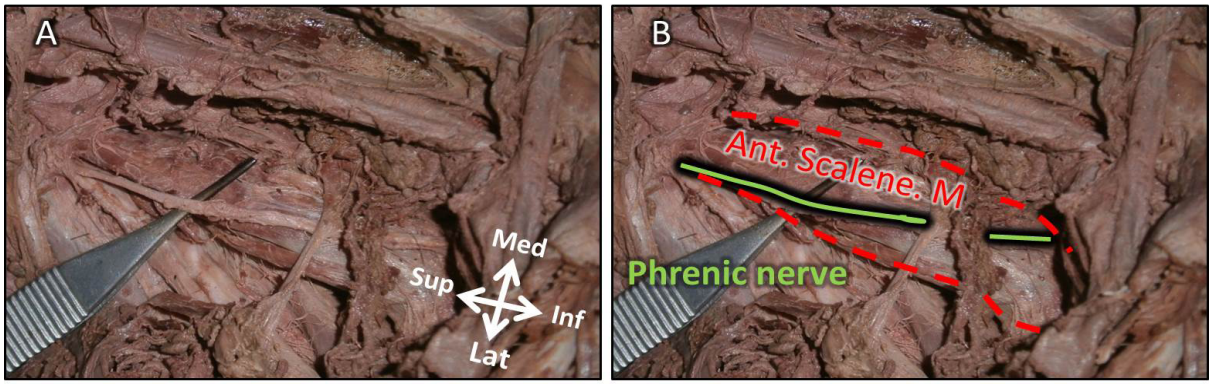

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Figure 1. Phrenic nerve in cervical region; passing of phrenic nerve anteriorly to the right anterior scalene muscle (A and B).

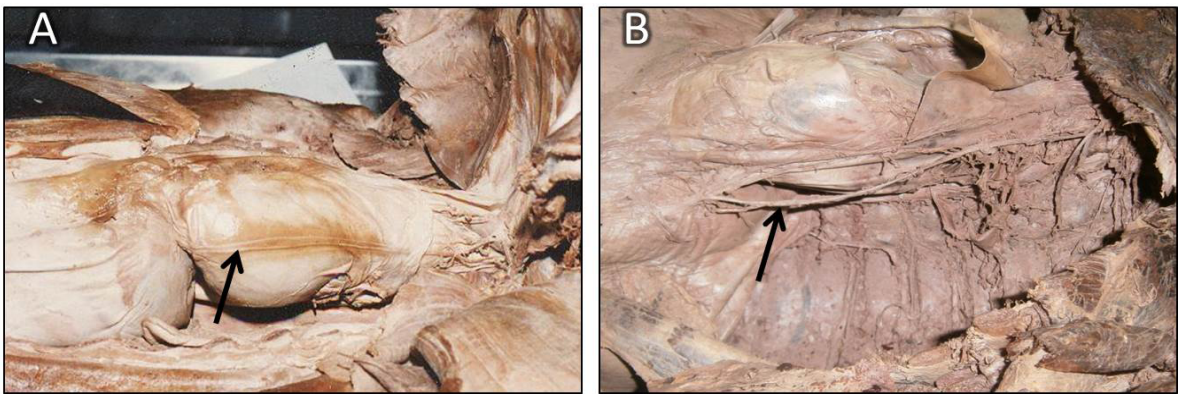

Figure 2. Phrenic nerve (arrow) in thoracic region; before dissection (A), after dissection (B)

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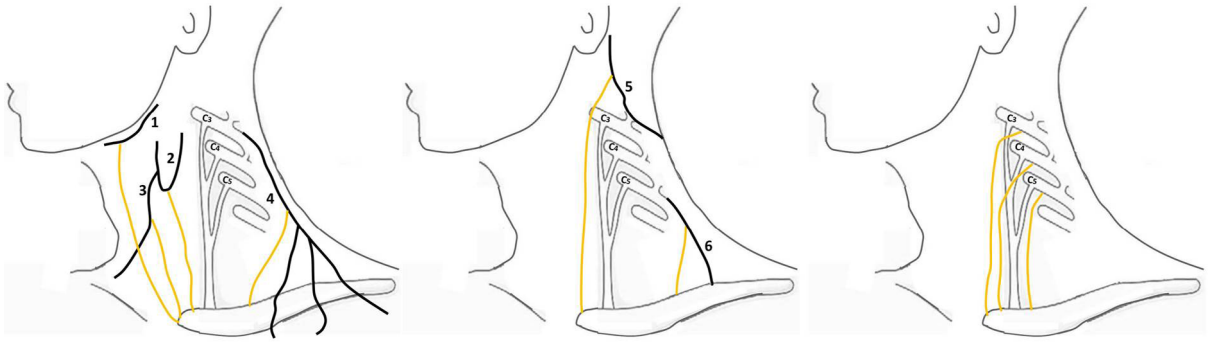

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Figure 3. The APN (yellow lines) could originates from different points, such as hypoglossal nerve (1), ansa cervicalis (2), nerve to sternohyoid (3), supraclavicular nerve (4), spinal accessory nerve (5), nerve to subclavius (6), C3, C4 and C5 nerves

One limitation of this study is that it was conducted in a single province. A broader investigation across multiple Iranian provinces is recommended to provide a more comprehensive understanding of APN prevalence in the Iranian population.

Conclusion

Considering racial anatomical differences, collecting anatomical data from diverse populations is essential. Understanding the prevalence, variable origins, and anatomical relationships of the APN can assist clinicians and surgeons in optimizing thoracic surgical procedures.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Rafsanjan University of Medical Sciences, Rafsanjan Iran (Code: IR.RUMS.REC.1402.035).

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Authors' contributions

Conceptualization, methodology, funding acquisition: Seyed Hassan Eftekhar-Vaghefi and Abdolreza Babaee; Review and editing: Samereh Dehghani-Soltani; Physical examination: Seyed Parviz Raygan.

Conflict of interest

The authors declare no conflict of interest.

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