

## Topographic and Anatomical Characteristic of the Relationship of the Phrenic Nerve and Subclavian Vessels

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### Abstract

It was shown in this study that in one of 10 accidentally dissected corpses, we encountered the course of the phrenic nerve in front of the subclavian vein. At the same time, the right subclavian artery was the leftmost branch of the aortic arch. The topography of the phrenic nerve can lead to complications during catheterization of the subclavian vein.

**Keywords:** Phrenic Nerve; Subclavian Artery

### Introduction

Variants of relationship of the phrenic nerve and the subclavian vein are of clinical significance, since there is a risk of damage to the phrenic nerve when performing catheterization of the subclavian vein. Classically, the phrenic nerve enters the thoracic cavity just behind the subclavian vein, sometimes it can be located in front of the artery, and in rare cases, perforation of the latter can occur. The terminal branches of the nerve pass through the diaphragm and spread along the abdominal surface of the diaphragm, providing innervation of the parietal peritoneum through the connections with the branches of the celiac plexus. The prevention of diagnostic and manipulative errors in the subclavian vein catheterization is at the basis of this study. The study of variants of topography of the phrenic nerve is necessary to explain and prevent damage to the subclavian vein [1].

The phrenic nerve provides the motor innervation of the diaphragm, as well as the pericardial, pleural, and peritoneal sensitivity with the help of its afferent fibers, which determines its clinical role. The phrenic nerve originates mainly from the 4<sup>th</sup> cervical nerve, but also receives contributions from the 5<sup>th</sup> and 3<sup>rd</sup> cervical nerves (C3-C5). After arising, the phrenic nerve descends obliquely with the internal jugular vein across the anterior scalene, deep to the prevertebral layer of deep cervical fascia and the transverse cervical and suprascapular arteries [2]. On the left, the phrenic nerve crosses anterior to the first part of the subclavian artery. On the right, it lies on the anterior scalene muscle and crosses anterior to the 2<sup>nd</sup> part of the subclavian artery. On both sides, the phrenic nerve runs posterior to the subclavian vein as it enters the thorax where it runs anterior to the root of the lung. In the thorax, each phrenic nerve supplies the mediastinal pleura and pericardium.

### Case Report

10 adult formalin-fixed cadavers were dissected, resulting in 20 nerve specimens. During the dissection, the topography and interrelations of phrenic nerves with the subclavian vessels was studied.

During the study, in the 19 of 20 cases we observed the classical version of the course of the phrenic nerve behind the subclavian vein. However, the following important variation was observed only on the right side in a 61-year old male cadaver: phrenic nerve has passed in front of the subclavian vein, just before entering the thorax, which makes it very vulnerable to subclavian catheterization. This variant of the course of the phrenic nerve is combined with the unusual course of the right subclavian artery. This artery had raised as an independent trunk from the aortic arch and lateral to the left subclavian artery. In the literature, this variation often is called arteria lusoria and occur in 0.5-2.0% [3,4].

### Discussion

Right subclavian vein catheterization is a commonly performed procedure for vascular access for hemodialysis, and the phrenic nerve palsy manifesting as hemidiaphragmatic paralysis is an important complication associated with it [5,6]. In 4 - 35% of cases, the catheterization of the subclavian vein leads to complications, such as pneumothorax, hemothorax, and mediastinal hemostasis, damage to the brachial plexus, piercing of the subclavian artery, thrombophlebitis, air embolism and damage to the recurrent laryngeal or phrenic nerve. Paralysis of the phrenic nerve, as a rule, is a direct complication of the subclavian venipuncture, but can sometimes be a late complication. Typically, paralysis of the phrenic nerve in patients leads to a decrease in lung capacity, in combination with symptoms of hypoxia and rarely pain in the right shoulder [1].

Injuries of the phrenic nerve in subclavian and central venous catheterization have been explained in a number of mechanisms. Direct nerve damage is usually associated with repeated venipuncture attempts. Even without perforation of the subclavian vein, hemorrhagic compression of the phrenic nerve is possible under the action of a mediastinal hematoma or compression of the phrenic nerve by the hard tip of a venous catheter. The main factor for more serious nerve damage in case of a perforated vein is the large needle size [7]. Transitory paralysis of the phrenic nerve when performing local anesthesia manifests itself at the beginning of catheterization. Squeezing of the phrenic nerve may be due to inflammation of the venous wall because of catheterization. The variant of the passage of the phrenic nerve in front of the subclavian vein is a rare case. The variability of location deviations is found from 7.25% to 9% [8].

The accessory phrenic nerves occurring from 61.8% to 75% can pass in front of the subclavian vein [9]. The frequency of damage to the accessory nerves varies from 22% to 84%. However, M. Loukas noted that a phrenic-accessory phrenic nerve loop was found around the subclavian vein in 30% of the cases. In the presence of the accessory phrenic nerve, damage to the main trunk during catheterization will not lead to complete paralysis of the corresponding half of the diaphragm due to the content of motor fibers in the accessory nerve [10].

### Conclusions

It was shown in this study that in one of 10 accidentally dissected corpses, we encountered the course of the phrenic nerve in front of the subclavian vein. At the same time, the right subclavian artery was the leftmost branch of the aortic arch. The topography of the phrenic nerve can lead to complications during catheterization of the subclavian vein. As the study shows, this anomaly occurs often enough that it is necessary to take into account during the manipulation of catheterization because of impossibility to determine that anomaly neither clinically or through ultrasonography.

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