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Case Report

Anomalous phrenic nerve – A case report

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ABSTRACT

In this paper we report a variation in the formation of phrenic nerve and mention its clinical implications. Phrenic nerve arises chiefly from the fourth cervical ventral ramus, but also the ventral rami of the third and fifth cervical spinal nerves contribute to its formation. A 60-year-old male cadaver presented bilateral variations in the origin of the phrenic nerve. Phrenic nerve was arising from supraclavicular nerve on both sides and receiving a communicating branch from the superior trunk of the brachial plexus. The same cadaver also presented an early division of the superior trunk of the brachial plexus. The clinical significance of such variations during regional anaesthesia is of considerable interest. ***Neuroanatomy; 2006; 5: 47–49.***

Key words [phrenic nerve] [accessory phrenic nerve] [supraclavicular nerve] [superior trunk of the brachial plexus]

Introduction

Phrenic nerve arises chiefly from the fourth cervical ventral ramus, but also the ventral rami of the third and fifth cervical spinal nerves contribute to the formation of the nerve. It is formed at the upper part of the lateral border of scalenus anterior muscle (Fig. 1) and descends almost vertically across its anterior surface behind the prevertebral fascia. It descends posterior to sternocleidomastoid and the inferior belly of the omohyoid muscles, also the internal jugular vein, transverse cervical and suprascapular arteries and on the left side thoracic duct. At the root of the neck, it runs anterior to the second part of the subclavian artery from which it is separated by the scalenus anterior muscle (on the left side, the nerve passes anterior to the first part of the subclavian artery). It descends to the thorax and supplies fibrous pericardium, parietal pleura (mediastinal and central part of the diaphragmatic) and diaphragm [1].

Accessory phrenic nerve is composed of fibres from the fifth cervical ventral ramus which run in a branch of the nerve to subclavius. The incidence of such accessory phrenic nerve was 75% as reported by Bergman [2]. This nerve descends posterior to the subclavian vein. The accessory phrenic nerve joins the phrenic nerve near the first rib. The accessory phrenic nerve may be derived from the ventral rami of the fourth or sixth cervical spinal nerves or from the ansa cervicalis [2].

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The phrenic nerve was arising from the supraclavicular nerve, deep to the sternocleidomastoid muscle just above the superior trunk of the brachial plexus (Figs. 2, 3). The nerve descended obliquely in front of the scalenus anterior muscle crossing from its lateral to medial border, deep to superficial cervical and suprascapular arteries. At the root of the neck, behind the subclavian vein, a nerve root arising from superior trunk of the brachial plexus joined the nerve. This nerve root from the superior trunk of the brachial plexus also descended in front of the scalenus anterior muscle and deep to superficial cervical and transverse cervical arteries. It is also observed that there was an early division of the superior trunk of the brachial plexus into ventral and dorsal divisions. The nerve to subclavius was arising from the ventral division and the suprascapular nerve arising from the dorsal division of the superior trunk (Figs. 2, 4).

In the same cadaver, the external jugular vein was formed by thin posterior auricular vein and posterior division of the retromandibular vein on the surface of the sternocleidomastoid muscle. Lower down the external jugular vein descended medially and joined the internal jugular vein.

It was also observed that, a nerve root arising from the ventral ramus of fifth cervical spinal nerve was piercing the upper part of the scalenus medius muscle and lower down divided into dorsal and ventral divisions. The dorsal division formed the dorsal scapular nerve accompanying

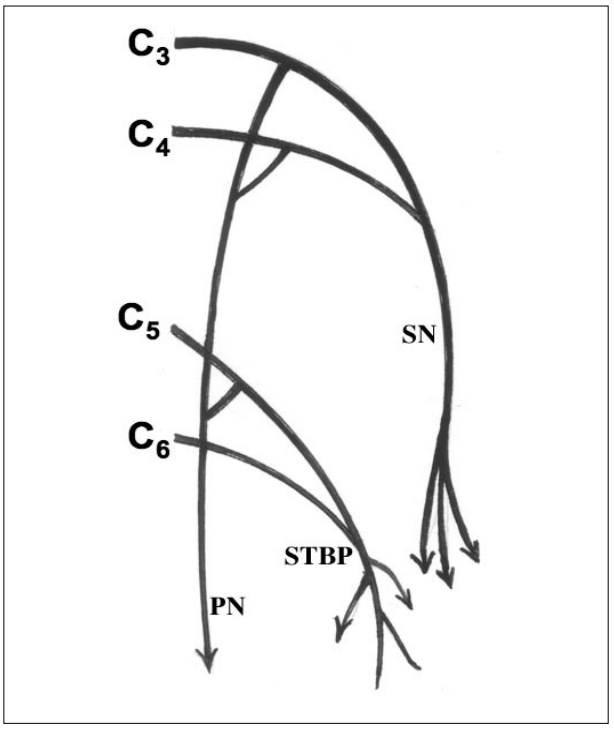

Figure 1. Normal way of formation of phrenic and supraclavicular nerves and supraclavicular part of the brachial plexus (schematic line diagram). *(**SN:** supraclavicular nerve; **STBP:** superior trunk of brachial plexus; **PN:** phrenic nerve)*

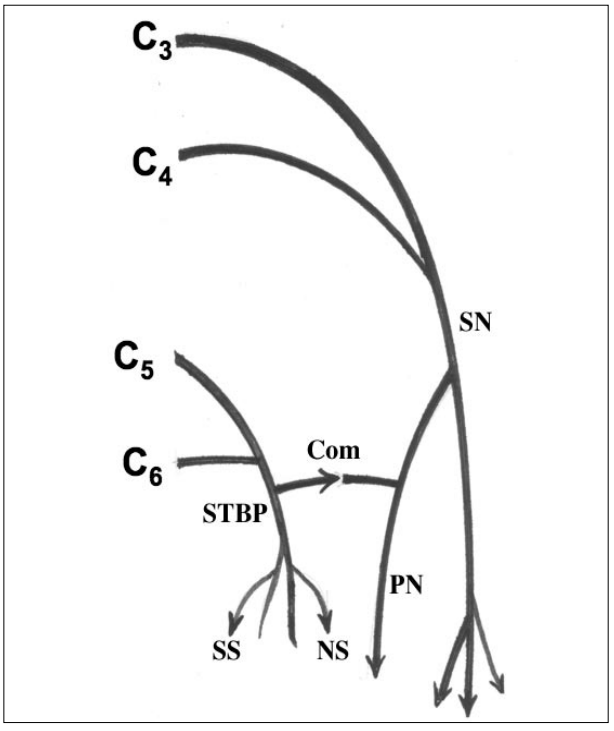

Figure 2. Variation in the formation of phrenic nerve and supraclavicular part of the brachial plexus (schematic line diagram). *(**SN:** supraclavicular nerve; **SS:** suprascapular nerve; **NS:** nerve to subclavius muscle; **STBP:** superior trunk of brachial plexus; **Com:** communication between superior trunk of the brachial plexus and phrenic nerve; **PN:** phrenic nerve)*

the dorsal scapular artery. Its ventral division was joining the nerve root derived from the ventral ramus of the sixth cervical spinal nerve to form the long thoracic nerve (Figs. 2, 4).

Discussion

In literature, numerous variations in origin, course, and distribution of the phrenic nerve have been reported. The phrenic nerve may receive additional roots from one or more of the following nerves: nerve to subclavius; nerve to sternohyoid; second or rarely, sixth cervical spinal nerves; descendens cervicalis; ansa cervicalis; and brachial plexus. It may receive a branch from CN XII (hypoglossal) and may communicate with CN XI (spinal accessory). The phrenic nerve may arise exclusively from the nerve to subclavius; occasionally it supplies a branch to the subclavius muscle. The consolidation of the phrenic into a single trunk may not occur until it enters the thorax. The size of the nerve may vary bilaterally [2]. Though, these anomalies regarding the origin of the phrenic nerve were reported. However, to the best of our knowledge, its origin from supraclavicular nerve has not been previously reported. Moreover, a branch from supraclavicular nerve to the phrenic nerve may pass down into the thorax over the subclavian artery or vein before joining the phrenic nerve. An additional bundle from the fifth cervical spinal nerve joining this branch has been reported. Bergman et al reported the communication of the phrenic nerve with the brachial plexus, but details are not explained [2]. Aktan et al report the communication between left phrenic nerve and superior trunk of the brachial plexus [3].

The anomalous origin of the phrenic nerve from the supraclavicular nerve will explain the segmental origin of the phrenic nerve, because the supraclavicular nerve is derived from the third and fourth cervical segments of the spinal cord.

The formation of the supraclavicular nerve by nerve roots from ventral rami of third and fourth cervical nerves occurs deep to sternocleidomastoid muscle. The nerve roots for the formation of the phrenic nerve from ventral rami of the third and fourth cervical spinal nerves arise earlier to the origin of supraclavicular nerve. However in the present case, the phrenic nerve was arising from the common trunk of supraclavicular nerve at the lateral border of the strnocleidomastoid muscle. The branch arising from the superior trunk of the brachial plexus receive fibers from the ventral ramus of the fifth or sixth cervical spinal nerve.

It is necessary to have a thorough knowledge of the anatomical variations, as well as the standard anatomy for safe and efficient practice of regional anaesthesia.

Bigeleisen reported that a supraclavicular block performed for ulnar ostetomy resulted in twitching of diaphragm along with motor response in forearm [4]. This is due to direct stimulation of the patient's phrenic nerve. The author claims that contribution to phrenic nerve from nerve to subclavius (accessory phrenic nerve) arises in close proximity to the site where supraclavicular block is performed. Thus, when one considers the relatively high

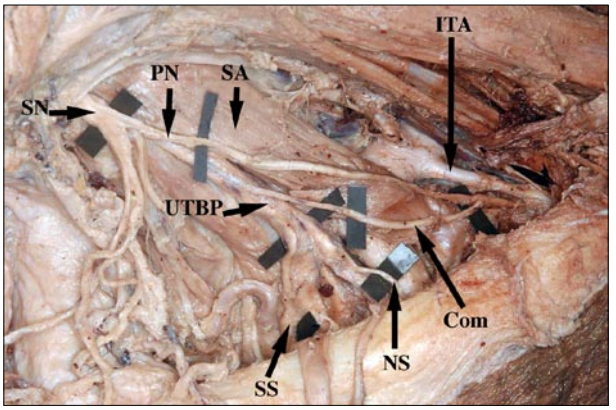

Figure 3. Photograph showing anomalous origin of phrenic nerve and its communication with superior trunk of the brachial plexus. Color version of figure is available online. *(**SN:** supraclavicular nerve; **UTBP:** upper trunk of brachial plexus; **SS:** suprascapular nerve from the dorsal division of the upper trunk; **NS:** nerve to the subclavius from ventral division of the upper trunk; **Com:** communication from the upper trunk of the brachial plexus to phrenic nerve; **ITA:** internal thoracic artery; **SA:** scalenus anterior muscle; **PN:** phrenic nerve)*

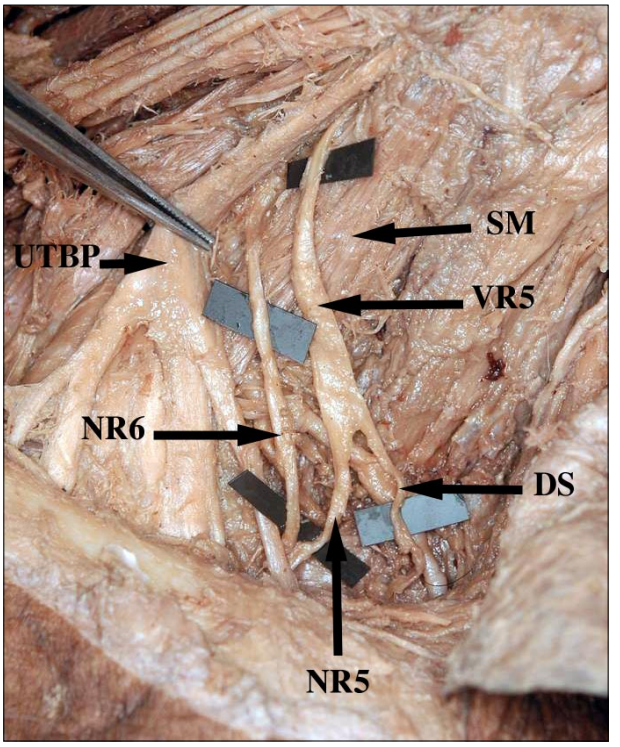

Figure 4. Anomalous formations of nerve to serratus anterior and dorsal scapular nerve. Color version of figure is available online. (***UTBP:*** upper trunk of brachial plexus; ***NR6:*** nerve root from ventral ramus of sixth cervical spinal nerve to long thoracic nerve; ***NR5:*** nerve root from ventral ramus of fifth cervical spinal nerve to long thoracic nerve; ***DS:*** dorsal scapular artery and nerve; ***SM:*** scalenus medius muscle; ***VR5:*** ventral ramus of fifth cervical spinal nerve)

frequency of an accessory phrenic nerve or a branch from the brachial plexus itself, there is a significant possibility of anaesthetizing only part of the phrenic nerve with a supraclavicular block. In the present case the communication from the superior trunk of the brachial plexus could be the accessory phrenic nerve.

Division of the phrenic nerve in the neck completely paralyses the corresponding half of the diaphragm. If an accessory phrenic nerve exists, section or crushing of the main nerve as it lies on scalenus anterior muscle will not result in complete paralysis. Historically, it was deliberately injured in order to collapse and hence rest the lung in patients with pulmonary tuberculosis. In the present case the accessory root for the phrenic nerve was arising from the superior trunk of the brachial plexus. Hence division of the supraclavicular nerve by supraclavicular block may damage the superior trunk of the brachial plexus.

In the same cadaver an early division of the superior trunk of the brachial plexus was noticed. The nerve to subclavius was arising from ventral division and suprascapular nerve from dorsal division of the superior trunk.

The dorsal scapular nerve arises from C5 root, pierces the scalenus medius muscle and passes downwards and backwards beneath the levator scapulae muscle. The long thoracic nerve (nerve to serratus anterior) is formed by C5, C6 and C7 root. The C5 and C6 roots pierce the scalenus medius muscle, and the C7 root joins the nerve at a lower level in the axilla. In the present case, the C5 nerve root pierced the scalenus medius muscle and lower down divided into two branches. The dorsal branch continued to form dorsal scapular nerve and ventral branch joined C6 nerve root to form the long thoracic nerve. Such common nerve root of C5 for dorsal scapular and long thoracic nerve was not reported previously.

In conclusion, variations in the formation of nerve plexus are common. Some of them attain greater clinical significance and few of them are of simple academic interest. In the present case report, the anomalous origin of phrenic nerve from supraclavicular nerve is of considerable clinical significance. A supraclavicular block of superior trunk of the brachial plexus can involve phrenic nerve and cause paralysis of diaphragm. The early division of the superior trunk of the brachial plexus and anomalous origin of nerve to serratus anterior is of academic interest.

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