CASE REPORTS

An Abnormal Variation of the Brachial Plexus with Potential Clinical Significance

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ABSTRACT

In this case of a male adult Caucasian cadaver, variations were noted involving the location of the C5 ventral ramus descending anterior and superolateral to the anterior scalene muscle. An unusual communicating branch was discovered that originated from C5 at the midpoint of the anterior scalene muscle, two centimeters proximal to Erb's point, to communicate with C6 and another communicating branch originating from C6 to C7. Awareness of the possibility of this variation is of great importance during certain surgical procedures. Comparison of this case with the literature is discussed.

Variación Anormal del Plexo Braquial con Potencial Importancia Clínica

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RESUMEN

En este caso de un cadáver adulto varón caucásico, se observaron variaciones que involucraban la localización de la rama ventral del quinto nervio cervical (C5) anterior descendente y superior lateral en relación con el músculo escaleno anterior. Se descubrió una rama comunicante inusual que se originaba a partir del C5 en el punto medio del músculo escaleno anterior, dos centímetros próximo al punto de Erb, para comunicarse con el C6 y otra rama comunicante son su punto de origen en C6 hasta C7. Conocer la posibilidad de esta variación es de gran importancia durante la realización de ciertos procedimientos quirúrgicos. Se discute la comparación de este caso con la literatura.

INTRODUCTION

The topography of the brachial plexus plays an essential role in diagnoses, therapy and surgical procedures (1). Knowledge of variations in this nerve plexus is imperative for clinicians in the fields of surgery, neurosurgery, orthopaedic surgery, vascular surgery, neurology and radiology. In this report, we describe an unusual variation of the brachial plexus in relation to the anterior and middle scalene muscles. To the best of our knowledge, this is the first case of this type presented in the literature.

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The majority of nerves in the upper limb arise from the brachial plexus, a network of nerves which originate in the posterior triangle of the neck. The brachial plexus is formed by the union of ventral rami C5 through C8 nerves, the greater part of the ventral ramus of T1, and the union of roots C5 and C6 form the superior trunk. The middle trunk is a continuation of the C7 root and the inferior trunk is formed by the union of C8 and T1 roots. Typically, the trunks pass inferolaterally through a gap between the anterior and middle scalene muscles to the outer border of the first rib.

The posterior triangle of the neck, including blood vessels, cervical lymph nodes, supraclavicular nerves, brachial plexus and fibro-fatty tissue, is a key landmark during certain surgical procedures (2). The roots of the plexus and the subclavian artery emerge commonly between the middle scalene and the anterior scalene muscles, forming an important neurovascular network supplying the upper limb (3).

Observing the anatomy of the brachial plexus in relation to scalene musculature may dictate key decisions for

surgeons and neurologists. Variations in the plexus may occur in the formation of trunks, divisions and cords (1). Origins and/or combinations of branches may differ from patient to patient (1). Variations in relations of the plexus to the axillary artery and scalene muscles have also been observed (8). Specific signs and symptoms of injury or disease depend on which part of the brachial plexus is involved.

Harry *et al* (1) found that most variations between the scalene muscles and brachial plexus involved the anterior scalene in his studies of 61 cadavers. The classically described anatomic relationship between the brachial plexus and scalene muscles was found to be present in only 35% of sides of cadavers and only in 32% unilaterally.

Case Report

A male Caucasian cadaver was dissected during an anatomy laboratory session at St George's University, Grenada, West Indies. Neither the medical history nor the dissection revealed any pathology involving the upper limbs, head or neck. In this routine dissection, the right pectoralis muscle was reflected laterally and superiorly. Additionally, the clavicle and subclavius muscle were cut and reflected to expose the superior region of the brachial plexus and the surrounding vasculature. The thyrocervical trunk was slightly reflected but remained intact, stemming from the right subclavian artery. As seen in Figure, the C5 ventral ramus descended

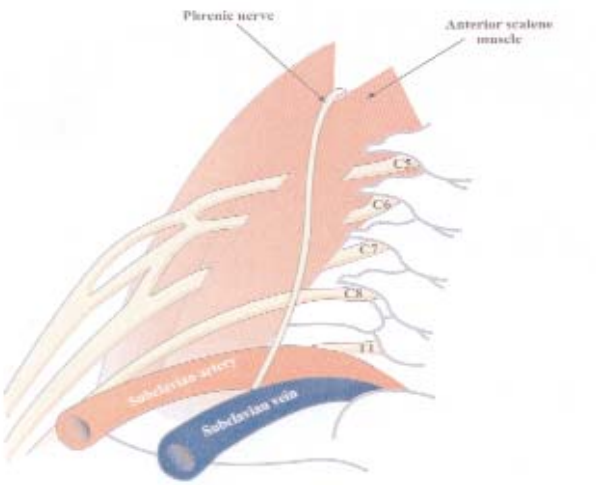

Figure: A schematic drawing of the abnormal connections between C5, C6 and C7 ventral primary rami. The abnormal connections took place after the ventral ramus pierced the anterior scalene muscle close to Erb's p.

anteriorly and lateral to the cranial part of the anterior scalene muscle and inferior to the phrenic nerve. After its descent over the anterior scalene muscle, C5 met and joined the C6 ventral ramus to form the superior trunk at Erb's point. The suprascapular nerve originated immediately after the junction of C5 and C6. Further dissection of the anterior scalene muscle revealed an additional branch of C5 communicating with C6 (Figure). This communication was located at the midpoint of the anterior scalene, 2 cm proximal to Erbs point. It was noted that another atypical communication was present between C6 and C7 (Figure). The remaining anatomy of the cadaver was unremarkable. The Institutional Review Board approved this study (IRB/06014). Individual consent was waived as data collection (age and patient history) was obtained from cadaver records.

DISCUSSION

Knowledge of variations in anatomy is important to clinicians, especially in radiological diagnoses and surgical procedures. The presence of anatomic variations is often used to explain symptoms that might not otherwise be obvious. Our report of an atypical position of the C5 ventral root superior to the anterior scalene demonstrates yet another brachial plexus variation. The C5 and C6 roots forming the superior trunk of the brachial plexus normally run inferior to, and in between the anterior and middle scalene muscles, by which they are somewhat protected from superficial trauma.

An abundance of literature detailing the variations in the brachial plexus and scalene musculature is available (4–9). Yet, this is the first reported case of a C5 ventral root travelling anterior to the anterior scalene muscle and communicating with C6 at two different points with a communication between C6 and C7 at the same level. Variations in the contributions to the plexus may be correlated with the position of the limb bud in which (period of initial nervous innervation) the nerves first grow into it in the embryo and many variations are similar to the normal forms of the brachial plexus found in different primates (7). Many studies have described that neuropathies such as thoracic outlet syndrome, can result from variations in musculature, nerve elements and vessels or combinations of the three (10).

Harry *et al* (1) described anatomical variations of scalene muscles and the brachial plexus and their clinical significance. They concluded that there were no consistent anatomic causes of thoracic outlet syndrome. Causes of this syndrome include the presence of a cervical rib or scalenus minimus muscle and variations in the relationship of the scalene muscles to the plexus (1). Due to the unusual positioning of C5 in the present case, certain types of trauma could possibly cause neuropathic pain or dysfunction.

A multiple single-subject design study (11) evaluated actions of the scalene muscles during rotation of the cervical spine. That study concluded that all three scalene muscles produce rotation of the cervical spine to the same side and that maximum stretching of the scalene muscles included rotation to the opposite side. Therefore, the abnormal course of C5, as seen in our case, could be a possible source of neuropathic pain or neuritis with neck musculature strain or hyper-abduction injuries.

Awareness of variations in neurovascular anatomy allows physicians to derive more specific differential diagnoses. In the fields of neurosurgery and orthopaedic surgery,

the knowledge of potential abnormal courses of any component of the brachial plexus would be valuable before proceeding with certain surgical procedures. Dubuisson and Kline (3) analyzed the epidemiology, pre-operative management, operative findings, operative treatment and post-operative results in a group of 99 patients who sustained 100 injuries to the brachial plexus. Causes of injury were primarily: sudden displacement of the head, neck and shoulder. Associated major trauma was present in 59 patients. Emergent surgery for vessel or nerve repair was necessary in 18 patients. Dubuisson and Kline (12) concluded that brachial plexus injury represents "a severe and difficult-to-handle" traumatic event. Before the surgical correction of a brachial plexus or vascular injury of the neck, surgeons should be aware of variations as found in our case. Our cadaver had no anterior scalene muscle protecting C5 and, in addition, the superior trunk of the brachial plexus. This superficial location of the C5 ventral root could result in significant neurological deficit, if damaged. The C5 ventral root contributes branches to a variety of nerves such as the dorsal scapular, long thoracic nerve to subclavius, suprascapular, lateral pectoral, musculocutaneous, upper subscapular, lower subscapular, axillary, radial and phrenic nerves. Knowledge of this aberrant cord location would be important prior to surgical procedures of the neck.

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