

Surgical anatomy of the spinal accessory nerve: review of the literature and case report of a rare anatomical variant

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Abstract

Objective: To evaluate the prevalence of variations in the anatomical route of the spinal accessory nerve from the base of the skull to the point where it enters the trapezius muscle. A case report is used to demonstrate an example of a rare but clinically important anatomical variant of this nerve.

Methods: An independent review of the literature using Medline, PubMed and Q Read databases was performed using combinations of terms including 'spinal accessory nerve', 'anatomy', 'surgical anatomy', 'anatomical variant', 'cranial nerve XI' and 'shoulder syndrome'.

Results: Our report demonstrates marked variation in spinal accessory nerve anatomy. At the point of crossing over the internal jugular vein, the spinal accessory nerve passes most commonly laterally (anterior) to the internal jugular vein. The reported incidence of this lateral relationship varies from 67 to 96 per cent. The nerve can also pierce the internal jugular vein, as demonstrated in our case study, with incidence ranging from 0.48 to 3.3 per cent.

Conclusion: Anatomical variations of the spinal accessory nerve are not uncommon, and it is important for the surgeon to be aware of such variations when undertaking surgery in both the anterior and posterior triangles of the neck.

Key words: Accessory Nerve; Anatomy; Anatomic Variation; Cranial Nerves

Introduction

Radical neck dissection was first described by George Crile in 1906.¹ It involved the removal of three key structures of the neck: the internal jugular vein (IJV), the sternocleidomastoid muscle and the spinal accessory nerve. This method provided oncological clearance, but often left the patient with severely decreased mobility of the shoulder and impacted upon quality of life. Since Crile's first description, many surgeons have modified the technique. In 1945, Dargent and Papillon were the first to propose the preservation of the spinal accessory nerve.² Then, in 1963, Suarez was the first to describe selective neck dissection,³ and his work was later greatly enhanced by Bocca and colleagues.^{4,5} The final result of these pioneering works is today's modified neck dissection, which has been conclusively shown to have equal oncological efficiency.^{6–12}

An independent review of the literature regarding spinal accessory nerve anatomy was conducted using Medline, PubMed and Q Read databases (for papers published up to August 2015). This involved a search of combinations of the following terms: 'spinal accessory nerve', 'anatomy', 'surgical anatomy', 'anatomical variant', 'cranial nerve XI' and 'shoulder syndrome'. We also manually searched the reference lists of articles and used institutional access to the South Australia Health Library Service to identify further relevant papers. A case report is used to demonstrate an example of an interesting but rare anatomical variant of the spinal accessory nerve and IJV.

'Shoulder syndrome' and iatrogenic injury

A major complication of neck dissection or indeed any surgery involving the posterior triangle of the neck is severe shoulder disability from accessory nerve damage.¹³ Damage to this nerve in radical neck dissection was first described by Ewing and Martin in 1952,¹⁴ and occurred in 50–70 per cent of patients.^{15,16} In 1961, Nahum *et al.* went on to describe the 'shoulder syndrome'.¹⁷ It comprises a multitude of symptoms: shoulder pain, impaired abduction of the shoulder, drooping of the affected shoulder, winging of the scapula, atrophy of the sternocleidomastoid and trapezius, and compensatory hypertrophy of the other muscles of the affected shoulder.^{18,19}

Iatrogenic injury of the spinal accessory nerve has not been completely eradicated by the advancement of nerve sparing neck dissections. Van Wilgen *et al.* found that shoulder complaints occurred in 33.3 per cent of patients after modified radical neck dissection.¹⁶ Birinci *et al.* found that shoulder dysfunction occurs less significantly in those patients who have minor changes on intra-operative neuro-monitoring of the spinal accessory nerve, compared with those patients with larger changes on neuro-monitoring.²⁰ Other surgical procedures of the neck can also cause injury to the nerve. Iatrogenic spinal accessory nerve injury still occurs in about 3–6 per cent of patients undergoing cervical lymph node biopsies,²¹ and iatrogenic damage to the nerve is a major source of malpractice litigation.²²

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Anatomy review

Although the spinal accessory nerve has been widely discussed in the literature, its function has not been conclusively agreed upon. It is generally accepted as being a motor nerve, supplying the sternocleidomastoid and the trapezius muscles. Emerging works have postulated a nociceptive role of the spinal accessory nerve as well.^{23–25} The nerve is frequently encountered in operations involving both the anterior and posterior triangles of the neck. Accurate, timely and consistent identification of the spinal accessory nerve is crucial for preserving this nerve, and this requires extensive anatomical knowledge.

The XIth cranial nerve is classically described as having a spinal and a cranial root. The spinal root of the spinal accessory nerve arises from the spinal nucleus of the lateral grey matter of cervical vertebrae C1 to C5.²⁶ Filaments from these segments form a trunk before ascending through the foramen magnum into the posterior fossa. This spinal root joins briefly with the cranial root, which originates from the dorsolateral surface of the medulla oblongata,²⁷ and together they exit the skull as the common trunk.²⁴

The common trunk exits the skull via the middle compartment of the jugular foramen, lateral to the vagus nerve and anterior to the IJV.^{13,28} From here it enters the neck, lying compactly between the internal carotid artery and the IJV.¹⁸ The common trunk terminates in the retrostyloid space,²⁶ and again separates into cranial and spinal roots. The cranial root joins the superior ganglion of the vagus nerve, and supplies muscles of the palate, pharynx and larynx.²⁴ The spinal root continues on and passes most commonly laterally (anterior) to the IJV, although incidences vary widely.^{18,29–32} The largest study of 207 necks found a lateral relationship in 96 per cent of cases,³² whilst another study of 84 necks found it in 67 per cent.³³ Less commonly, as shown in our case study described below, the spinal accessory nerve can pass through the IJV. Incidence of this variant ranges from 0.48 to 3.3 per cent, although only nine cases have been reported.^{31,32,34} A fourth variation has been described, where the spinal accessory nerve itself divides and passes both medial and lateral to the IJV.³²

After crossing the IJV, the spinal accessory nerve progresses anterior to the transverse process of the atlas,³⁵ although this is another site of anatomical variance. Durazzo *et al.* found that in 77.5 per cent of cadavers, the spinal accessory nerve lies anteriorly to the transverse process of the atlas, in 20 per cent it lies in the lateral position and in 2.5 per cent it lies medial.³⁰ The spinal accessory nerve descends medial to the styloid process and stylohyoid and digastric muscles. It then passes into (70–80 per cent) or under (20–30 per cent) the sternocleidomastoid,²⁸ in close proximity to the sternocleidomastoid branch of the occipital artery.³⁶

After taking a tortuous course through the sternocleidomastoid muscle, it exits the posterior border at a point 7–9 cm above the clavicle.³⁷ It passes 1 cm superior to Erb's point (where the bundle of sensory nerves from the cervical plexus emerges from the posterior border of the sternocleidomastoid muscle).³⁰ It crosses the posterior triangle of the neck in an inferolateral direction, superficial to the levator scapulae, separated from it by the pre-vertebral layer of deep cervical fascia and adipose tissue.^{18,26,30} It then pierces the trapezius muscle, most commonly at a point 2–4 cm above the clavicle.³⁸

Anatomical landmarks

Several anatomical landmarks have been described in the literature as useful in the identification of the spinal accessory

nerve within the posterior triangle of the neck. They include: (1) the distance between the clavicle and the point at which the spinal accessory nerve passes under or pierces the anterior trapezius;^{13,39} (2) Erb's point – the point at which the bundle of sensory nerves from the cervical plexus emerges from the posterior border of the sternocleidomastoid muscle;^{26,30} (3) the superficial cervical vein at the point where it vascularises the anterior border of the trapezius muscle;⁴⁰ and (4) the sternocleidomastoid branch of the occipital artery.³⁹

Within the anterior triangle of the neck, the anatomical landmarks most commonly reported in the literature are the transverse process of the atlas^{30,35} and the IJV.^{18,26,28,31,32,34}

Case report

We present the case of a selective neck dissection in a 48-year-old male non-smoker, who had squamous cell carcinoma of the left tonsil with a tumour–node–metastasis grading of T₂N₁M₀. The neck dissection was undertaken following a transoral oropharyngectomy. The intra-operative photograph demonstrates the spinal accessory nerve entering the IJV (Figures 1 and 2).

Discussion

Preservation of the spinal accessory nerve in modified radical neck dissection results in significantly increased quality of life for the patient. The literature demonstrates that there is a great deal of variance in the route of the spinal accessory nerve from the skull base through the neck to the anterior

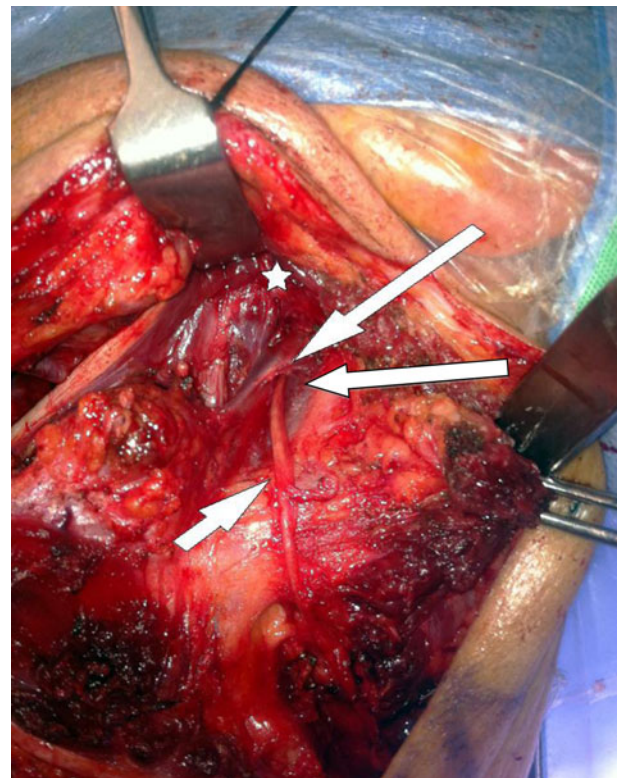


FIG. 1

Intra-operative photograph taken during a left selective neck dissection, demonstrating the accessory nerve entering the internal jugular vein (IJV). (The short white arrow points to the accessory nerve, the long white arrows indicate the IJV either side and the star overlies the posterior belly of digastric muscle.)

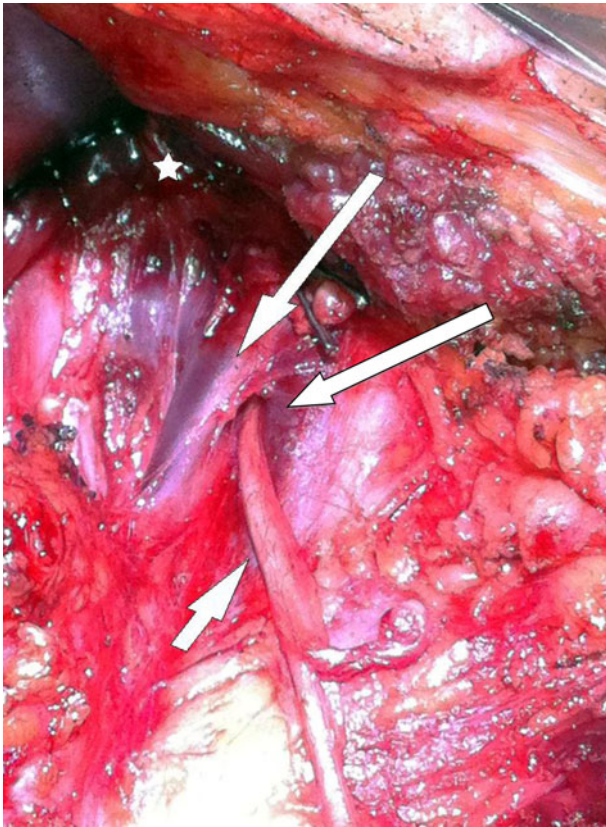


FIG. 2

Magnified (3×) view of Figure 1, showing the accessory nerve running through the internal jugular vein (IJV). (The short white arrow points to the accessory nerve, the long white arrows indicate the IJV either side and the star overlies the posterior belly of digastric muscle.)

border of the trapezius. Many structures in both the anterior and posterior triangles of the neck have been postulated to be useful anatomical landmarks. However, variation clearly exists in the relationship of the XIth cranial nerve to these structures. It is imperative that the head and neck surgeon is mindful of the anatomical variability of the spinal accessory nerve and IJV relationship when dissecting the accessory nerve, in order to avoid accidental injury to either structure at the skull base.

- Spinal accessory nerve anatomy has been widely discussed in the literature
- The nerve is generally considered to have a motor-related function, although emerging evidence indicates a nociceptive role
- The spinal accessory nerve is frequently encountered in surgery involving the anterior and posterior triangle of the neck
- The nerve is vulnerable to surgery from the skull base to point of entry into trapezius
- This article highlights significant anatomical variations at certain points of the nerve's route, particularly at the internal jugular vein
- Awareness of variation is important to prevent significant morbidity associated with nerve injury

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