Review Article

The Accessory Nerve

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The radical neck dissection (RND) in the management of head and neck cancers may be done in the expense of the spinal accessory nerve (SAN) [1]. De-innervations of the muscles supplied by SAN and integrated in the movements of the shoulder joint, often result in shoulder dysfunction. Usually the result is shoulder syndrome which subsequently affects the quality of life[1]. The modified radical neck dissections (MRND) and selective neck dissection (SND) intend to minimize the dysfunction of the shoulder by preserving the SAN, especially in supra-hyoid neck dissection (Level I-III±IV) and lateral neck dissection (level II-IV)[2, 3]. This article aims to focus on the SAN to increase the awareness during MRND and SND.

Keywords: Spinal accessory, Sternocleidomastoid, Trapezius, Cervical plexus.

The accessory nerve is a motor nerve but it is considered as containing some sensory fibres. It is formed in the posterior cranial fossa by the union of its cranial and spinal roots [4-8] (i.e. the internal and external branches respectively[9,10]) but these pass for a short distance only[11]. The cranial root joins the vagus nerve and considered as a part of the vagus nerve, being branchial or special visceral efferent nerve[4,5,9,11]. The spinal root may be considered as general somatic[12], special visceral efferent[7,13] or mixed, depending on the view taken of the embryological origin of the sternocleidomastoid and trapezius muscles which it supply[11].

The custom of describing the two roots as a single cranial nerve has been followed in the standard references of anatomy. The spinal root is assumed purely motor, but there is an evidence for the presence of afferent fibers (proprioceptive) provided by the occurrence of ganglion on the nerve in the prenatal and early postnatal human materials[10]. The nerve may communicate with the dorsal roots of the upper cervical spinal nerves, although such observations are not confirmed in adult materials[11].

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The Cranial Root:

The cranial root is the smaller, attached to the post-olivary sulcus of the medulla oblongata (Fig.1)[8,10] and arises forms the caudal pole of the nucleus ambiguus (SVE)[4, 7, 9] and possibly also of the dorsal vagal nucleus[11, 14], although both of them are connected[11].

The nucleus ambiguus is the column of large motor neurons that is deeply isolated in the reticular formation of the medulla oblongata[11], it lies midway between the spinal nucleus of the trigeminal nerve and the inferior olivary complex. The nucleus ambiguus continues downwards into the spinal nucleus of the accessory nerve. The lower part of the nucleus ambiguus gives rise to the cranial root of the accessory nerve[4,9,11,12].

The cranial root runs lateral to the jugular foramen, perhaps there is an interchanging fibers here with the spinal root[11], in which it unites for a short distance (Fig.1). Also it connects with the superior vagal ganglion[4]. It traverses the jugular foramen, separates from the spinal root and continues over the inferior vagal ganglion, in which it adheres[11] and becomes inseparable from the vagus nerve below this level[10]. Usually the cranial root distributed mainly in the pharyngeal plexus, the external laryngeal nerve[10], and the recurrent (inferior) laryngeal branches of the vagus nerve[7, 9], and this is probably the source

of the vagal motor fibres which run in the pharyngeal plexus branches to the palatal muscles.

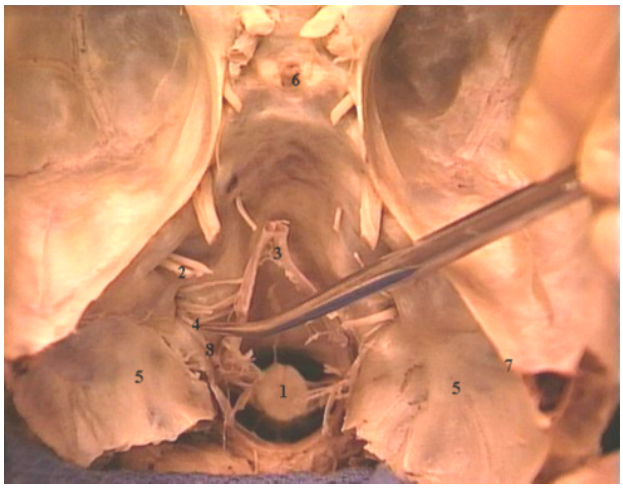

Figure.1: Shows the cranial nerves in the posterior and middle cranial fossae. (*Kyle E & Lyun J. Human interactive tutorial and reference. 1995. University of Florida & Gold Standard Multimedia*) [17]
1.Spinal cord (cut). 2.Facial and Vestibulocochlear nerves (internal acoustic meatus). 3.Basilar artery. 4.Cranial root (part) of the accessory nerve. 5.Posterior cranial fossa. 6.Connecting stalk of the pituitary gland. 7.Tentorium cerebelli (cut). 8.Spinal part of the accessory nerve.

Some filaments continue into the vagus below the inferior vagal ganglion to be distributed with recurrent laryngeal nerve and also with the cardiac branches of the vagus[11].

The Spinal Root:

The spinal root arises from the spinal nucleus of the accessory nerve[4, 11]. The spinal nucleus of the accessory nerve is located laterally in the spinal anterior grey column. This nucleus extends from midlevel of the pyramidal decussation at the medulla and downwards as far as the upper fifth[4] (or sixth) cervical segment of the spinal cord (mainly C2, 3 and 4)[4,6,9,11]. Inferiorly the spinal nucleus of the accessory nerve forms the lateral processes of the anterior grey horns of the spinal cord.

The spinal nucleus of the accessory nerve receives projections fibre from variety of sources. It is thought to receive corticospinal fibres from both cerebral hemispheres[12]. The corticospinal fibres designed for the sternocleidomastoid neurons in the cervical part of the spinal cord undergo double decussation in the brainstem. Consequently the motor cortex on one side controls the sternocleidomastoid of that side.

Fibers arising from the nucleus pass laterally traversing the lateral white columns of the spinal cord. The fibres emerge at the lateral side of the cervical part of the spinal cord[9] between the ventral and the dorsal spinal roots[4, 6, 11] (Fig.2), and ascend on the side of the spinal cord joining together forming a nerve trunk[7]. The nerve trunk ascends in the subarachnoid space behind the denticulate ligaments anterior to the dorsal roots of the spinal nerves to reach the foramen magnum. Here, it enters the skull through foramen magnum behind the vertebral artery[11] over the top of denticulate ligament[6, 8] to reach the posterior cranial fossa. It turns upward and laterally over the lateral margin of foramen magnum [11]. It unites with the cranial root just medial to the jugular foramen (endocranial opening of the jugular foramen)[6], to form the trunk of the accessory nerve (Fig.1).

Trunk of the accessory nerve traverses the jugular foramen in the middle compartment (pars nervosa) in a single dural sheath with the vagus nerve[4, 6], but separated from it by a fold of arachnoid mater[11]. At the endocranial opening of the jugular foramen, the vagus and the accessory nerves could not be distinguished as separate nerves. Even the course of the vagus and accessory nerves deep in the foramen could not be determined by dissection or on CTscan[15]. The two nerves travel together as they enter the foramen in positions changing from anterior to and inferior to the jugular spine of the temporal bone[15]. In the jugular foramen the vagus nerve may receives one or two rami from the cranial root or join it for short distance[11].
At its exit from the jugular foramen the two roots of the accessory nerve separate. The spinal root turns posterolaterally, usually posterior to the internal jugular vein. Here the

nerve crosses the transverse process of the atlas[14] and is crossed itself by the occipital artery[11]. The accessory nerve then descends obliquely, medial to the styloid process, stylohyoid, and posterior belly of digastric muscle. With the superior sternocleidomastoid branch of the occipital artery it reaches the upper part of the sternocleidomastoid muscle, enters its deep surface[8], between its upper two quarters[11], and joins branches of the second and third cervical spinal nerves[6] (Fig.3) to supply the muscle with motor and sensory fibers respectively[11]. The spinal root emerges from the sternocleidomastoid muscle a little above the midpoint of the muscle's posterior border[14], then crosses the posterior triangle of the neck with characteristic wavy course being adherent to the inner surface of the investing deep cervical fascia[7].

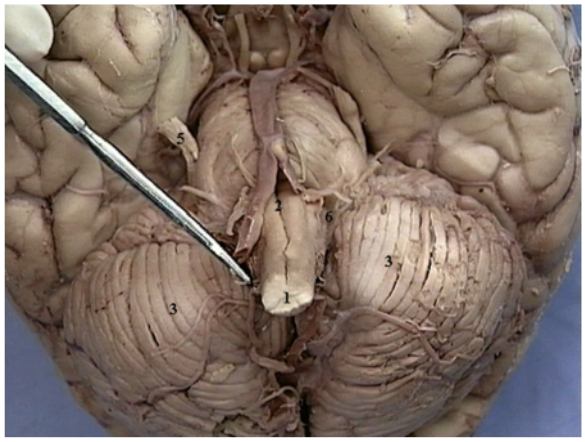

Figure.2: Shows the base of the brain. (*Kyle E & Lyun J. Human interactive tutorial and reference. 1995. University of Florida & Gold Standard Multimedia*).
1. Spinal cord. 2. Anterior median fissure of the Medulla oblongata. 3. Cerebellum. 4. Spinal root (part) of the Accessory nerve (at the tip of the pointer). 5. Trigeminal nerve. 6. Cranial root of the accessory nerve arises from the retro-olivary sulcus.

Here the nerve lies on levator scapulae muscle[8, 14] and is separated from this muscle by the prevertebral layer of the deep cervical fascia and adipose connective tissue[11]. In the posterior triangle of the neck, the spinal accessory nerve is comparatively superficial[11], being closely related to the superficial cervical lymph nodes (cervicales laterales[6, 10]) and receives branches from the ventral rami of the third and fourth cervical spinal nerves. About five centimeters above the clavicle it passes behind the anterior border of trapezius muscle[6, 14] at the junction of the middle and lower thirds of the muscle's anterior border and forming a plexus on its deep surface. From this plexus the trapezius muscle is innervated[11].

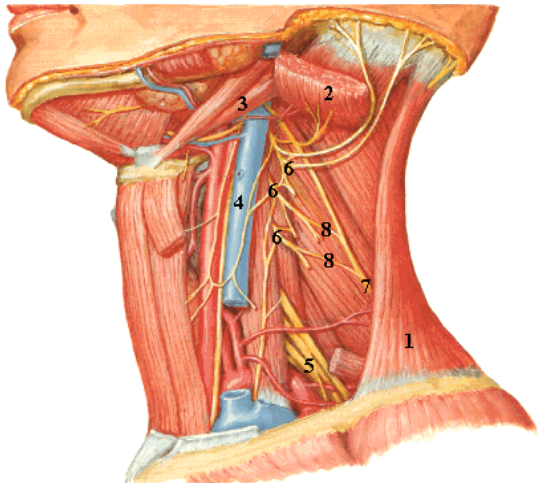

Figure.3: Shows the sensory branches from the cervical plexus (C3 and4) to Accessory nerve. (*Frank H & Myers H. Interactive atlas of Human anatomy. 1995, Novartis medical education*).
1.Trapeziusmuscle.2.Sternocle-idomastoid muscle (reflected upward). 3. Posterior belly of digastric muscle. 4.Internal jugular vein. 5.Brachial plexus. 6.Cervical plexus. 7.Accessory nerve. 8.Branches from the cervical plexus to the accessory nerve.

The spinal root of the accessory nerve is the sole motor supply to the sternocleidomastoid muscle[9]. Branches from the second and third cervical spinal nerves convey proprioceptive fibers from the muscle[11]. The spinal root of the accessory nerve supplies the descending part of the trapezius muscle, whereas the transverse and ascending parts of the muscle are innervated by both spinal accessory nerve and the cervical plexus[18]. But, the innervations of the trapezius muscle is less certain; some consider that the third and fourth cervical spinal nerves are purely

proprioceptive fibers[14], but others consider that the cervical nerves also supply motor fibres to the trapezius muscle[11].

Ultrasonography (Fig.4) allows visualization of the normal accessory nerve as well as changes after accessory nerve palsy[19]. The ultrasonography uses a 5-to12-MHz linear transducer. On High-resolution ultrasonography (HRUS), the accessory nerve appeared as a small hypoechoic oval structure in the transverse plane and as a hypoechoic linear structure in the longitudinal plane. The diameter of the nerve is approximately one mm. It is best identified at the lateral cervical (posterior) triangle of the neck, after identification of the trapezius and sternocleidomastoid muscles, which aid as guiding structures. This appearance was previously reported by Silvestri *et al*.[20], who stated that the appearance would most probably be caused by a number of neuronal fascicles embedded in the epineurium. Furthermore, they stated that a small nerve such as the recurrent laryngeal nerve appears hypoechoic.

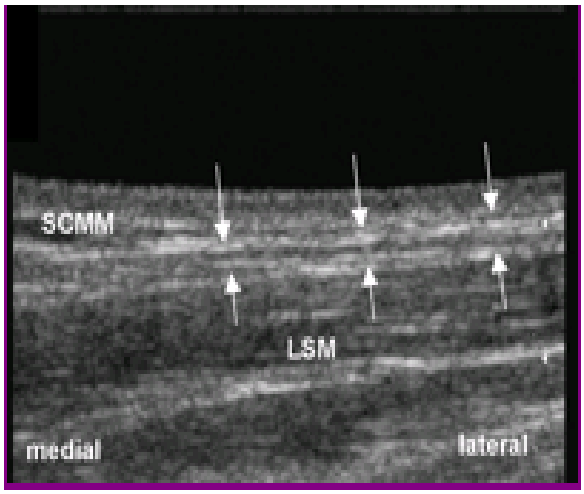

Figure.4: Shows Ultrasonography of the accessory nerve, it appears like tubular structure. The arrows show the nerve course. SCMM - Sternocleidomastoid muscle. LSM-Levator scapulae muscle.

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