European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 9, Issue 3, Winter 2022

ORIGINAL RESEARCH

Revisiting The Attachment And Innervation Of Cadaveric Sternocleidooccipitomastoid Muscles And Its Clinical Implications

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ABSTRACT

Sternocleidooccipitomastoid (SCOM) muscles of16 cadavers were dissected over a period of eight years to study possible clinical significance. It was observed that fifteen cadavers had the classical attachment and innervation as described in the standard textbooks of anatomy. But SCOM in one male cadaver revealed bilateral anomalous attachments. Both sides SCOM had supernumerary clavicular heads whereas the sternal heads (LSH, RSH) had the usual attachments. On the right side there were three clavicular heads (RCH1, RCH2, RCH3) out of which medial two heads (RCH1 & RCH2) joined with RSH at the level of cricoid cartilage to get inserted on the mastoid process extending up to the superior nuchal line. The RCH3 remained separate up to the level of greater cornu of hyoid bone, where it gives a slip to the main belly before inserting on the superior nuchal line, as two slips. On the left side also, there were three clavicular heads (LCH1, LCH2, LCH3) which merged with LSH at the level of thyroid prominence before attaching on the mastoid process and superior nuchal line. At the level of greater cornu of hyoid bone, another supernumerary slip arising from deep aspect of left main belly was noticed which inserted on the medial aspect of superior nuchal line and external occipital protuberance. The left SCOM had an additional twig from ansa cervicalis apart from accessory nerve whereas the right SCOM had the usual nerve supply. During ablative and reconstructive surgeries of the face and oral cavity surgeons should remember the variation in clavicular head and additional nerve supply of SCOM.

Key words: Sternocleidooccipitomastoid, ansa-cervicalis, variant, anatomy, supernumerary.

INTRODUCTION

The sterno-cleido-occipito-mastoid muscle (SCOM) is so named because of its four attachments on anterior surface of manubrium sterni, medial one third of superior surface of clavicle, lateral surface of mastoid process, which extends on the superior nuchal line of the occipital bone. SCOM is described to be present in two layers with five heads three heads are in the superficial layer superficial sternomastoid SM, sterno-occipital SO, and a cleido-occipital part CO, and two in the deep layer consisting of a deep sternomastoid SM and a

cleido-mastoid CM part (Bergman et al).SCOM can be called the "Pandora's box" as it covers many important structures such as the accessory nerve, brachial plexus, cervical plexus nerves, carotid artery, internal jugular vein, and jugular chain of lymph nodes (Hasan, 2011). Variations of SCOM in relation to attachment, supernumerary heads and nerve supply have been reported in abundance. The objective of this study was to demonstrate some unusual variation in attachments and innervation of SCOM and the possible clinical significance.

MATERIALS AND METHODS

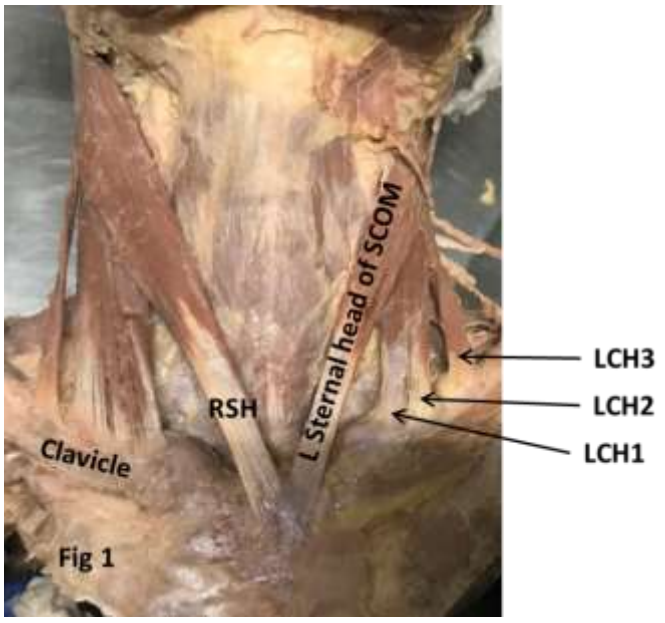
Over a period of eight years sixteen cadavers were dissected during routine dissection classes in the department of Anatomy at North DMC Medical College, Delhi. The SCOM was examined in detail on both sides of all 16 cadavers (32 muscles in total) for its origin, insertion and nerve supply. In one male cadaver abnormal attachments of SCOM was noticed, the remaining showed classical attachments as described in standard textbooks. The nerve supply to each muscle was identified and carefully dissected. An unusual nerve supply from the descendens hypoglossi to the left SCOM was noticed, in the same male cadaver. Meticulous dissection was carried out for all the SCOM muscles in all cadavers and appropriate photographs were taken.

RESULTS

The dissected SCOM in 15 cadavers had tendinous attachment on the anterior surface of the manubrium sterni that joined the fleshy muscular clavicular head. The fleshy clavicular head passed deep to the sternal head spiralling it around its posterior border approximately in the middle of the neck, forming a lesser supraclavicular fossa above the clavicle. The SCOM had a tendinous insertion on mastoid process with an aponeurotic extension onto the superior nuchal line on the occipital bone. The accessory nerve and branches from the cervical plexus were noted to enter into the deep surface of the muscle approximately in the middle of the muscle (Table 1).

In one of the male cadavers, the SCOM of both sides had supernumerary clavicular heads whereas the left and right sternal heads (LSH& RSH) had the usual attachments (Fig.1).

Fig 1- Photograph shows bilateral 3 clavicular heads of SCOM, origin of sternal heads appears normal. LCH- left clavicular heads



On the right side there were three clavicular heads (RCH1, RCH2, RCH3) (Fig.2a) out of which medial two heads (RCH1 & RCH2) joined with RSH at the level of cricoid cartilage (CC) to get inserted on the mastoid process (MP) extending up to the superior nuchal line (SNL)(Fig.2b).

Right Lateral view.

Fig 2a: Medial two clavicular heads (RCH1 & RCH2), out of the three heads joined the RSH at the level of cricoid cartilage (CC). The third head (RCH3) remained separate up to the level of greater cornu of hyoid bone (HB), where it gives a slip to the main belly.

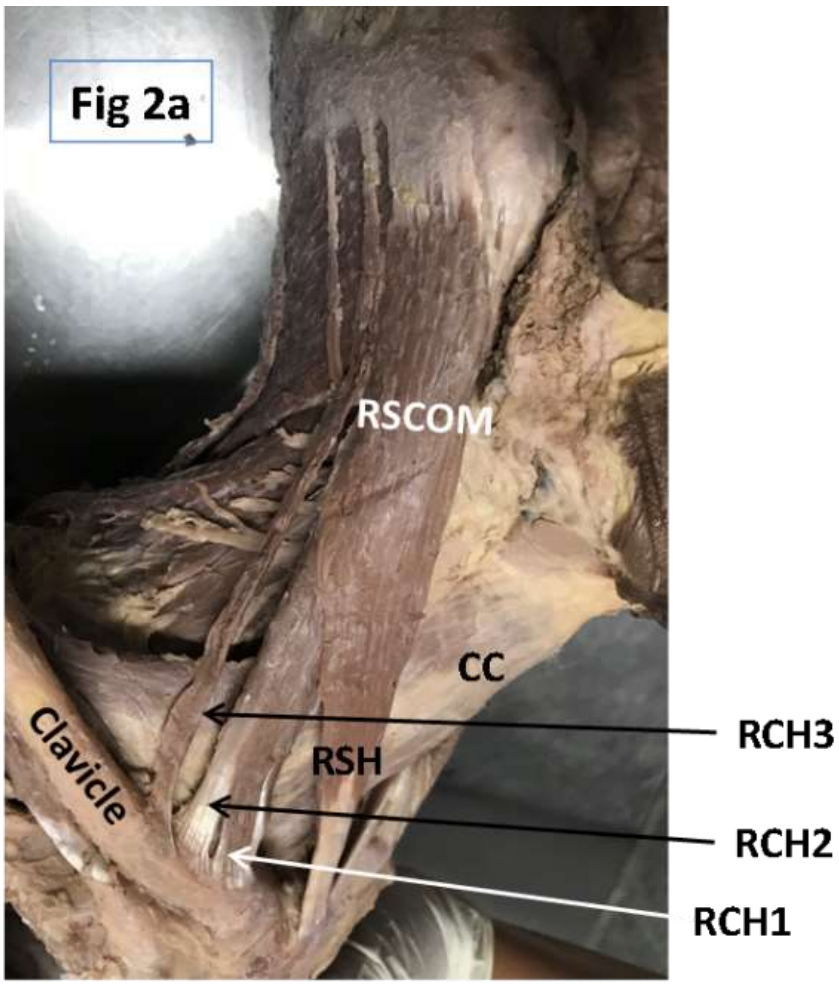
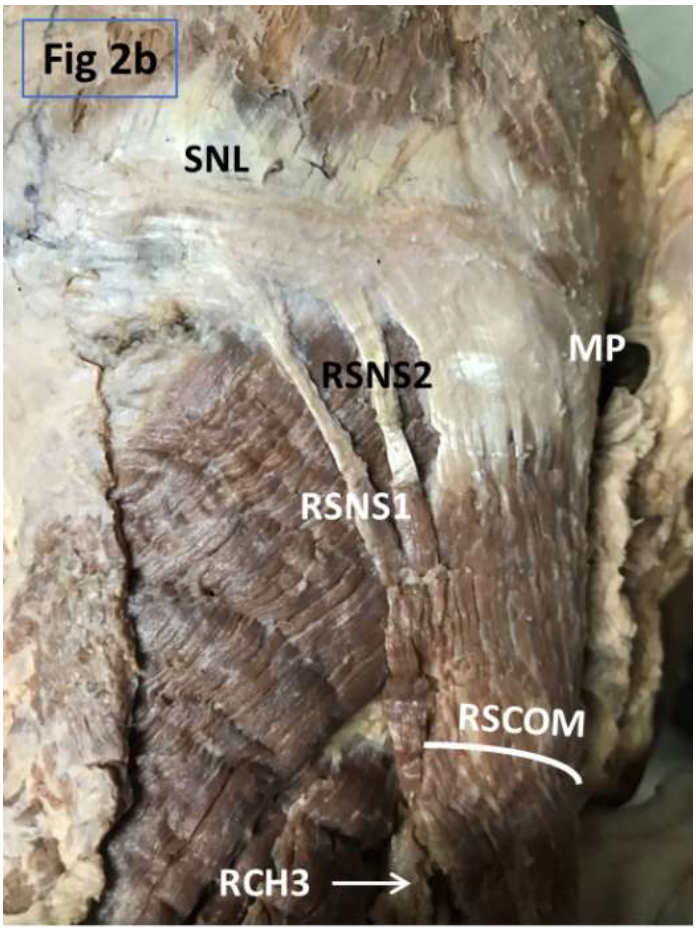


Fig 2b: After giving a slip to the main belly, the third head divides into two supernumerary nuchal slips (RSNS1, RSNS2) before inserting on the superior nuchal line (SNL). The main belly inserted on the mastoid process (MP) extending up to the SNL.



The RCH3 remained separate up to the level of greater cornu of hyoid bone (HB), where it gives a slip to the main belly (Fig.2b). After giving a slip to the main belly, the third head divides into two supernumerary nuchal slips (RSNS1, RSNS2) before inserting on the superior nuchal line (SNL).Therefore, there were three additional clavicular heads, accompanying the main sternal head making four heads in total. The main belly inserted on the mastoid process (MP) extending up to the SNL.

Whereas, on the left side at the level of thyroid prominence, the three clavicular heads (LCH1, LCH2, LCH3) merged with left sternal head (LSH) before attaching on the mastoid process and superior nuchal line (Fig3a, 3b). In similarity with right side, at the level of the greater cornu of hyoid bone (HB), another supernumerary nuchal slip (LSNS) arises from deep aspect of left main belly which inserted on the medial aspect of superior nuchal line (SNL) and external occipital protuberance (EOP) (Fig 3b).

Left Lateral view.

Fig 3a: At the level of thyroid prominence, the three clavicular heads (LCH1, LCH2, LCH3) merged with LSH before attaching on the mastoid process and superior nuchal line.

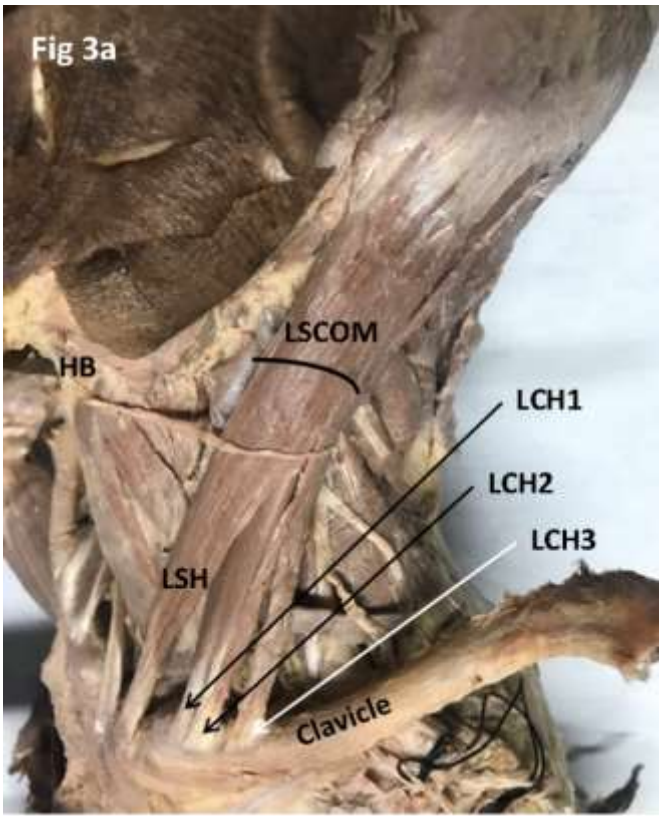
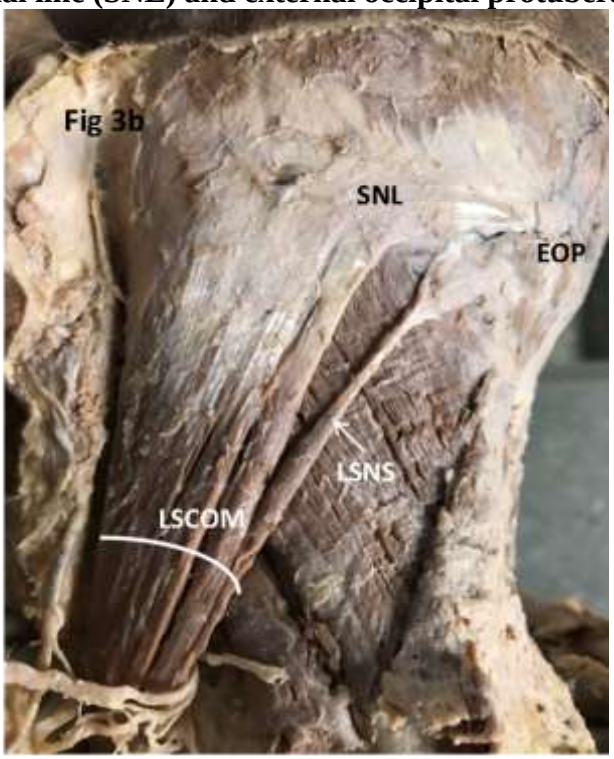


Fig 3b: At the level of greater cornu of hyoid bone (HB), another supernumerary nuchal slip (LSNS) arises from deep aspect of left main belly which inserted on the medial aspect of superior nuchal line (SNL) and external occipital protuberance (EOP).



Further dissection has shown the usual nerve supply to right side SCOM from the Eleventh Cranial nerve (XI) and branches from cervical plexus, probably from C3, C4 (Fig 4a). However, on left side, apart from usual nerve supply (XI, C3, C4), the SCOM got two additional twigs (T1, T2) from descendens hypoglossi carrying C1 & C2 fibres (fig 4b). T1 innervates at the junction of upper and middle third whereas T2 at the junction of middle and lower third of SCOM (Fig 4b).

Fig 4a: Right lateral view shows the usual nerve supply to RSCOM from Eleventh Cranial nerve (XI) and proprioceptive fibres from C3, C4.
IJV- Internal Jugular Vein, SBO- Superior belly of Omohyoid, CCA- Common Carotid Artery, PBD- Posterior belly of digastric

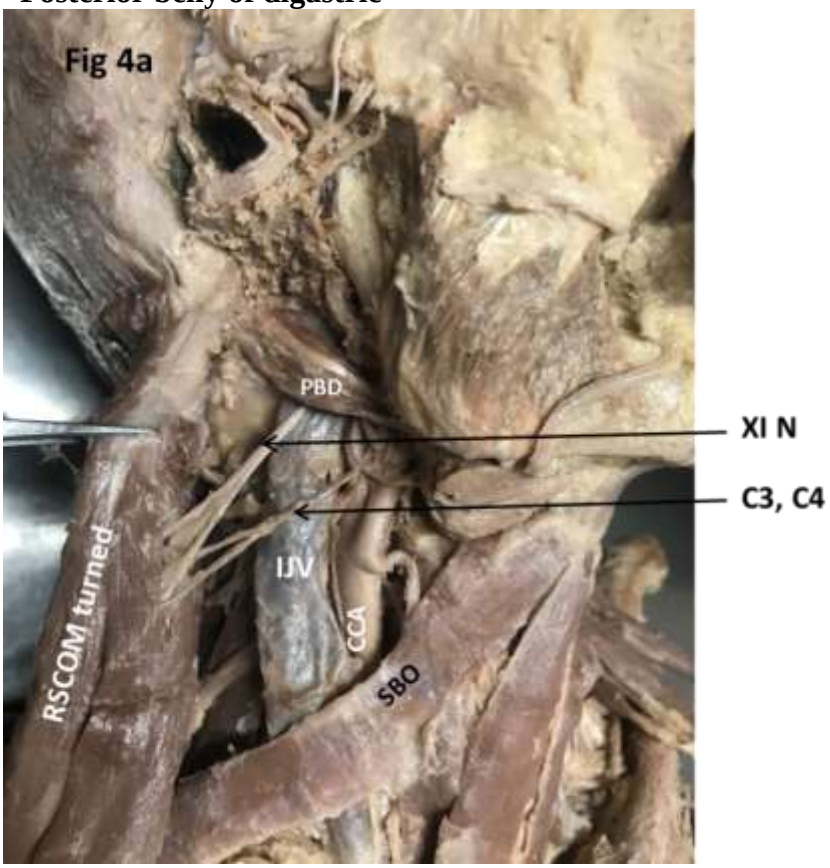


Fig 4b: Left lateral view. Apart from usual nerve supply (XI, C3, C4), the LSCOM got two additional twigs (T1, T2) from descendens hypoglossi carrying C1 & C2 fibres. T1 innervates at the junction of upper and middle third whereas T2 at the junction of middle and lower third of LSCOM. CCA- Common carotid artery, IRAC- Inferior root of ansa cervicalis, SRAC- Superior root of ansa cervicalis, AC- Ansa cervicalis, SG- Submandibular gland.

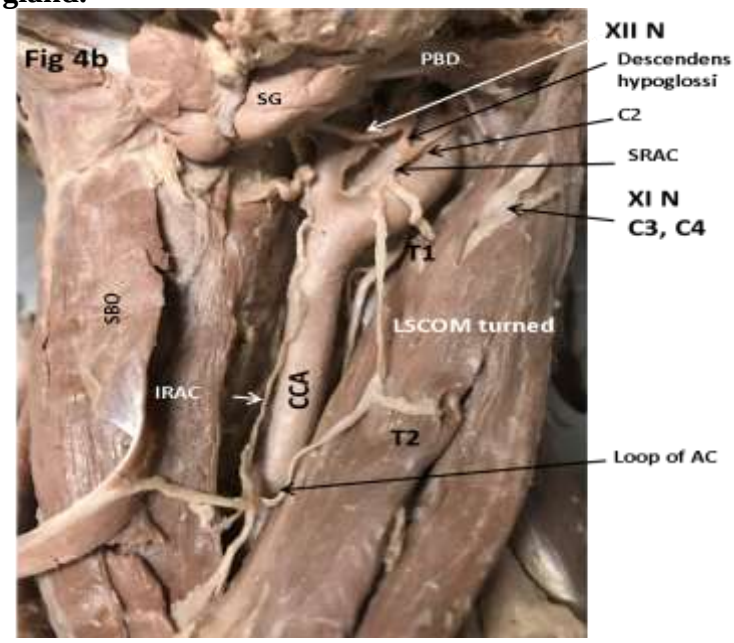


Table1: Showing the comparison of the reported muscle attachment and its variations from standard textbooks, literature with the present study.

Available reports & gender distribution (M/F)	Sternal attachment	Clavicular attachment	Mastoid attachment	Nuchal attachment	Innervation
Classical description (Grays Anatomy, 2021) Gender not mentioned	Tendinous	Fleshy	Tendinous	Aponeurotic	XI & C2, C3
Present study, 15/16 cases (12M, 3F), 94%,	Tendinous	Fleshy	Tendinous	Aponeurotic	XI & C2, C3
1/16, M	Tendinous	Fleshy with 3 heads	Tendinous	Aponeurotic with 1 or 2 nuchal slips	XI & Descendens hypoglossi
Mori, 1964, Gender not mentioned	450/510 cases, 88.6%, two sternal and clavicular heads of SCOM forming independent muscles				
Wood, 1879, Gender not mentioned	33%, supernumerary cleidooccipital independent head				

DISCUSSION

As far our knowledge goes, this is the first report of unique variation in the attachment and innervation of the SCOM. The unique findings in the present study were the unusual innervation from descendens hypoglossi and the extension of attachment of SCOM up to the EOP.

In classic anatomical literature, the sternal and clavicular portions of sternocleidomastoid muscle are attached to the sternum and clavicle. The muscle is inserted in the lateral surface of the mastoid process and the lateral half or the two-third part of the superior nuchal line of the nape of the neck, in the occipital bone (Gardner, 1988). Knowledge of the anatomical variations in muscles of the neck is necessary as it elucidates some specific anatomical variations in the area. There are reports concerning the clavicular origin of the SCOM, it was subdivided occasionally into several slips, separated by narrows intervals (Gray, 1918; 1977). Variability in anatomy of SCOM may cause complications while trying to access the vital structures that are located in the lesser supraclavicular fossa. There may be damage to the spinal accessory nerve, and unsuccessful cannulation of the internal jugular vein may also occur.

Gruber, 1885, reported innervation of the muscle from two extra twigs from the ansa cervicalis whereas in the present case it is from the descendens hypoglossi (Gruber, 1885; Miyauchi, 1983). This kind of anomaly may arise during the early development of the somites. Various somitomeres join to form a composite muscle like SCOM. Differential innervation of the somitomeres during early development may give rise to this kind of anomalous innervation. During development different chemoattractive and chemorepulsive factors secreted by the somites determine the final innervation of a muscle. A similar event might have happened during the development of the SCOM muscle in the present study. (Larsen's, 2009)

Its innervation is attributed to the cranial accessory nerve (XI), which in general passes through the muscle; as well as by ventral branches of the second, the third and sometimes the fourth spinal nerves (Machado, 1992). The identification (and preservation where possible) of both the hypoglossal and accessory nerves during upper neck surgery is essential to reduce patient morbidity postoperatively. In this context, recognition of the common anatomical variants in the course and distribution of these nerves is important. Variation in innervation of SCOM and trapezius by the spinal root or part of the accessory nerve and trapezius by the cervical plexus are well recognised [Bergman, 1988]. However, less is known about other nerves that might provide a motor supply to SCOM. SCOM may receive both sensory and motor innervations from the cervical plexus, mainly from C2, 3 and sometimes C4. Studies have described innervation by a branch originating from the lower (C2, 3) component of the ansa cervicalis [Shima, 1956] or the C1 (superior) division of the ansa cervicalis in 24 % in a cadaveric study of 50 dissected necks [Miyauchi,1983]. The motor nucleus of the hypoglossal nerve in the medulla oblongata is in continuity with the general somatic efferent column in the developing spinal cord, which contains the neuronal cell bodies that give rise to the motor part of the cervical plexus [Krause, 1876]. The axons of the neurons that contribute to the superior branch of the ansa cervicalis (C1 and sometimes C2) travel with the hypoglossal nerve [Sanli, 2006; Hassan, 2011; Krause, 1876]. According to phylogenetical and ontogenetical studies of the accessory nerve and the musculature are considered that the sensory element, included in the accessory nerve in lower vertebrates and embryos of mammals, migrated at later stages to the dorsal roots of adjacent cervical nerves, and subsequently, some motor fibres in the accessory nerve also migrated to the cervical nerves.

The ansa cervicalis (AC) is a union of nerves found in the anterior triangle of the neck, which gives motor innervation to the infrahyoid muscles. Variability in the course and location of the AC along the great vessels of the neck, as well as the significant differences observed in

the arrangement of its contributing roots and regional branching patterns, pose a great challenge to surgeons during surgical procedures of the neck (Loukas et al., 2007). The ansa cervicalis nerve has become a prime choice for use in laryngeal reinnervation because of its proximity to the larynx and it is quite active during phonation (Lee et al., 2007). The ansa cervicalis nerve is formed by the junction of two main nerve roots (descending and ascending). The descending root is derived from the ventral ramus of C1 through the hypoglossal nerve. The ascending root is derived from the ventral rami of C2 & C3. A loop is formed at the point of their connections. With the expanding use of the ansa cervicalis for reinnervation procedures and the fact that it is located in the vicinity of major nerves and vessels of the neck, knowledge of the topography and morphology of this loop is necessary for the modern era (Loukas et al., 2007). Any variation in the course, contributing roots, or branching pattern of the ansa cervicalis potentially alters and perhaps complicates the course of any procedure involving this nerve. So, in our study, we found the usual nerve supply to the right side SCOM from the eleventh cranial nerve (XI) and proprioceptive fibres from C3, C4. However, on the left side, apart from the usual nerve supply (XI, C3, C4), the SCOM got two additional twigs (T) (T1& T2) from descendens hypoglossi carrying C1 & C2 fibres. T1 innervates at the junction of upper and middle third whereas T2 at the junction of middle and lower third of SCOM.

The detailed knowledge about the common variations in anatomy and innervation helps for cannulation of internal jugular vein during central venous access, temporary haemodialysis, the placement of inferior vena cava filters and other devices. Hence, the present study will add new information towards the previous studies which will be helpful for anatomists and surgeons while performing surgeries like branchial cyst removal and dealing with the myocutaneous flaps.

CONCLUSION

The unusual variation reported in present study was in addition to supernumerary clavicular heads, there were also supernumerary nuchal slips at the site of insertion which is not usually found, Also, apart from usual nerve supply (XI, C3, C4), the SCOM on left side got two additional twigs (T1, T2) from descendens hypoglossi carrying C1 & C2 fibres. The knowledge of such a variation is a matter of concern to general and plastic surgeons, radiologists and oncologists who are dealing with this region. Surgeons should have the knowledge of these nuchal slips to use for various reconstructive procedures along with the clavicular heads. In a failure of conservative treatment of primary spasmodic torticollis, rhizotomy of spinal XI nerve & ventral rami of C1, C2 is being recommended (Hua et al 2018). Therefore, the contribution of ventral rami of C1 & C2 to SCOM should also be kept in mind during a surgical procedure.

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