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Classification of the Patterns of the Emerging Branches of the Superficial Cervical Plexus

Clasificación de los Patrones de las Ramas Emergentes del Plexo Cervical Superficial

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SUMMARY: The cutaneous branches of the superficial cervical plexus (SCP) emerge at variable points, from beneath the posterior margin of the sternocleidomastoid muscle and from this point radiate like "spokes of a wheel" antero-inferiorly and postero-superiorly. This study aimed to classify the emerging points of the branches of the superficial cervical plexus in relation to their location on the sternocleidomastoid muscle. In order to classify the emerging points of the superficial cervical plexus, the sternocleidomastoid muscle was first measured from mastoid process to clavicle; subsequently each branch of the superficial cervical plexus was measured from the mastoid process to their exit points. The emerging points of the superficial cervical plexus branches were classified according to Kim *et al*. (2002) seven categories: Type I (32 %); Type II (13 %); Type III (35 %); Type IV (13 %); Type V, VI, VII (2 %). The order in which the superficial cervical plexus branches emerged from the posterior margin of the sternocleidomastoid muscle remained constant, i.e. lesser occipital, great auricular, transverse cervical and supraclavicular nerves. Knowledge of emerging points may assist in the effective anaesthesia to all branches of the superficial cervical plexus during surgical procedures of the neck, viz. carotid endarterectomy and thyroid surgery.

KEY WORDS: Superficial cervical plexus; Fetal, emerging points; Branching patterns.

INTRODUCTION

In accordance with standard anatomical literature, the superficial and deep cervical plexuses innervate areas of skin on the head, neck and chest, muscles of the neck and the diaphragm (Ellis & Fieldman, 1993; Standring *et al*., 2008). The formation of the cervical plexus is well defined, however there is paucity of literature regarding the emerging patterns and relations of the deep and superficial plexuses.

The cervical plexus is formed by the ventral primary rami of the first four cervical nerves and each branch receives a grey ramus communicans from the superior cervical ganglion to form three simple loops (Ellis & Fieldman; Mcminn, 1999; Standring *et al*.; Singh, 2015). The ventral rami of the second, third and fourth cervical nerves divide into ascending and descending branches, which give rise to the superficial and deep cervical plexuses (Standring *et al*.).

In the neck, the sternocleidomastoid muscle is a crucial muscular landmark, which forms the sternocleidomastoid region. The sternocleidomastoid muscle visibly divides each side of the neck into an anterior and posterior triangle (Moore *et al*., 2014). Standard anatomical literature describes the superficial cervical plexus as it emerges from beneath the posterior margin of the sternocleidomastoid muscle as four distinct cutaneous branches viz. lesser occipital, transverse cervical, great auricular and supraclavicular nerves; and the deep cervical plexus as muscular branches, communicating branches, ansa cervicalis and the phrenic nerve (Stranding *et al*.). However, there have been controversial opinions with regard to the emergence of the superficial cervical plexus, as well as its course and branching patterns (Ellis & Fieldman; Suresh & Templeton, 2004).

The cutaneous branches of the superficial cervical plexus are located at or about the midpoint of the posterior margin of the sternocleidomastoid muscle and from this point radiate like "spokes of a wheel" antero-inferiorly and postero-

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superiorly (Miller, 1981). Moore & Dalley (1999), suggested the emergence of these nerves around the middle of the posterior margin of the sternocleidomastoid muscle, which is clinically known as the nerve point of the neck or Erb's point. Salasche & Bernstein (1988), Monsen (1992) and Nason *et al*. (2000) describe this point as the "great auricular point".

In addition, Cramer *et al*. (2004), stated that these superficial cervical plexus branches course around the posterior surface of the sternocleidomastoid muscle and pierces the cervical fascia to emerge from behind its midpoint in proximity to one another. Hollinshead (1974) suggested that the upper three branches of the superficial cervical plexus appear at the posterior edge of the sternocleidomastoid muscle and the lowest branch is not intimately related to the posterior margin of the sternocleidomastoid muscle.

The second to fourth cervical nerves of the superficial cervical plexus innervate the dermatome level of the anterior and lateral aspects of the neck, therefore regional blocks of afore-mentioned plexus has been conducted to anesthetized the anterior triangle of the neck (Motamed *et al*., 2004; Karamanlioglu *et al*., 2005; Tarekegn *et al*., 2017). Clinically, regional anesthetic block of the cervical plexus is an increasingly available alternative for surgery of the, viz. thyroid surgery and is particularly used for carotid endarterectomy because of the possible overall lower incidence of morbidity and mortality neck (Santamaria *et al*., 2004; Suresh & Templeton; Pintaric *et al*., 2007; Tarekegn *et al*.). Kim *et al*. (2002) stated to complete an effective anaesthetization of the superficial cervical nerves, the anaesthetic should be inserted into the middle aspect of the posterior margin of the sternocleidomastoid muscle (Gupta *et al*., 2013). In addition, there are advancements in clinical practice whereby the use of high-resolution ultrasound imaging of these plexuses is utilized for cervical plexus blocks (Roessel *et al*., 2007).

The various branching patterns and distribution of the superficial cervical plexus may lead to surgical complications while conducting anaesthetic techniques (Gupta *et al*.), therefore this study aims to classify the patterns of the emerging branches of the superficial cervical plexus in adult and fetal cadavers in the KwaZulu-Natal region.

MATERIAL AND METHOD

Forty fetuses of gestational age of approximately 15 to 28 weeks and fifteen adult cadavers were obtained from the Department of Clinical Anatomy, University of KwaZulu-Natal (Westville and Nelson Mandela School of Medicine campuses) in accordance with the National Health Act 61 of 2003. Ethical Clearance was obtained (BF 156/07).

Selection criteria. Fetuses and adult cadavers with a neck region that appeared normal and free of overt pathology were included in this study, while fetuses and adult cadavers with signs of injuries, trauma or pathology in the lateral and posterior compartments of the neck were excluded from this study.

Dissection procedure. Anatomical dissection of the posterior triangle of the neck and deep microdissection of the prevertebral space was performed on the fetal and adult cadaveric specimens. The first skin incision was made from the mastoid process to the lateral end of the clavicle. The second incision was from the medial end of the clavicle to a point 3.0 cm lateral to acromion of the scapula (Fig. 1a). The skin was then reflected anteriorly to the midpoint of the

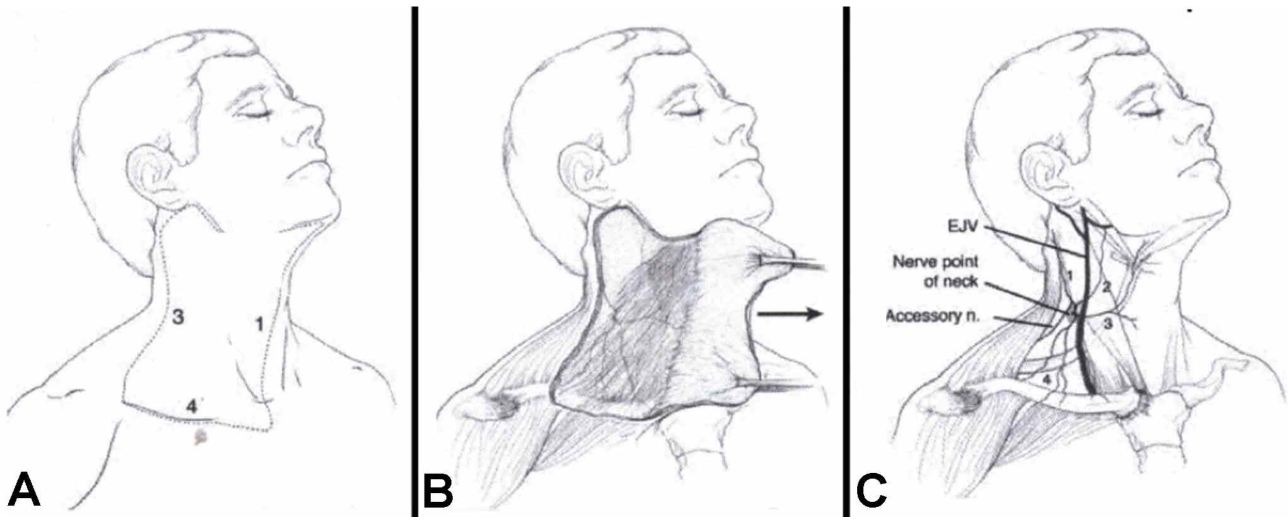

Fig. 1. Illustration of dissection procedure (Adapted from Hankin & Stoller, 2009).

mandible and detached (Fig. 1b). With cautious dissection, the layer of subcutaneous fat was removed. The platysma muscle, which lies in the superficial fascia and covering the lower part of the posterior triangle, was identified. With the use of a probe, the platysma was reflected superiorly and further dissection freed the muscle from the deeper structures. The accessory nerve was identified in the superficial layer of deep cervical fascia. The fascia covering the sternocleidomastoid muscle was carefully removed, leaving the branches of the superficial cervical plexus and the external jugular vein intact. Fine dissection on the sternocleidomastoid muscle exposed the lesser occipital, great auricular, transverse cervical and supraclavicular nerves, as it curved around the posterior margin of the sternocleidomastoid muscle (Fig. 1c). These nerves were identified and traced to the structures they provide innervation too. Thereafter, the sternocleidomastoid muscle was measured from the mastoid process to the clavicle using a Wilson Wolpert Digital vernier caliper (0 – 150 mm), and subsequently divided into 3 parts (upper, middle and lower thirds). The lesser occipital, great auricular, transverse cervical and supraclavicular nerves were measured from the mastoid process to their emerging points on the sternocleidomastoid muscle to determine the emerging point of the nerves in relation to the sternocleidomastoid muscle (Fig. 2). This study adopted the classification pattern for the emerging points of the superficial cervical plexus branches from Kim *et al*.

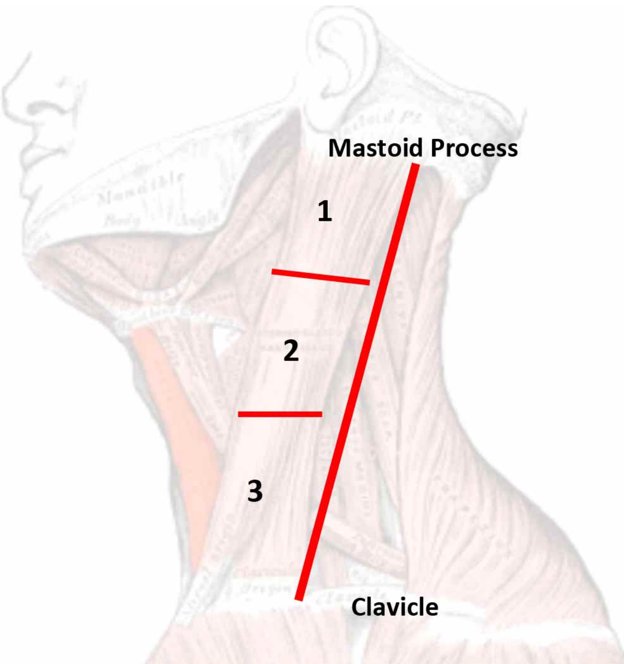

Fig. 2. Illustration of the division of the sternocleidomastoid muscle (Adapted from Standring *et al*., 2008).

RESULTS

In order to classify the emerging points of the superficial cervical plexus, the first measurement of the sternocleidomastoid muscle was from mastoid process to clavicle; subsequently each branch of the superficial cervical plexus was measured from the mastoid process to their exit points (Table I). The average length of sternocleidomastoid muscle was 75.18 ± 2.87 mm and 77.85 ± 2.93 mm in the adult, and 28.57 ± 3.38 mm and 27.91 ± 3.38 mm in fetuses on the right and left sides, respectively (Table I). The first nerve to exit the sternocleidomastoid muscle was the lesser occipital nerve at a distance of 23.59 mm and 23.96mm in adult and 11.32 mm and 11.55 mm in fetuses, while the supraclavicular nerve was the last to exit at a distance of 34.93 mm and 35 mm in adults and 16.86 mm and 16.88 mm on the right and left sides, respectively (Table I).

Table I: Average length of the sternocleidomastoid muscle and superficial cervical plexus branches.

LENGTHS (mm)	ADULT		FETUSES	
	Right	Left	Right	Left
SCM	75.18	77.85	28.57	27.91
LON	23.59	23.96	11.31	11.55
GAN	24.71	25.73	12.65	13.16
TCN	31.23	31.79	14.79	14.92
SCN	34.93	35.96	16.86	16.88

Key: SCM – Sternocleidomastoid muscle, LON - Lesser Occipital nerve, GAN – Great Auricular nerve, TCN – Transverse Cervical nerve, SCN – Supraclavicular nerve

The emerging points of the superficial cervical plexus branches were classified according to Kim *et al*., seven categories (Table II). The most frequent location was Type III (Fig. 4) and Type I (Fig. 3), with an incidence of 35 % and 32 %, respectively. The order in which the superficial cervical plexus branches emerged from the posterior margin of the sternocleidomastoid muscle remained constant, i.e. lesser occipital, great auricular, transverse cervical and supraclavicular nerves.

DISCUSSION AND CONCLUSION

Gupta *et al*. stated that there are insufficient published studies that describe the emerging patterns and distribution of the cervical cutaneous nerves. Furthermore, Becser *et al*. (1998) reported wide variability in the location of the branches of the superficial cervical plexus. This study attempts to classify the emerging points of the branches of the superficial cervical plexus in relation to their location on the sternocleidomastoid muscle.

Table II. Classification of the emerging points of superficial cervical plexus.

Pattern of Emergence	Right side (n =54)	Left side (n =54)	Total (108)
TYPE I - LON, GAN, TCN, SCN emerged on middle $^{1}/_{3}$ of SCM	21 (39 %)	14 (26 %)	35 (32 %)
TYPE II – LON, GAN, TCN emerged on middle $^{1}/_{3}$, and SCN on lower $^{1}/_{3}$	7 (13 %)	8 (15 %)	15 (13 %)
TYPE III – LON emerged on upper $^{1}/_{3}$ and GAN, TCN and SCN on middle $^{1}/_{3}$	14 (26 %)	24 (44 %)	38 (35 %)
TYPE IV – LON, GAN emerged on upper $^{1}/_{3}$ and TCN and SCN on middle $^{1}/_{3}$	8 (15 %)	6 (11 %)	14 (13 %)
TYPE V – LON, GAN, TCN, SCN emerged on upper $^{1}/_{3}$	1 (2 %)	1 (2 %)	2 (2 %)
TYPE VI – LON, GAN, TCN emerged on upper $^{1}/_{3}$ and SCN on middle $^{1}/_{3}$	2 (4 %)	-	2 (2 %)
TYPE VII – LON, GAN emerged on middle $^{1}/_{3}$ and SCN on lower $^{1}/_{3}$	1 (2 %)	1 (2%)	2 (2 %)

Key: SCM – Sternocleidomastoid muscle, LON - Lesser Occipital nerve, GAN – Great Auricular nerve, TCN – Transverse Cervical nerve, SCN – Supraclavicular nerve

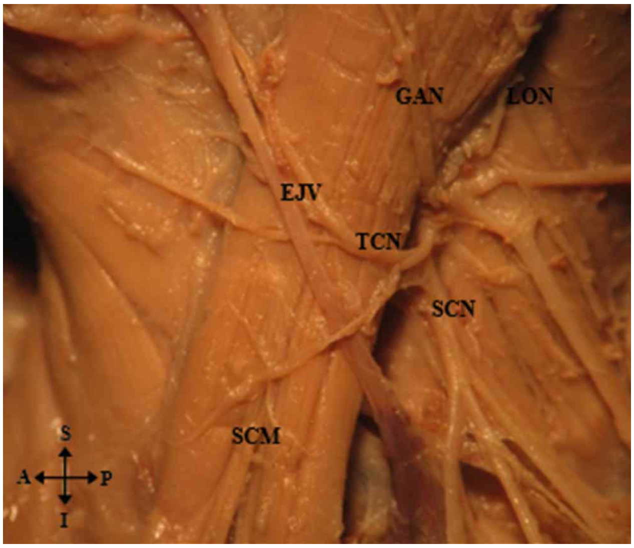

Fig. 3. Left anterior view of Type III emerging pattern. LON – lesser occipital nerve, SCM – Sternocleidomastoid muscle, GAN – Great auricular nerve, TCN – Transverse cervical nerve, SCN – Supraclavicular nerve.

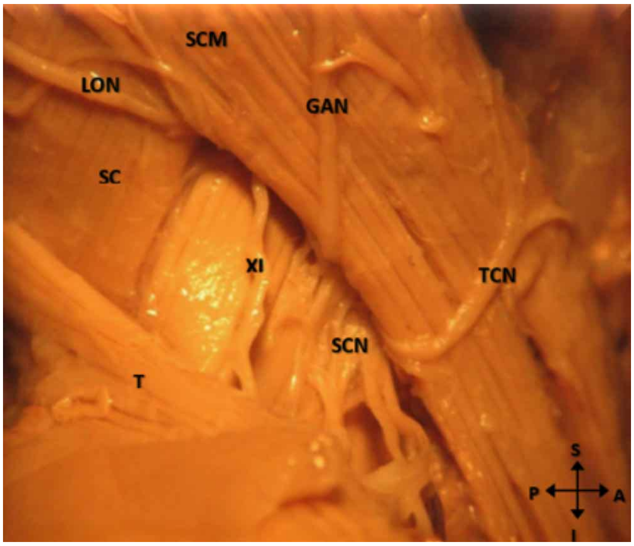

Fig. 4. Right anterior view of Type I emerging pattern. LON – lesser occipital nerve, SCM – Sternocleidomastoid muscle, GAN – Great auricular nerve, TCN – Transverse cervical nerve, SCN – Supraclavicular nerve, T –Trapezius muscle.

In this study, the most frequent classification was type III, where the lesser occipital nerve emerging on the upper third and the great auricular, transverse cervical and supraclavicular nerves emerging on the middle third of the sternocleidomastoid muscle, with a prevalence of 35 %. However, Kim *et al*. reported the separated type (L-G-T-S) as their most frequent classification in 50 % of their Korean sample. A possible explanation for this discrepancy may be influenced by the difference in sample size, as well as population-specific differences.

Kim *et al*. suggested that the knowledge of emerging points may assist in the effective anaesthesia to all branches of the superficial cervical plexus during surgical procedures of the neck, viz. carotid endarctectomies and thyroid surgery.

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RESUMEN: Las ramas cutáneas del plexo cervical superficial (SCP) emergen en puntos variables, desde el margen posterior del músculo esternocleidomastoideo y desde este punto inferior irradian como "radios de rueda" anteroinferior y posterosuperior. Este estudio tuvo como objetivo clasificar los puntos emergentes de las ramas del plexo cervical superficial en relación a su ubicación en el músculo esternocleidomastoideo. Para clasificar los puntos emergentes del plexo cervical superficial, primero se midió el músculo esternocleidomastoideo desde el proceso mastoides hasta la clavícula; posteriormente se midió cada rama del plexo cervical superficial desde el proceso mastoideo hasta sus puntos de salida. Los puntos emergentes de las ramas del plexo cervical superficial se clasificaron según Kim *et al*. (2002) en siete categorías: Tipo I (32 %); Tipo II (13 %); Tipo III (35 %); Tipo IV (13 %); Tipo V, VI, VII (2 %). El orden en el que las ramas del plexo cervical superficial emergían del margen posterior del músculo esternocleidomastoideo se mantuvo constante, es decir, los nervios occipital menor, auricular magno, cervical transverso y supraclavicular. El conocimiento de los puntos emergentes puede ayudar a la anestesia eficaz de todas las ramas del plexo cervical superficial durante los procedimientos quirúrgicos del cuello, a saber, endarterectomía carotídea y cirugía de tiroides.

PALABRAS CLAVE: Plexo cervical superficial; Fetal; Puntos emergentes; Patrones de ramificación.

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