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The sternocleidomastoid muscle variations: a mini literature review

S. Silawal, G. Schulze-Tanzil et al., **A literature survey on sternocleidomastoid muscles**

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Abstract

The sternocleidomastoid muscles (SCM) are prominent paired muscles of the neck connecting proximally the manubrium sterni and the clavicle to the mastoid process and the occipital bone distally. Following their points of attachment sternomastoid, sternooccipital, cleidomastoid and cleidooccipital portions of this muscle have been described. Altogether 23 case reports from year 2000 till 2020 with 29 subjects related to the SCM supernumerary variations were searched and analyzed where parameters such as supernumerary proximal variation types (sternal vs. clavicular), insertional variation, unilaterality/ bilaterality of the variation, study type, reported gender of the subjects and the country of research were extracted. The research shows that 48.3% of the subjects had bilateral presentation of SCM variations. If present unilaterally, three quarters of the cases were on the left side. The most frequent variation is located at the clavicular side of the proximal SCM head whereas isolated sternal sided proximal head variation or an insertional variation alone are very rare. Interestingly, with 96.6%, most of cases in the literature were discovered in cadavers during anatomical dissections. Male gender represented with 82.8% higher prevalence than females. The higher male prevalence in the body donor system, predominantly in the Asian continent could play a decisive role in the outcome as more than half of the reported cases stemmed from India in this period. Importantly, the knowledge of different anatomical variations of the SCM is highly relevant for surgical, clinical or radiological approaches in the neck.

Key words: sternocleidomastoid, sternocervical, sternopharyngeal, trapezius, variation

INTRODUCTION

The sternocleidomastoid muscles (SCM) are prominent paired muscles of the neck connecting the sternum and the clavicle proximally to the mastoid process and the occipital bone distally [1]. Altogether, four different portions of the SCM i.e. sternomastoid, sternooccipital, cleidomastoid and cleidooccipital of this muscle have been described [2]. The SCM blood supply is provided superiorly by the branches of the occipital artery and superior thyroid artery or direct branches of the external carotid artery or both and inferiorly by a branch arising from the suprascapular artery, the transverse cervical artery, the thyrocervical trunk or the superficial cervical artery [3]. The neural innervation to the sternomastoid muscle originates in the rostral portion of the brainstem nucleus of the accessory nerve which receives input from both cerebral hemispheres whereas the neural branches to the cleidomastoid and trapezius muscles originate in the caudal portion of the brainstem nucleus and receive input only from the contralateral hemispheres [4]. In general, unilateral contraction of this muscle flexes the neck ipsilaterally and rotates the head so that the face is turned superiorly towards the contralateral side. Bilateral contraction helps to (i) extend the neck at the atlantooccipital joints, (ii) flex cervical vertebrae that pulls chin towards the manubrium, or (iii) extend superior cervical vertebrae while flexing inferior vertebrae that thrusts the chin forward keeping the head levelled [5]. Also, a direct correspondence of the vestibular area with deep and superficial neck muscles such as SCM clarifies the importance of this muscle in movement and posture of the head and neck [6]. Furthermore, SCM is also part of the inspiratory muscles during deep respiration [5]. Any anomaly in the structure or/and physiology of this muscle could hence, result in respective functional limitation and alterations of the head or neck or even asymmetry in motion, in cases of unilateral variations.

From a developmental point of view, the muscles of the vertebrate neck generally comprise of the cucullaris and hypobranchial muscles along with the contribution of cephalic neural crest cells [7-9]. The cucullaris muscle is a gnathostome-specific muscle that is a homologue of sternocleidomastoid and trapezius muscles in mammals [8]. As suggested by the German anatomist Lubosch 1938, these two muscles are evolutionary derived from a single muscle that splits into two parts during amniote evolution [8]. A 3D reconstruction technique in an human embryo showed the trapezius/SCM complex as a single cell condensation at estimated post-fertilization age between 33 and 38 days which was later

detected with separate identifiable muscles around 41 days [10]. The splitting of the embryological common trapezius-SCM complex can still be recognized as they share their innervation via the 11th cranial accessory nerve [11].

This process of separation of the common trapezius/SCM complex could result in different forms of SCM as well as trapezius variations. SCM variations are common where accessory branches from the clavicle or sternum connect to the normally existing SCM or separately either to the mastoid process or attach laterally to the superior nuchal line towards the trapezoid muscle insertion [12-27]. The variations at the insertional end of the muscle are less common in comparison to the occurrence of accessory proximal heads [15]. Depending upon the shape and courses of these additional muscular slips, neighboring anatomical structures in the posterior triangle of the neck could be compromised. A clinical case report has also been reported where functional impairment with torticollis related to SCM variation was addressed in a male patient [20]. But also, a complete absence of the posterior triangle of neck on the left side of a 60-year-old Indian male cadaver was described in a case report where a unilateral separation of the trapezius/SCM complex failed to appear [28]. Hence, documentation of all these various anatomical variations of the SCM could be useful in clinical settings as well as surgical or radiological approaches in the neck.

METHODS

Studies related to the SCM supernumerary variations as well as embryological studies were achieved with Medline, Google Scholar as well as researchgate using mesh terms such as: sternocleidomastoid variations, sternocleidomastoid origin variation, sternocleidomastoid insertional variation. Supernumerary variation reports in proximal as well as distal attachment points of the SCM between year 2000 and 2020 have been included in this study. All reports with poor quality with no clear description of attachment points were excluded. 29 subjects (*individuals*) in 23 research studies were analyzed where parameters such as supernumerary proximal variation types (sternal vs. clavicular), insertional variation, unilaterality/ bilateralism of the variation, study type as well as reported gender of the subjects and the country of research were extracted. Other variations, however, controversial in their affiliation to SCM variations, such as cleidocervical [29], cleidooccipital platysma [30], cleidohyoideus accessories [31] or recently described sternopharyngeal [32] muscles were not included in this survey.

RESULTS

The results from our small literature survey with altogether 23 case reports with 29 subjects has been illustrated in Table 1. Out of the total reported subjects, 86.2% presented with a muscular variation in the clavicular side of the SCM proximal head whereas 27.6% in the sternal side. However, isolated sternal head variation was reported only in 6.9% of the subjects. 20.7% presented with muscular variations in both clavicular as well as sternal ends of the SCM. Less than half of the analyzed subjects (48.3%) showed a bilateral occurrence of a SCM variation. In case of a unilateral presentation, 66.7% out of 15 unilateral subjects were found on the left side of the SCM. Altogether, 96.6% of the SCM variations were discovered in anatomical dissection in cadavers. Furthermore, 82.8% of the subjects in the reported cases were male and 17.2% female. 58.6% of the case reports that were analyzed in this study stemmed from India. Five case reports with six subjects were available from outside the Asian continent (Turkey included). Interestingly, there was 100% bilateral representation of the SCM variation in these cases. Also, all 6 reported subjects were male. Clavicular sided proximal variation was found in 83.3% of the cases whereas only a single report was available reporting an insertional variation.

DISCUSSION

A macroscopical study in an Indian population, SCM variations were reported in 27.8% of studied 18 cadavers [27]. Another similar small survey with 17 cadavers from Colombia showed 11.76% prevalence of SCM variations [38]. Focusing on the variation cases, we could show that clavicular sided variation of SCM is with around three-fold more frequent in comparison to a sternal sided variation. Only a single report with an insertional variation was included in this review where a bilateral variant of the SCMs send one tendon to the mastoid and six distinct tendons along the lateral superior nuchal line to the midline [15]. A very low prevalence of this muscular insertional variation was seen in a Japanese statistical study of year 1968 where abnormal insertion of the SCM was found in 3.5% of Kyushu-Japanese male and 4.6% of the female from 354 bodies analyzed [40]. Most case studies analyzed in our survey, reported that the insertional attachments of the SCM were “normal”, “as usual”, “on the mastoid process”, “lateral/ near to the mastoid process” or “on the nuchal line”. One of the limitations in most of the case reports where that even reported as normal insertional attachments, the manuscripts did not provide images showing the complete course of the SCM with clear depiction of the muscular insertion [13, 14, 16-19, 21-27, 34-36, 38, 39]. Other insertional variations of SCM such as cleidocervical, cleidooccipital platysma or

the recently described sternopharyngeal variation of SCM have been described, however, they are discussed controversially in the literature as a subtype of a SCM variation [29, 32, 41, 42]. Since, this discussion is beyond the scope of this review, these variations have been excluded from our analysis.

Bilateral and unilateral presentation of the SCM variation was almost equally divided with 48.3% and 51.7% of the analyzed subjects. If available unilaterally, there was a higher chance with 66.7% to be located on the left side of the neck. Discussing about the unilaterality, a clinical case of a young male patient was included in the study, where a right accessory unilateral clavicular head of SCM caused torticollis and limited the cervical range of motion in the patient [20]. This shows that besides unilateral agenesis of SCM or trapezius muscles, SCM variations can present a clinical image of congenital torticollis [43-45]. A different scenario was introduced before where a unilateral absence of the posterior triangle of the neck can also lead to access musculature on one side in comparison to other [28]. Even undiagnosed, many mild cases of such variations could limit certain range of cervical motion in affected people.

In our survey, 82.8% of the SCM variations were reported in males. There are two causes for this result. Either the variations in the embryological development is higher in males in comparison to females or simply the body donors for the dissections are dominantly males. In the above mentioned study from West Bengal, India with 18 cadavers, 3 out of 18 cadavers in anatomical dissections were female [27]. Likewise, the other study from Colombia also showed that from the 17 cadavers dissected, only 2 were female [38]. A lower female representation in the donor system of different countries can hence influence the statistics of variations in respect to gender-association. Cultural, religious, socioeconomic factors as well as specific research interests could exert great influence on the outcome of the results [46, 47]. 58.6% of the case reports that were analyzed in this survey stemmed from India. Altogether five case reports with SCM variations from outside the Asian continent have been published since the year 2000. A heterogeneous collection of data from all parts of the world could probably provide a more representative picture. Likely the interest of reporting new anatomical case reports is not high enough today, where anatomical researches have more transitioned into cellular and molecular researches and macroscopical anatomy is underrepresented. On the other hand, a publication on case reports showed that there is still a big number of submitted case reports, but many are not published due to poor writing despite their academic worthiness [48]. Encouraging young students, investigators or clinicians and academics for publishing such case reports could support and improve practice of academic

writing. In addition, the maintenance of practical dissection courses during early and late education of medical doctors opens the understanding for the multitude of variations possible, far away from the classical textbook knowledge – some of them indeed with practical clinical relevance. More data has to be documented for representative epidemiological researches. Finally, case reports can play a special role to inspire a possible association between an anatomical variation and developmental or genetical studies in the related area.

CONCLUSIONS

Analyzing available case reports on the SCM variations we summarize that there is bilateral presentation in almost one in two SCM variations. If present unilaterally, three quarters of the cases are located on the left side. The most frequent variation is located at the clavicular side of the proximal SCM head whereas isolated sternal sided proximal head variation or an insertional variation alone are very rare. Interestingly, most of cases in the literature were discovered in male cadaver studies in anatomical dissections. This could be the result of higher male prevalence in the body donor system, predominantly in the Asian continent. Besides, reports of SCM variations from other clinical fields have to be encouraged to obtain a broader perspective in this field since knowledge of morphological variations are very relevant for clinical, surgical and radiological approaches into the neck.

Disclosures

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Table 1: List of the case reports with muscular variations of the sternocleidomastoid muscle.

Publications	Proximal variation		Insertional variation	Unilateral		Bilateral	Cadaver report	Sex		Country
	Sternal	Clavicular		Left	Right			♂	♀	
Nayak et al 2006[22]	+					+	+	+		India (1)
Rao et al 2007[25]		+				+	+	+		Not provided (1)
Cherian et al 2008[14]		+		+			+	+		India (1)
Natsis et al 2009[21]	+	+				+	+	+		Greece (1)
Amorim Júnior et al 2010[12]		+	Not provided			+	+	+		Brazil (1)
Mehta et al 2011[33]		+		+			+	+		India (1)
Rani et al 2011[34]		+		+			+		+	India (1)
Raikos et al 2012[24]	+	+	#			+	+		+	Not provided (1)
Sirasanagandla et al 2012[35]		+			+		+	+		India (1)
Kaur et al 2013[18]	+	+			+		+	+		India (1)
Sabnis et al 2013[36]	+	+			+	+	++	+	+	India (2)
Kumar et al 2014[37]	+				+		+		+	India (1)
Saha et al 2014[27]		+++++		+++		++	+++++	+++++		India (5)
Kim et al 2015[19]	+	+				+	+	+		Korea (1)
Fulzele et al 2015[26]		+		+			+	+		India (1)
Anil et al 2017[13]		+				+	+	+		Turkey (1)
Arquez et al 2017[38]		++				++	++	++		Colombia (2)
Kaur et al 2017[39]		+		+			+	+		India (1)
Dupont et al 2018[15]			+			+	+	+		USA (1)
Mansoor et al 2018[20]		+			+			+		Pakistan (1)
Oh et al 2019[23]		+				+	+		+	Korea (1)
Heo et al 2020[17]	+	+		+			+	+		Korea (1)
Fulmalí et al 2020[16]		+		+			+	+		India (1)
	8/29 (27.6%)	25/29 (86.2%)	1/29 (3.5%)	10/29 (34.5%)	5/29 (17.2%)	14/29 (48.3%)	28/29 (96.6%)	24/29 (82.8%)	5/29 (17.2%)	
+ represents the number of subjects. # cleidocervical variation										