International Journal of Anatomy and Research,
Int J Anat Res 2013, Vol 1(2):69-74. ISSN 2321- 4287

Original Article

ANATOMICAL VARIATIONS IN THE ANSA CERVICALIS AND INNERVATION OF INFRAHYOID MUSCLES

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ABSTRACT

Background: – Infrahyoid muscles are supplied by the ansa cervicalis. The present study aimed to study the variations in the ansa cervicalis and the innervation of infrahyoid muscles. **Methods:** The study was conducted on 40 cadaveric hemi-necks. **Results:** Out of the 40 hemi-necks, high level of ansa cervicalis was observed in 2 hemi-necks, intermediate level of ansa was observed in 35 hemi-necks and low level of ansa was observed in 3 hemi-necks. Additionally, dual ansa with absence of inferior root was seen in 4 hemi-necks, dual ansa with absence of inferior root and inter-communication between C2 and C3 was seen in 2 hemi-necks, common trunk supplying all infrahyoid muscles including superior belly of omohyoid was seen in 2 hemi-necks, nerve to inferior belly of omohyoid from inferior root was seen on 1 side. In one specimen unilaterally, superior belly of omohyoid was innervated by a branch from hypoglossal nerve, two superior roots arising from hypoglossal nerve and the inferior root formed only by C3 was seen in the same specimen. **Discussion:** The knowledge of the possible variations of ansa in relation to the great vessels of the neck prevents the inadvertent injury to those vessels. Any injury can result to phonation disability in professional voice users. In case of infrahyoid muscles palsy, patients have no serious voice problems in their normal speech but the pitch of their voice and also prosody in their singing are lost dramatically. **Conclusion:** These variations are of clinical importance for the reconstructive surgeries which involve the infrahyoid muscles.

KEY WORDS: ANSA CERVICALIS; DUAL ANSA; INFRAHYOID MUSCLES; RECONSTRUCTIVE SURGERIES.

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Access this Article online

Quick Response code

Web site: International Journal of Anatomy and Research
ISSN 2321-4287
www.ijmhr.org/ijar.htm

Received: 29 July 2013
Peer Review: 29 July 2013 Published (O):23 Aug 2013
Accepted: 20 Aug 2013 Published (P):30 Sep 2013

BACKGROUND

Infrahyoid muscles namely, the sternohyoid, sternothyroid, thyrohyoid and omohyoid usually depress the hyoid bone during deglutition and during phonation [1]. These strap muscles are usually found in pairs. They are innervated by the branches arising from the ansa cervicalis. Although variations in their absence, presence of accessory bellies, presence of additional tendons, duplication of muscles are reported, studies regarding their innervation are limited.

Variations in the formation of ansa cervicalis has been well documented in the literature. Ansa cervicalis is a loop of nerves found in the neck. It is formed by the ventral rami of upper three cervical spinal nerves, thereby forming a part of the cervical plexus. It has two roots, namely the superior and the inferior roots. The superior root is formed by the ventral ramus of first cervical spinal nerve. These fibers join the hypoglossal nerve. A few of these fibers descend down to form the superior root (descendens hypoglossi). The remaining C1 fibers supply the thyrohyoid and geniohyoid muscles. A branch is given off from the superior root to supply the superior belly of omohyoid muscle. The inferior root is formed by the ventral rami of second and third cervical spinal nerves.

Three branches arise from the loop of ansa cervicalis to supply the remaining infrahyoid muscles [1].

Therefore, in this study, we aimed to find out the variations in the formation of ansa cervicalis and also the innervation of all the infrahyoid muscles.

MATERIALS AND METHODS

Necks of 20 formalin-fixed cadavers of both sexes (18 males and 2 females) of age approximately 30-50 years were dissected bilaterally during the routine dissection for undergraduate students following the Cunningham's manual of practical anatomy volume 3. The ansa cervicalis was painted and photographed. Gross variations in the infrahyoid muscles were also observed.

RESULTS

Based on the level of the loop with respect to the omohyoid muscle, ansa cervicalis was divided into 3 categories. The loop at the level of the hyoid bone was classified as high level ansa (Fig. 1).

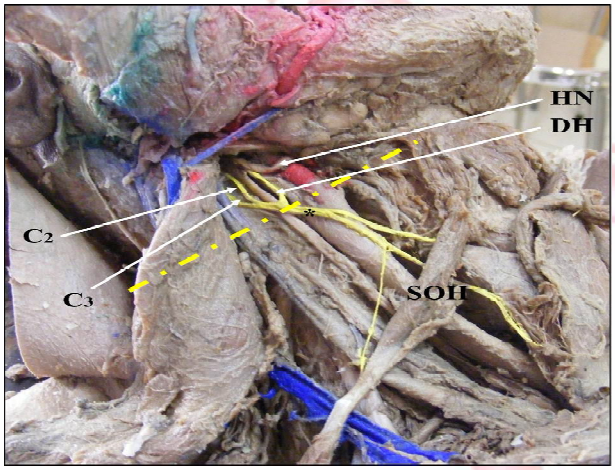

Figure 1: Right hemi- neck showing high level ansa. C2 – 2nd cervical nerve, C3 – 3rd cervical nerve, DH – Descendens hypoglossi, HN – Hypoglossal nerve, * - common trunk which supplies all the infrahyoid muscles including the superior belly of omohyoid, SOH – Superior belly of omohyoid.

It was seen in 2/40 (5%) hemi-necks unilaterally. The loop in between the hyoid bone and the omohyoid muscle was classified as intermediate ansa (Fig. 2). It was seen in 35/40 (87.5%) hemi-necks unilaterally. The loop below the omohyoid muscle was classified as low level ansa. It was seen in 3/40 (7.5%) hemi-necks unilaterally (Fig. 3).

Figure 2: Left hemi-neck showing intermediate ansa. C2 – 2nd cervical nerve, C3 – 3rd cervical nerve, DH – Descendens hypoglossi, HN – Hypoglossal nerve, SOH –Superior belly of omohyoid.

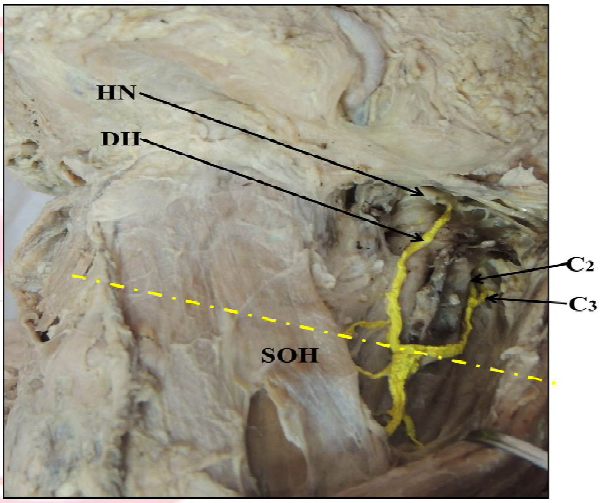

Figure 3: Left hemi- neck showing low level ansa. DC – Descendens cervicalis, DH –Descendens hypoglossi, HN – Hypoglossal nerve, SOH – Superior belly of omohyoid.

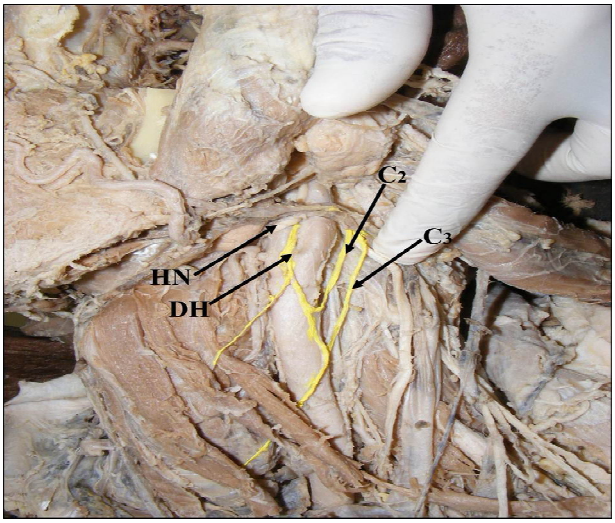

Figure 4: Left hemi- neck showing dual ansa formation with absent inferior root. C2 – 2nd cervical nerve, C3 – 3rd cervical nerve, DH – Descendens hypoglossi, HN – Hypoglossal nerve, SOH – Superior belly of omohyoid.

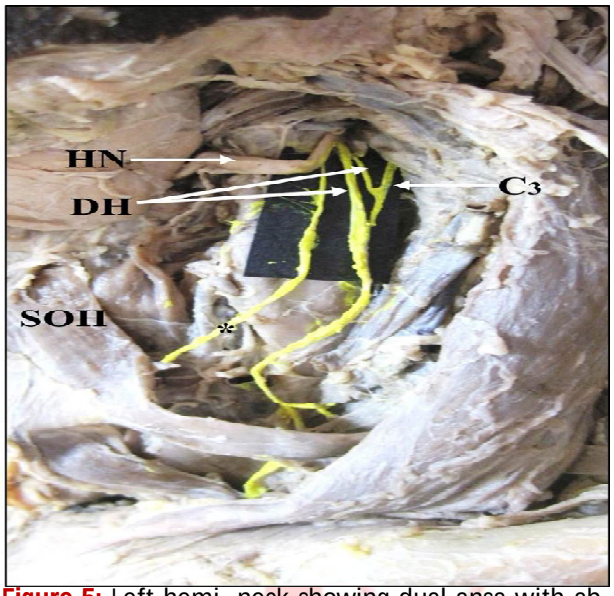

Figure 5: Left hemi- neck showing dual ansa with absent inferior root and inter-communication between C2 and C3. C2 – 2nd cervical nerve, C3 – 3rd cervical nerve, DH – Descendens hypoglossi, HN – Hypoglossal nerve, white arrow - common trunk from the loop, * - inter-communication between C2 and C3, SOH – Superior belly of omohyoid.

Figure 6: Left side of the neck showing ansa with DH – 2 descendens hypoglossi, SOH – Superior belly of omohyoid, * - nerve supply by a branch of hypoglossal nerve, C3 – forming descendens cervicalis.

Based on its formation, ansa cervicalis was classified as follows –

a. Normal ansa (with superior root formed by C1 fibers and inferior root formed by C2 and C3 fibers) – seen in 32 hemi-necks (80%).

b. Dual ansa with absent inferior root (C2 and C3 joining the superior root separately) – seen in 4 hemi-necks (10%) (Fig. 4).

c. Dual ansa with absent inferior root and inter-communication between C2 and C3 fibers – seen in 2 hemi-necks (5%) (Fig. 5).

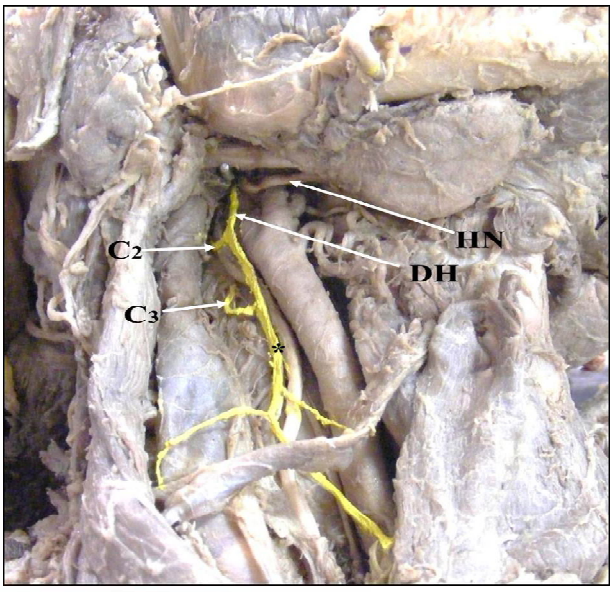

Figure 7: Right hemi-neck showing dual ansa with absent inferior root and the nerve supply of all infrahyoid muscles by a common trunk from the loop. C2 – 2nd cervical nerve, C3 – 3rd cervical nerve, DH – Descendens hypoglossi, HN – Hypoglossal nerve, SOH – Superior belly of omohyoid, * - Common trunk which supplies all infrahyoid muscles including superior belly of omohyoid.

d. Inferior root formed by C3 fibers only – seen in in 1 hemi-neck (2.5%) (Fig. 6).

Unusual ansa with two superior roots (one root from C1 fibers, the other a branch of hypoglossal nerve) – seen in 1 hemi-neck (2.5%) (Fig. 6).

Innervation of Infrahyoid muscles –

a. Superior belly of omohyoid muscle: Supplied by the superior root (C1 fibers) in 36 hemi-necks (90%); by a common trunk from the ansa in 3hemi-necks (7.5%) (Figures 1 and 7) and from hypoglossal nerve in 1hemi-neck (2.5%) (Figure 6).

b. Inferior belly of omohyoid muscle: Supplied by a common trunk from the ansa in 39 hemi-necks (97.5%) (Figures 1 and 7), by inferior root in 1 hemi-neck (2.5%).

c. Sternohyoid muscle: Supplied by a common trunk from the ansa in 40 hemi-necks (100%) (Figures 1 and 7).

d. Sternothyroid muscle: Supplied by a common trunk from the ansa in 40 hemi-necks (100%) (Figures 1 and 7).

e. Thyrohyoid muscle: Supplied by C1 fibers coming out from hypoglossal nerve in 40 hemi-necks (100%).

Medial and lateral series of ansa – 34/40 (85%) hemi-necks showed medial ansa (Figures 1, 4, 5 and 7) and 6/40 (15%) hemi-necks showed lateral ansa (Figures 2, 3 and 6).

DISCUSSION

Variations in the ansa cervicalis have been well documented in the literature. Chhetri and Berke classified the position of the loop of ansa cervicalis as short and long ansa [2]. According to a study conducted by Loukas et al. on 100 adult formalin-fixed cadavers, 70% cases showed long ansa (above the omohyoid muscle) and 30% cases showed short ansa (below the omohyoid muscle) [3]. According to a study conducted by Pillay et al. [4] 63/80 fetuses (79%) depicted short ansa and 17/80 fetuses (61%) depicted long ansa. Mwachaka et al. [5] in their study on 38 (76 hemi-necks) formalin-fixed cadavers showed short ansa in 46/76 (64.6%) hemi-necks, 7/76 (9.21%) hemi-necks showed long ansa and 16/76 (24.6%) hemi-necks showed ansa at the level of omohyoid muscle. In the present study, high ansa (at the level of hyoid bone) was seen in 2/40 (5%) hemi-necks; intermediate ansa (in between hyoid bone and omohyoid muscle) was seen in 35/40 (87.5%) hemi-necks and low ansa (below omohyoid muscle) was seen in 3/40 (7.5%). Therefore, the present study showed greater percentage of short ansa.

The origin of the superior root in this study was only from the C1 fibers passing through the hypoglossal nerve. Several authors have reported the vago cervical complex, where the superior root although derived from the C1 fibers, descends through the vagus nerve (descendens vagi) [6,7,8]. In a study conducted on 80 fetuses, the vago cervical complex formed by the contribution from hypoglossal nerve, vagus and C2 and C3 nerves was observed in 2/80 fetuses (3%) [4]. The present study does not report any such finding.

Mwachaka et al. showed 42/76 (56%) hemi-necks with superior root above the posterior belly of digastric muscle, 29/76 (38.7%) hemi-necks with superior root below the muscle and 4/76 (5.26%) hemi-necks showed superior root at the level of the posterior belly of digastric muscle [5]. Caliot and Dumont [9] in a series of 80 dissections showed that the superior root above posterior belly of digastric muscle in 60/80 (75%) of cases and at the level of the muscle in 20/80 (25%) cases. In the present study, the superior root was seen above the posterior belly of digastric muscle.

Ventral rami of C2 and C3 both formed inferior root in 28/108 cases (26%), from ventral ramus of C3 in 63/108 cases (63/108) and from ventral rami of C2 in 17/108 cases (16%) [4]. Loukas et al.[3] in his study on 100 cadavers showed that inferior root was derived from the ventral rami of C2 and C3 in 38% cases, C2, C3 and C4 in 40% cases and from C3 in 40% cases and from C2 in 12% cases. In a study on 25 fresh post-mortem cadavers conducted by Hegazy [10] showed that the inferior root was formed by C2 and C3 in 42/50 cases (84%), by C2 in 8/50 cases (16%). According to Caliot and Dumont [9], C3 most often contributed to the inferior root. However, in the present study, C2 and C3 were the main contributors of inferior root.

Double loops with the presence of both the descendens hypoglossi and descendens vagi were already described [11, 12]. In both these cases, the upper loop is formed by the fusion of descendens hypoglossi and descendens vagi and the lower loop is formed by descendens vagi and descendens cervicalis. The present study does not report any such finding.

Double loop (dual ansa cervicalis) with C2 and C3 joining the superior root separately was reported in 2/80 fetuses (3%) [4]. The presence of a unilateral dual ansa was reported in a single case [13]. In the present study, dual ansa was observed unilaterally in 4/40 (10%) hemi-necks.

Yamada [14] described the position of ansa as medial (when the ansa lies medial to IJV) and lateral (when the ansa lies lateral to IJV).

Additionally Bannehaka [15] added a mixed type when the two separate inferior roots lies lateral and medial to IJV to join the superior root. Superior root descended infront of common carotid artery and internal jugular vein in 69/108 cases (64 %) and posterior to IJV in 39/108 cases (36 %)[4]. Mwachaka et al. [5] showed lateral series in 53/76 (81.5%) hemi-necks and medial series in 12/76 (18.5%) hemi-necks. In the present study, 20/40 (50%) hemi-necks showed medial series and 20/40 (50%) hemi-necks showed lateral series.

1/80 fetuses (1%) showed dual superior roots. Inferior root formed by C3 only [4]. A similar case was seen unilaterally in the present study.

Superior root of AC gave branch to Superior belly of omohyoid in 48/50 cases (96%).Inferior root gave a branch to Inferior belly of omohyoid in 2/ 50 cases (4%). The rest of the muscles had normal innervation.

No studies in the literature have shown inter-communicating nerves between C2 and C3. Therefore, this is a significant finding in this study.

Among the seven morphologic forms of the ansa cervicalis described by Caliot and Dumont [9], we have found three forms. Type A – double classic form, in which the C1 forms the superior root and C2 and C3 joins to form the inferior root. This was seen in 32 hemi-necks (80%). Type C – Double form with two separate roots, which is the dual ansa described in this study. It was seen in 4 hemi-necks (10%). Type E – Double short form, which is high ansa described in this study. It was seen in 2 hemi-necks (5%).

Embryological significance – The hypoglossal nerve after getting incorporated within the cranium, establishes communication with the upper cervical nerves and thus furnishes the nerve supply to the infrahyoid muscles [16, 17]. The hypoglossocervical plexus innervates the infrahyoid muscles since the muscles of the neck (scalene, prevertebral, geniohyoid and infrahyoid) are derived from the differentiation of the branchial arch mesenchyme and cervical somites [17, 18].

Surgical importance – Damage to the ansa cervicalis can lead to change in voice quality after sometime, even though the exact reason is not known for this phenomenon. It may be because of the loss of support provided by the strap muscles to the laryngeal cartilages during movements of vocal folds [19].

The knowledge of the possible variations of ansa in relation to the great vessels of the neck prevents the inadvertent injury to those vessels. Any injury can result to phonation disability in professional voice users. In case of infrahyoid muscles palsy, patients have no serious voice problems in their normal speech but the pitch of their voice and also prosody in their singing are lost dramatically [20]. In cases of unilateral vocal cord paralysis, anastomoses between the ansa cervicalis and the recurrent laryngeal nerve have resulted in excellent to normal function in the vocal cord affected [21-23]. During the surgical exposure of thyroid gland, the sternohyoid and sternothyroid muscles are frequently cut, often damaging the nerve branches of the ansa cervicalis [2].

CONCLUSION

The precise knowledge of the anatomical relations and variations of ansa cervicalis is of great clinical importance for the head and neck surgeons to accurately know the possible variations while performing surgery thereby reducing the risks of damaging the nerves and vasculature while performing neural blocks in regional anesthesia and nerve grafts.

Competing interests

The authors declare that they have no competing interests.

Acknowledgements

The authors wish to thank all the teaching and non-teaching staff for their support.

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How to cite this article:

Lydia S. Quadros, Nandini Bhat, Arathy Babu, Antony Sylvan D'souza. Anatomical variations in the Ansa cervicalis and innervation of infrahyoid muscles. Int J Anat Res, 2013;02:69-74.