

Full length research paper

Anatomical study of the human ansa cervicalis nerve and its variations

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With the expanding use of the ansa cervicalis nerve for laryngeal reinnervation procedures. So the aim of this work was to study the anatomical variations of ansa cervicalis in its roots, course and branching pattern. Twenty five Egyptian necks (50 sides) were dissected. The results showed that the ansa cervicalis (AC) consisted of two roots: superior and inferior roots. These two roots joined together to form a nerve loop. The superior root of AC originated from the hypoglossal nerve in 100%. The superior root of AC descended in front of the external carotid artery in 68% and in front of the internal carotid artery in 32%. The inferior root of AC was derived from the ventral rami of C₂ and C₃ in 84% and from C₂ in 16%. There were four morphological forms of the loop of ansa cervicalis: I- U-shaped loop in 84%. II- Y-shaped loop in 8%. III- double fused Y-shaped loop in 4%. VI- double separate Y-shaped loop in 4%. The superior root of AC gave a branch to the superior belly of omohyoid in 96% and a branch to sternomastoid in 24%. The inferior root of AC gave a branch to inferior belly of omohyoid and a communicating branch to phrenic nerve in 4%. These anatomical variations of the ansa cervicalis can be used in surgical procedures such as reinnervation of the laryngeal muscles following the damage of recurrent laryngeal nerve and to avoid the iatrogenic injuries of this nerve during the surgical operations of the neck.

Key words: Ansa cervicalis, human, anatomical variations, surgical procedures,

INTRODUCTION

The ansa cervicalis (AC) is a union of nerves found in the anterior triangle of the neck, which gives motor innervations to the infrahyoid muscles (Chetri and Berke, 1997). 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 (superior and inferior). The superior root is derived from the ventral ramus of C₁ through the hypoglossal nerve. The inferior root is derived from the ventral rami of C₂ & C₃. A loop is formed

at the point of their connections. Ansa is a Latin term meaning "handle of a cup". In the past, the superior root was called the descendens hypoglossi because it arises from the hypoglossal nerve. The inferior root was called the descendens cervicalis. The ansa cervicalis was called the ansa hypoglossi. The branches of the ansa cervicalis innervate the infrahyoid muscles except the thyrohyoid muscle which is supplied by the first cervical nerve through the hypoglossal nerve (Chetri and Berke, 1997). The infrahyoid muscles play a role in laryngeal steadiness and excursion during phonation and deglutition (Navak et al., 2009).

Recurrent laryngeal nerve paralysis represents one of the most serious complications in oesophageal cancer surgery (Miyachi et al., 2001). The ansa cervicalis is an ideal nerve for reconstruction of the recurrent laryngeal nerve, since it is located in close proximity to the larynx and is active during phonation, and since sacrificing the nerve causes no serious functional or cosmetic consequences (Vacher and Caix, 2004; Natsugoe et al., 2005).

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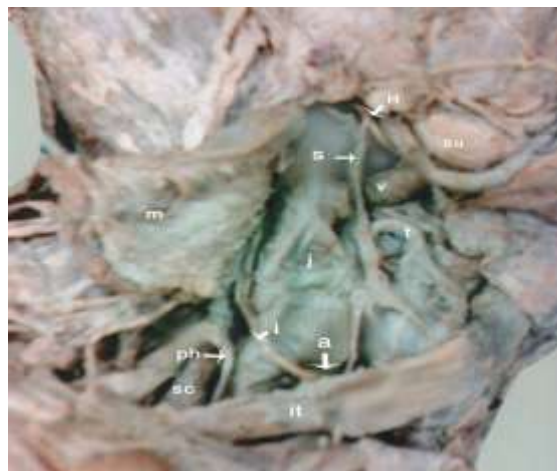


Figure 1. A photograph of a dissected right side of the neck showing: The ansa cervicalis (a) being in front of internal jugular vein (j), deep to intermediate tendon (it) of omohyoid. It is formed of superior root (s) and inferior root (i). Notice the hypoglossal nerve (H), common facial vein (V), submandibular gland (Su), superior thyroid artery (t), sternomastoid (m), scalenus anterior (Sc) and phrenic nerve (ph). [superior(s), inferior(i), anterior(A),posterior (P)].

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Recently, there has been an interesting debate as to which branch of the ansa cervicalis used for laryngeal reinnervation would result in the best vocal quality (Chetri and Berke, 1997). Crumley et al., (1998) have recommended the ansa cervicalis branch to the sternothyroid because this branch is located very near to the recurrent laryngeal nerve.

Because sacrificing this nerve causes no serious functional or cosmetic sequelae, it is an ideal candidate for its use in nerve reconstruction in the neck (Zheng et al., 1997 ; Miyauchi et al., 2001; Lorenz et al., 2008). The use of ansa cervicalis is not limited to laryngeal reinnervation. Kukwa et al. (1994) and Laurentjove et al., (2011) described the use of this nerve in preventing the morbidity associated with the tongue hemiatrophy after facial-hypoglossal anastomosis.

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 in 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 (Wan et al., 2007). So the aim of this work was to study the anatomical variations of ansa cervicalis in its roots, course, and branching pattern.

MATERIAL AND METHODS

Twenty five fresh postmortem human cadavers, 15 males and 10 females were utilized in this study (25 right and 25 left). These cadavers were obtained from the postmortem

room of Faculty of Medicine, Benha University. They were preserved in 10% formalin. Each specimen was dissected by removing the skin, superficial fascia and deep fascia from the base of the mandible to the clavicle. The deep fascia covering the infrahyoid muscles was removed. The infrahyoid muscles were separated from each other and their nerve supply were exposed. The sternomastoid muscle was incised at its middle, where its upper part was reflected upwards and its lower part was reflected downwards to expose the carotid sheath and its contents. The variable origin of ansa cervicalis, its course and the branching pattern were recorded and photographed by close-up camera under a light source.

RESULTS

Superior root of ansa cervicalis

In 25 specimens (50 sides) (100%), the hypoglossal nerve gave the superior root of ansa cervicalis (AC) which descended in front of the external carotid artery in 34 cases (68%) (Figure 1) and in front of internal carotid artery in 16 cases (32%) (Figure 4). Then the superior root descended on the common carotid artery to join the inferior root in front of the internal jugular vein (Figure. 1, 2, 7 & 8).

Inferior root of ansa cervicalis

The inferior root of AC originated from the ventral rami of the second and third cervical nerves in 42 cases (84%) (Figure 2&5) and from the second cervical nerve in 8



Figure 2. A photograph of a dissected right side of the neck showing: The ansa cervicalis (a) is in the form of U-shaped loop which gives a branch (n₁) to inferior belly of omohyoid (io). The superior root (s) gives a branch(n₂) to superior belly of omohyoid (so) and a branch (n₃) to sternomastoid (m). Notice the inferior root (i) is formed of C₂ and C₃ on the lateral side of internal jugular veins (j).



Figure 3. A photograph of the previous specimen showing : The ansa cervicalis (a) giving a nerve trunk (nt) which passes deep to the intermediate tendon (it) of omohyoid. This nerve trunk divides into three branches (n₁) & (n₂) to sternothyroid (st) and (n₃) to sternohyoid (sh). Notice the superior belly of omohyoid (so) and internal jugular vein (j).



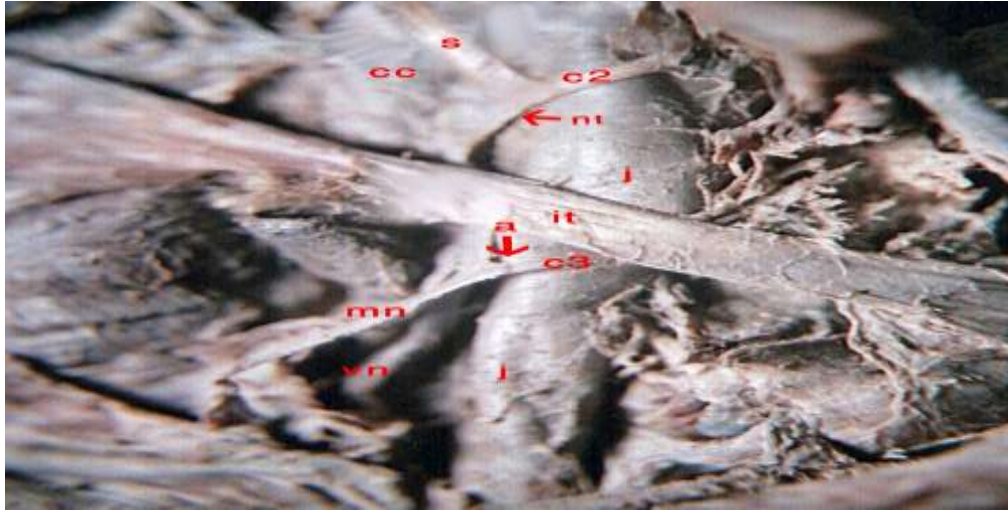
Figure 4. A photograph of a dissected left side of the neck showing: The ansa cervicalis (a) being in the form of Y-shaped loop. The superior root (s) descends in front of internal carotid artery (ic) and common carotid artery (cc). The inferior root (i) crosses the internal jugular vein (j) from lateral to medial. The two roots fuse with each other in front of common carotid artery to give a muscular nerve trunk (nt). Notice the external carotid artery (ec) and superior thyroid artery (t).

cases (16%) (Figure 4).The inferior root crossed the internal jugular vein from lateral to medial in all cases (Figure 1, 2, 4, 5, 7 & 8) except in three cases where the second cervical nerve appeared medial to the internal jugular vein (Figure 6).

Ansa cervicalis

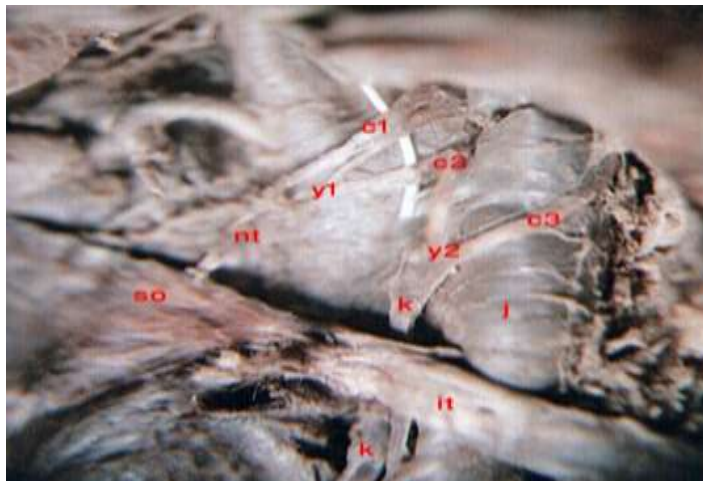
The superior and inferior roots fused with each other to form a nerve loop. In this study, the shape of this loop was variable. There were four forms of the nerve loop: I-

U- shaped loop in 42 cases (84%) (Figure 2&7); II- Y-shaped loop in 4 cases (8%) (Figure 5 & 8); III-Double fused Y- shaped in 2 cases (4%) (Figure 5), In these cases, the stem of upper Y-loop fused with 3rd cervical nerve to form the lower Y-loop; VI- Double separate Y-shaped loop in 2 cases (4%) (Fig.6). In these cases ,the upper Y- loop formed by fusion of the superior root with a part of 2nd cervical nerve .The lower Y-loop formed by fusion of the other part of 2nd cervical nerve with the 3rd cervical nerve . The two stems of the two Y- loops were separated from each other to form two muscular nerve trunks.



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Figure 5. A photograph of a dissected left side of the neck showing :the ansa cervicalis (a) being in the form of double fused Y-shaped loop. C2 fuses with the superior root (s) to form a stem of upper Y (nt) which descends in front of common carotid artery (cc), deep to intermediate tendon (it) of omohyoid and on medial side of I.J.V. (j). This stem fuses with C3 to form a stem of lower Y (mn). Notice the vagus nerve(vn).



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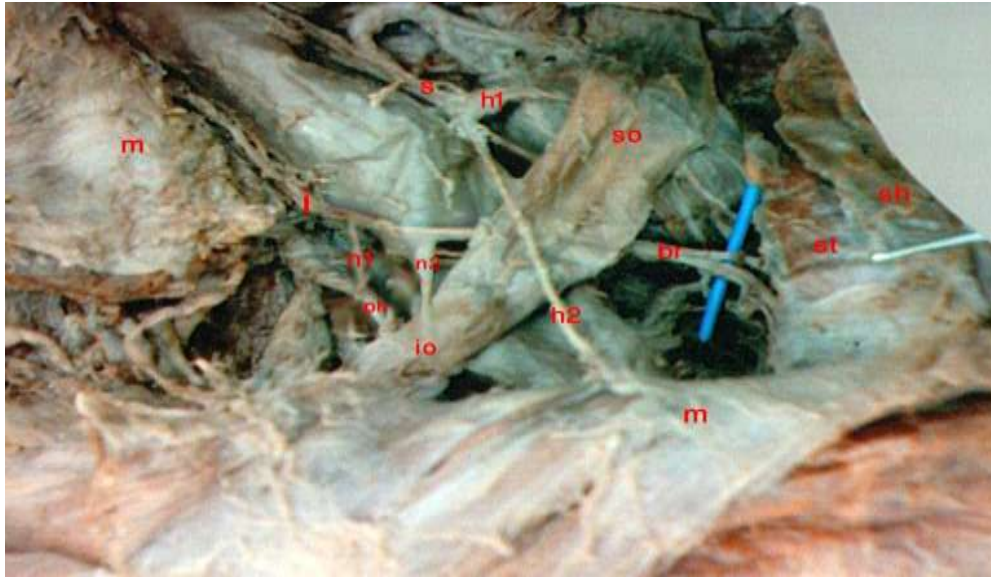
Figure 6. A photograph of a dissected left side of the neck showing: The ansa cervicalis being in the form of double separate Y-shaped loop. Y1 consists of superior root (C1) and a part of C2 to form a stem of upper Y- (nt) which supplies superior belly of omohyoid (so). Y2 consists of a part of C2 and C3 to form a stem of lower Y (K) which descends deep to the intermediate tendon of omohyoid (it). Notice the two parts of C2 emerge from the medial aspect of I.J.V.(j).

Branching pattern of ansa cervicalis

The superior root of AC gave a branch to the superior belly of omohyoid muscle in 48 cases (96%) (Figure 2) and a branch to the sternomastoid muscle in 12 cases (24%) (Figure 2 & 7). The inferior root of AC gave a branch to the inferior belly of omohyoid muscle and a communicating branch to the phrenic nerve in 2 cases

(4%) (Figure 7).

The U- shaped loop of AC gave a branch to the inferior belly of omohyoid muscle in 42 cases (84%) (Figure 2) and nerve trunk which passed deep to the intermediate tendon of omohyoid and divided into branches supplying the sternohyoid and sternothyroid muscles (Figure 2 & 3). In Y-shaped loop, its stem gave muscular branches to sternohyoid, sternothyroid and inferior belly of omohyoid



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Figure 7. A photograph of a dissected right side of the neck showing: The inferior root (i) giving a communicating branch (n_1) to the phrenic nerve (ph) and a branch (n_2) to inferior belly of omohyoid (io). The superior root (s) gives two branches (h_1) to superior belly of omohyoid (so) and (h_2) to sternomastoid (m). The ansa cervicalis gives branches (br) to sternohyoid (sh) and sternothyroid (st).



Figure 8. A photograph of a dissected left side of the neck showing: The ansa cervicalis (a) being in the form of Y-shaped loop. The superior root (s) descends. The inferior root (i) crosses the internal jugular vein (j) from lateral to medial. The two roots fuse with each other in front of common carotid artery to give a muscular nerve trunk (nt). Notice the hypoglossal nerve (h), digastric muscle (d), submandibular salivary gland (su), superior thyroid Vessels (v) and superior belly of omohyoid muscle (so).

in 4 cases (8%) (Figure 4). In double fused Y-shaped; the stem of lower Y-shaped gave muscular branches to the infrahyoid muscles in 2 cases (4%) (Figure 5). In double

separate Y-shaped loop, the stem of upper Y-loop supplied the superior belly of omohyoid muscle, while the stem of lower Y-loop supplied the sternohyoid, sternothy-

roid and inferior belly of omohyoid in 2 cases (4%).

DISCUSSION

In this study, the superior root of ansa cervicalis descended in front of the external carotid artery in 68% and in front of the internal carotid artery in 32%. These results are nearly similar to the results of Caliot and Dumont (1983) who observed that the superior root of AC descended on the external carotid artery in 60% and on the internal carotid artery in 40% of the cases and Loukas et al., (2007) who reported that the superior root of AC was found on the external carotid artery in 72% and on the internal carotid artery in 28%. This means that the superior root of AC usually descend in front of the external carotid artery.

In this study, the superior root of AC gave nerve to superior belly of omohyoid in 95.8% of the cases. This finding is in agreement with Liguoro et al. (1992) and Standring et al. (2008) who reported that the branch to the superior belly of omohyoid muscle is almost originated directly from the superior root of AC. In contrast to these results, Caliot and Dumont (1983) reported that the nerve to the superior belly of omohyoid originated from the superior root of AC in 60% and from the loop of the ansa in 40% of the cases.

In this study, the superior root of AC gave branch to sternomastoid muscle in 24%. This result is similar to the results of Koizumi et al. (1993) and Banneheka (2008b) who reported that the superior root of AC may send a branch to the sternomastoid, thyrohyoid and upper portions of the sternohyoid and sternothyroid.

In this study, the inferior root of AC was derived from the ventral rami of C₂ and C₃ in 84% and from C₂ in 16%. In contrast, the result of Poviraev and Chernikov (1967) who reported that the inferior root was formed of C₂ and C₃ in 74%, from C₂, C₃ and C₄ in 14%, from C₃ in 5%, from C₂ in 4% and from C₁, C₂ and C₃ in 2% of cases. Caliot and Dumont (1983) reported that the inferior root of AC was derived from C₂ and C₃ in 38%, from C₂, C₃ and C₄ in 10%, from C₃ in 40% and from C₂ in 12% of the cases. The differences in these results may be due to wide variations in the number of the dissected specimens.

In this study, the inferior root crossed the internal jugular vein from lateral to medial in all cases except in 3 cases where the second cervical nerve appeared medial to the internal jugular vein. Caliot and Dumont (1983) reported that the inferior root was lateral to I.J.V. in 81% and medial to I.J.V. in 15%. In 2 cases (4%) of the present study, the inferior root of AC gave a branch to inferior belly of omohyoid and a communicating branch to phrenic nerve. This result is in agreement with the results of Loukas et al., (2006) and Banneheka (2008a). Turner (1993) reported a case of the phrenic nerve receiving a root of origin from the superior root of AC. Loukas et al. (2006) reported more information about the accessory

phrenic nerve that it originated from the nerve to subclavius in 60.6%, from ansacervicalis in 12.1% and from nerve to sternohyoid in 7%.

In this study, there were four morphological forms of the loop of ansa cervicalis : I- U-Shaped loop in 84%. II- Y-shaped loop in 8%. III- double fused Y- shaped loop in 4%. VI- double separate Y- shaped loop in 4%. So, the most common form is U- shaped, while the other forms are rare. Chummy (2006) described two forms of ansa cervicalis; U-shaped loop and Y-shaped loop.

It is concluded that the ansa cervicalis has many variations in its origin, course and pattern of distribution. These variations can be used in nerve grafting of the laryngeal muscles and should be considered when the surgical procedures are performed on the neck. This study differs from the previous reports in having well definite four morphological forms of ansa cervicalis.

Finally, when studies are made on the variations of the ansa cervicalis, a higher number of cadavers should be dissected to discover a more variations and more applications.

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