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Original Article

Surgical anatomy of hypoglossal nerve as a guide for important head and neck surgeries

Anne D. Souza[a], Mamatha Hosapatna[b], Kantharaj Seva Naik[b], Antony Sylvan D. Souza[b], Vrinda Hari Ankolekar[b,*]

[a] Department of Anatomy, Kasturba Medical College, Manipal University, Manipal, Karnataka, 576104, India
[b] Department of Anatomy, Kasturba Medical College, Manipal University, 576104, India

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ABSTRACT

Introduction: The hypoglossal nerve (HN) may be damaged during neck surgeries. A detailed understanding of the anatomy of the hypoglossal nerve in relation to various anatomical landmarks and surrounding structures is important to reduce procedural complications and the risk of nerve damage.

Methods: The study was carried out using 21 sagittal sections of head and neck of male cadavers (16 right and 5 left). To measure the required parameters the anatomical landmarks taken were the posterior belly of digastric muscle (PBD), descendens hypoglossi of ansa cervicalis (AC), bifurcation of common carotid artery (CCA), tip of the mastoid process (TMP), lingual artery (LA) at the posterior border of hyoglossus muscle, tip of greater cornu of hyoid bone (GH), bifurcation of CCA to the attachment of descendens hypoglossi (CCA-AC).

Results: The length of PBD was 3.77 ± 1.08 cm on right side and 3.15 ± 0.05 cm on left side. The extended length was measured from the TMP to GH which was 6.7 ± 1.23 cm on right side and 6.75 ± 0.75 on left side. The distance between HN to the GH did not vary much between right and left sides which were 1.21 ± 0.35 and 1.2 ± 0.69 cm respectively. The distance between HN and LA at the posterior border of hyoglossus was 1.12 ± 0.3 cm on right side and 0.5 ± 0.3 cm on left side.

Discussion: HN dissection is more complicated, as the location of the HN is much deeper. Moreover, there are no bony landmarks around the HN. Therefore PBD, CCA, ICA, ECA, LA were used as landmarks for HN in head and neck surgeries.

1. Introduction

The hypoglossal nerve (HN) is motor to all the muscles of the tongue, except palatoglossus. The nerve emerges from the hypoglossal canal medial to the internal jugular vein & internal carotid artery. It then descends vertically between the vessels and anterior to the vagus to a point level with the angle of the mandible. Passes superficial below the posterior belly of digastric emerge between the internal jugular vein and internal carotid artery, crosses lateral to both internal and external carotid arteries and the loop of the lingual artery a little above the tip of the greater cornu of the hyoid, passes deep to the stylohyoid and tendon of digastric. In this region it gives a descending branch (desendens hypoglossi) which joins with the descendens cervicalis to form ansa cervicalis.[1]

The hypoglossal nerve may be damaged during neck surgeries. The literature mentions it is frequently damaged during the anterior approach to the cervical spine.[2] There are several reports in the otolaryngology, anesthesia and neurology literature concerning iatrogenic hypoglossal nerve palsy without direct nerve injury following tonsillectomy[3] laryngoscopy [4], transoral intubation [4] or poor body position.[5] It has also been suggested that malpositioning of the patient during surgery, particularly hyperextension of the neck, may result in nerve stretching and injury.[6]

A detailed understanding of the anatomy of the hypoglossal nerve, in relation to various anatomical landmarks and surrounding structures, is important to reduce procedural complications and the risk of nerve damage. It is difficult to define the proximal

* Corresponding author.
E-mail addresses: annedsouza_84@yahoo.co.in (A.D. Souza), mamatha2010@yahoo.com (M. Hosapatna), kantharaj871@gmail.com (K.S. Naik), asdsouza2000@yahoo.co.in (A.S.D. Souza), vrindahari@rediffmail.com (V.H. Ankolekar).

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part of the HN located immediately beneath the base of the skull, as the HN in this area is readily confused with accessory nerves or the vagus nerve.[7]

The present study focuses mainly on the relations of the HN with distance from the tip of mastoid process (TMP), posterior belly of digastric muscle (PBD) and the common carotid artery (CCA), which can be easily identified during the surgery. The relations of the anatomical landmarks and HN may be helpful to find the HN more easily and to reduce the risk of procedural complications.

2. Material and methods

The study was carried out using 21 sagittal sections of head and necks of male cadavers (16 right and 5 left) preserved in 10% formalin in department of Anatomy, Kasturba Medical College Manipal, India. The sternocleidomastoid muscle was reflected by cutting the sternal and clavicular heads. The PBD was dissected till its attachment to the mastoid process. The carotid sheath was dissected and the contents were visualized. In one specimen of left side the hypoglossal nerve was located in the digastric triangle above the posterior belly of digastric therefore it was not included in measuring the parameters.

To measure the required parameters the anatomical landmarks taken were the posterior belly of digastric muscle (PBD), descendens hypoglossi of ansa cervicalis (AC), bifurcation of common carotid artery (CCA), tip of the mastoid process (TMP), lingual artery (LA) at the posterior border of hyoglossus muscle, junction of body and greater cornu of the hyoid bone (GH).

Using the above landmarks following parameters were measured.

1 Relation of HN to the carotid arteries. (Fig. 1)

1a. Bifurcation of CCA to the attachment of descendens hypoglossi (CCA-AC)

1b. HN crossing the ECA and ICA (CCA- ECA and CCA-ICA)

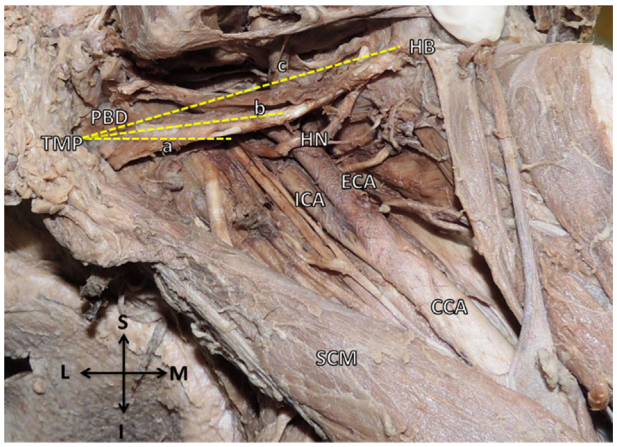

Fig. 2. Relation of hypoglossal nerve with posterior belly of digastric muscle.
PBD- Posterior belly of digastric, HN- Hypoglossal nerve, CCA- Common carotid artery, ECA- External carotid artery, ICA- Internal carotid artery, TMP- Tip of mastoid process, SCM- Sternocleidomastoid, HB- Hyoid bone
a- TMP to the posterior end of loop of HN
b- Total length of the PBD
c- Extended length of PBD i.e. TMP to HB

- Relation of HN to the PBD (Fig. 2)

2a. TMP to the posterior end of loop of HN
2b. Total length of the PBD
2c. Extended length of PBD i.e. TMP to GH

- GH to the anterior end of the HN
- HN to LA at the posterior border of hyoglossus muscle
- Extent of the loop of HN at it midpoint

The parameters 3, 4 and 5 depicted in Fig. 3.

The parameters were measured using digital callipers and their mean and standard deviations were calculated using SPPSS version 16.

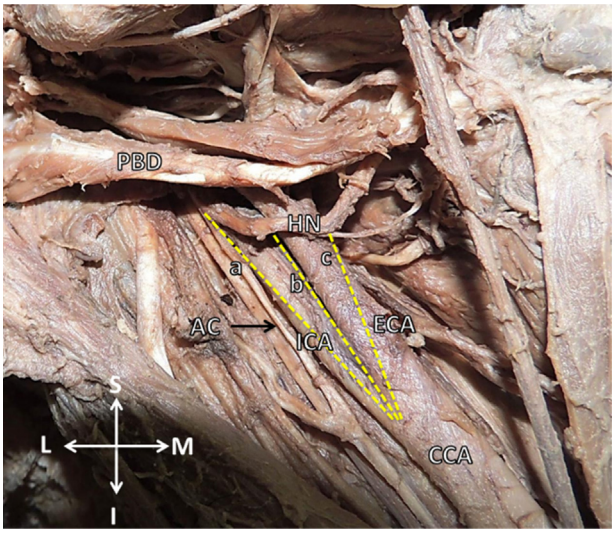

Fig. 1. Relation of hypoglossal nerve with carotid arteries.
PBD- Posterior belly of digastric, HN- Hypoglossal nerve, CCA- Common carotid artery, ECA- External carotid artery, ICA- Internal carotid artery, AC- Descendens hypoglossi of Ansa cervicalis
a- Bifurcation of CCA to the attachment of descendens hypoglossi (CCA-AC)
b- Bifurcation of CCA- ECA
c- Bifurcation of CCA-ICA

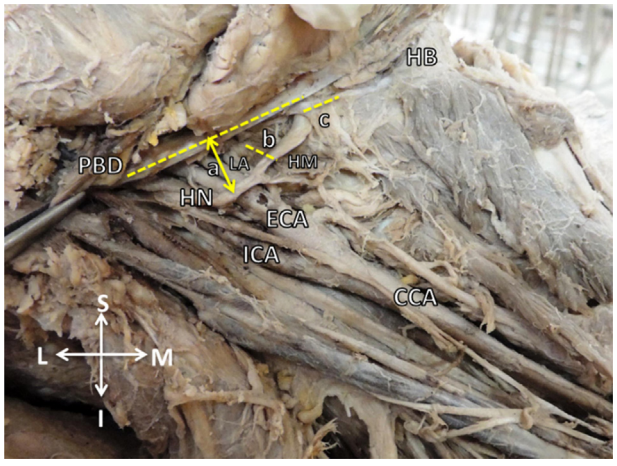

Fig. 3. Extent of the loop of hypoglossal nerve.
PBD- Posterior belly of digastric, HN- Hypoglossal nerve, CCA- Common carotid artery, ECA- External carotid artery, ICA- Internal carotid artery, HB- Hyoid bone, LA- Lingual artery, HM- Hyoglossus muscle
a- Vertical extent of the loop of HN
b- Distance between HN and LA along the posterior border of HM
c- Distance between HN and junction of body and greater cornu of HB

3. Results

3.1. Anatomy of the hypoglossal nerve

The loop of HN is considered as one of the contents of the carotid triangle which was observed just below the posterior belly of digastric muscle superficial to the contents of the carotid sheath. The descendens hypoglossi was observed anterior to the internal and common carotid arteries. The HN then traversed anteriorly superficial to the hyoglossus muscle whereas the lingual artery traversed deep to it. In one sagittal section of left side the hypoglossal nerve was located in the digastric triangle above the posterior belly of digastric muscle. (Fig. 4)

3.2. Relations of HN to the anatomical landmarks taken

The distances measured from the carotid arteries to the HN are shown in Table 1.

The length of PBD was 3.77 ± 1.08 cm on right side and 3.15 ± 0.05 cm on left side. The extended length on right side was measured from the TMP to GH which was 6.7 ± 1.23 cm and 6.75 ± 0.75 on left side. The HN crossed PBD. 2.72 ± 0.8 cm anterior to the TMP on right side while on left side it was situated 2.1 ± 0.57 cm anterior to TMP.

The distance between HN to the GH did not vary much between right and left sides which were 1.21 ± 0.35 and 1.2 ± 0.69 cm respectively. The distance between HN and LA at the posterior border of hyoglossus was 1.12 ± 0.3 cm on right side and 0.5 ± 0.3 cm on left side.

The values were not compared between the two sides due to the small sample size.

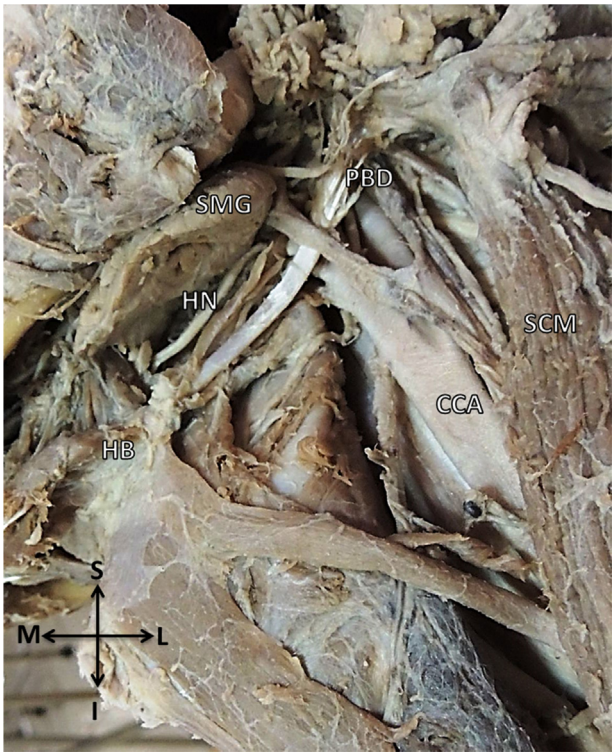

Fig. 4. Loop of hypoglossal nerve above the digastric muscle in the digastric triangle.
PBD- Posterior belly of digastric, SMG- Submandibular gland, HN- Hypoglossal nerve, HB- Hyoid bone, CCA- Common carotid artery, SCM- Sternocleidomastoid

Table 1
Mean and SD indicating the relation of hypoglossal nerve to carotid arteries.

Parameters measured in cm	Right (N = 16)	Left (N = 5)
CCA to AC	3.01 ± 0.81	2.6 ± 1.15
CCA to ECA	2.23 ± 0.58	2.00 ± 0.46
CCA to ICA	2.57 ± 0.67	2.25 ± 0.51

CCA- common carotid artery, ECA- external carotid artery, ICA- internal carotid artery.

4. Discussion

The aim of this morphometric study was to define the anatomical relations of HN to recognizable landmarks. The data helps to safely expose the HN for a new surgical technique to improve the results of conventional hypoglossal-facial nerve anastomosis.[8]

In the present study authors found that the distance from CCA to AC was 3.01 ± 0.81 cm and 2.6 ± 1.15 cm on right and left sides respectively. The distances from CCA to ECA 2.23 ± 0.58 cm and 2.00 ± 0.46 cm on right and left side respectively. The distance from CCA to ICA was 2.57 ± 0.67 cm and 2.25 ± 0.51 cm on right and left side respectively. Whereas a study done by Shin et al., showed CCA to AC distance was 2.76 ± 0.87 cm and 2.55 ± 0.61 cm on right and left side respectively which was similar to the present study. The distance from CCA to ECA 1.53 ± 0.65 cm and 1.47 ± 0.48 cm on right and left side respectively. The distance from CCA to ICA was 1.84 ± 0.75 cm and 1.85 ± 0.61 cm on right and left side respectively. These two parameters showed differences when compared to the present study.[9]

Carotid endarterectomy is a well-accepted and frequently used therapeutic approach to carotid artery disease. Awareness of the possibility of injury to hypoglossal nerve in this surgery has been heightened by many reports. Because of this complication, great care is necessary to avoid injury to the hypoglossal nerve in patients who will require bilateral carotid endarterectomy.[10–12]

The length of posterior belly of digastric was 3.77 ± 1.08 cm on right side and 3.15 ± 0.05 cm on left side respectively. In a study done by Shin et al. [7] the length of posterior belly of digastric was 6.22±.60 cm and 5.29 ± 0.72 cm on right and left side respectively. It was also noted that the length of posterior belly of digastric was longer in females when compared to males. In the present study the gender differences were not considered as the study was done only on male cadavers.

There is very limited literature available for the extended length of posterior belly of digastric. The extended length was measured from the TMP to GH it was 6.7 ± 1.23 cm on right side and 6.75 ± 0.75 cm on left side.

In the present study the hypoglossal nerve crossed the posterior belly of digastric 2.72 ± 0.8 cm anterior to the TMP on right side while on left side it was situated 2.1 ± 0.57 cm anterior to TMP. Study done by found that the HN appeared under PBD and crossing point corresponded to about 65.5% of the whole length of PBD from the digastric groove.[9]

Considering the complicated anatomy of the cervical and submandibular region, the use of only one surgical landmark is not recommended. The PBD and the CCA represent good landmarks during submandibular dissection to identify the HN.[13,14,15]

In the present study the authors used two new landmarks like GH and LA which were not observed in previous studies in the literature. The distance between HN to the GH did not vary much between right and left sides which were 1.21 ± 0.35 and 1.2 ± 0.69 cm respectively. The distance between HN and LA at the posterior border of hyoglossus was 1.12 ± 0.3 cm on right and 0.5 ± 0.3 cm on left side. The HN constitutes an important anatomic structure that is related to the lingual artery.[16] So above parameter

may help the surgeon in locating the hypoglossal nerve in reference to the lingual artery.

HN dissection is more complicated, as the location of the HN is much deeper. Moreover, there are no bony landmarks around the HN. Therefore PBD, CCA, ICA, ECA, LA were used as landmarks for HN in head and neck surgeries.

5. Conclusion

The present study provides useful information regarding the morphometric anatomy of hypoglossal nerve. It also provides additional information about the relation of hypoglossal nerve to lingual artery and hyoid bone which are frequently used surgical landmarks.

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