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Neuroanatomical study

# Microsurgical anatomy of the hypoglossal nerve

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**Abstract**

The aim of the present study was to review the surgical anatomy of the hypoglossal nerve (HN), to reveal its relationships on its course and to provide some landmarks to its identification. Ten cadaveric head dissections (20 sides) were performed using microsurgical techniques. The anatomical relationships between the HN and other nerves, muscles, arteries and veins were carefully recorded, and some measurements were made between the HN and related structures. Thus, various landmarks were determined for the easy identification of the HN. In addition, the hypoglossal triangle, which containes major vascular structures, is described. The HN is divided into three main parts: cisternal, intracanalicular and extracranial. The HN arises from the medulla as a line of rootlets situated along the anterior margin of the lower two-thirds of the olive in the preolivary sulcus. It is the newly described 'hypoglossal' triangle in the anterior neck that is bordered by the descending hypoglossus laterally, transverse hypoglossus inferiorly and inferior border of the stylohyoid muscle superiorly. In our specimens, we determined that the HN was 3–7 mm (mean 5 mm) inferior to the digastric tendon, as well as mostly superficial. The occipital artery arose from the posterior surface of the external carotid artery (ECA) 6–9 mm (mean 7 mm) above the carotid bifurcation. There is also an important 'cross' between the occipital artery and the HN. In all cadavers, this crossing point was 7–9 mm (mean 8 mm) superior to the emergence of the occipital artery from the ECA. In conclusion, understanding the detailed anatomy of the HN and using landmarks to identify the nerve are crucial for surgery in the region.


*Keywords:* Hypoglossal nerve; Microsurgical anatomy

## 1. Introduction

The hypoglossal nerve (HN), also known as cranial nerve XII, is the motor supply of the tongue. It is important to understand its entire course to evaluate hypoglossal pathology. The trajectory of the HN can be separated into two main parts: intracranial and extracranial. Understanding the course of the extracranial HN and its anatomical relationships with neurovascular structures and muscles, as well as having some landmarks to evaluate the nerve, are essential in surgical procedures such as carotid endarterectomy, especially in stenosis with high plaques, hypoglossofacial anastomosis or HN grafting as a donor. In addition to the neural control of tongue movement, the HN also has a role in respiration and swallowing. Avoiding damage to the nerve is possible with an understanding of the normal and varied trajectory of the nerve. In the present anatomical study, we undertook cadaveric dissections to assess the course of the nerve and display its relationships with neighbouring anatomical structures.

## 2. Methods

The HN was studied on 10 formalin-fixed adult cadaver heads (20 sides). The specimens were obtained after routine autopsy procedures had been performed and the cadavers had been embalmed in 10% formaldehyde solution. The internal carotid arteries, the vertebral arteries and the internal jugular veins were dissected, cannulated and irrigated with saline solution to remove any residual blood clots in the lumens. The vascular structures were perfused with col-

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ored latex in eight specimens and with colored silicon in two specimens in order to facilitate their definition. Cadaveric heads in the present study were examined under magnifications of $\times 3 - \times 40$ using an Opmi-Zeiss surgical microscope (Carl Zeiss Surgical GmbH, Thornwood, NY, USA). Dissections were performed along the entire trajectory of the HN.

## 3. Results

The HN can be divided into three main parts: cisternal, intracanalicular and extracranial.[1]

The HN arises from the medulla as a line of rootlets situated along the anterior margin of the lower two-thirds of the olive in the preolivary sulcus (Fig. 1). The cisternal segment extends through the dorsolateral part of the premedullary cistern and its contents, the rootlets of the HN, usually come together to form two main trunks of the nerve. It is important that the rootlets of the HN arise along the anterior margin of the inferior olive and pass laterally behind the vertebral artery to enter through the hypoglossal canal. The hypoglossal canal is directed anterolaterally above the occipital condyle. The external orifice of the hypoglossal canal is situated above the anterior third of the condyle. The HN exits the inferolateral part of the hypoglossal canal, at which point the extracranial portions begin.

To understand the topographic anatomy of the HN, it is first necessary to have some knowledge of the adjacent structures. There are two important triangles described in the anterior neck.[2] The large or 'anterior' triangle is formed by the anterior border of the sternocleidomastoid muscle posteriorly, the mid-line of the neck anteriorly and the border of the mandible and the mastoid process superiorly, and contains the branches of the ansa cervicalis, which innervates the infrahyoid muscles of the neck. From the neurosurgical view, the second or 'submandibular triangle' is the most important area described in the anterior neck.[2] It is formed by the inferior border of the mandible and the anterior and posterior bellies of the digastric muscle.

In this study, we describe a new 'hypoglossal' triangle in the anterior neck, which is bordered by the descending hypoglossi laterally, transverse hypoglossi inferiorly and inferior border of the stylohyoid muscle superiorly (Fig. 2). The occipital artery, internal carotid artery (ICA) and external carotid artery (ECA) pass through the hypoglossal triangle.

### 3.1. Muscular relationships

Muscles appear as clear borders in the neck and as important surgical landmarks. The sternocleidomastoid muscle forms the posterior border of the anterior triangle of the neck and attaches to the mastoid process of the temporal bone and lateral half of the superior nuchal line.[3] It courses obliquely downward and inserts at the superior part of the manubrium sterni (pars sternalis) and medial one-third of the clavicle (pars clavicularis) (Fig. 2). It is innervated by the accessory nerve and cervical plexus.

The posterior belly of the digastric muscle attaches to the digastric groove of the mastoid process. It courses anteroinferiorly, becomes tendinous, pierces the stylohyoid muscle and attaches to the body and the greater horn of the hyoid bone (Fig. 2). Then, it starts at the anterior belly of the digastric muscle and courses anterosuperiorly and ends in the fossa digastrica mandibula. Pursuing the borders of the digastric muscle provides an important landmark to identify the HN. When the HN emerges between the ICA and the internal jugular vein (IJV) on its course toward the tongue, it becomes more superficially inferior to the tendon of the posterior belly of the digastric muscle. In our specimens, we determined that the HN was 3–7 mm (mean 5 mm) inferior to the digastric tendon, as well as mostly superficial.

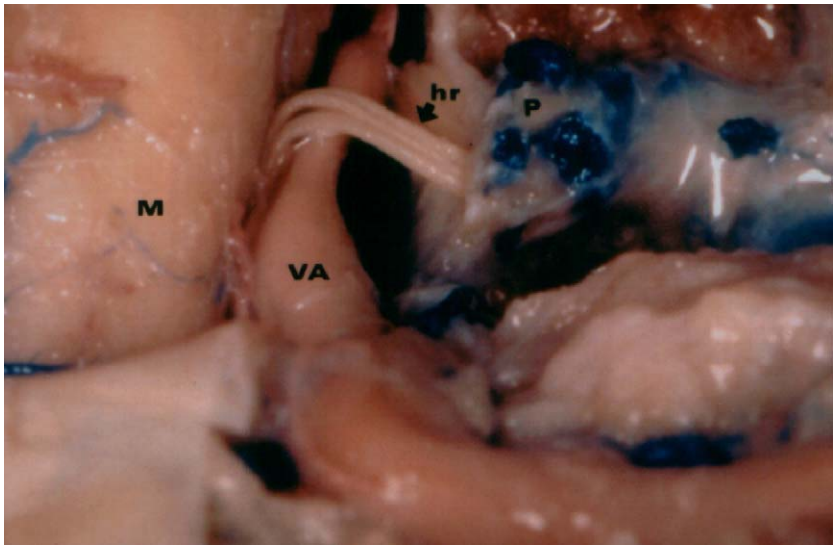


Fig. 1. Photograph of cadaveric dissection showing the exit of the right hypoglossal nerve as rootlets (hr) from the medulla (M) and the relationship between the hypoglossal nerve and the vertebral artery (VA). The occipital condyle was removed. P, the venous plexus of the canalis hypoglossi.