

Literature Review Article

The hypoglossus nerve (XII cranial nerve pair): anatomical considerations and complications after injuries – a literature review

Felipe Celestrin de Toledo¹
Beatriz Carmona Ferreira¹
Alexandre Rodrigues Freire¹
Felippe Bevilacqua Prado¹
Ana Cláudia Rossi¹

Corresponding author:

Ana Cláudia Rossi
Universidade Estadual de Campinas
Departamento de Biociências, Divisão de Anatomia, Faculdade de Odontologia de Piracicaba
Avenida Limeira, n. 901 – Areião
CEP 13414-903 – Piracicaba – SP – Brasil
E-mail: rossianac01@gmail.com

¹ Biosciences Department, Piracicaba Dental School, Anatomy Division, University of Campinas – Piracicaba – SP – Brazil.

Received for publication: October 7, 2021. Accepted for publication: August 1, 2022.

Keywords:

hypoglossal nerve;
anatomy; injury;
intubation; tongue.

Abstract

Introduction: The hypoglossal nerve (XII cranial nerve) is the tongue's motor supply. The hypoglossal nerve trajectory can be separated into two main parts: intracranial and extracranial. **Objective:** Considering the rarity of hypoglossus nerve injury, and that when it occurs it results in clinical implications that should be known by the Medical and Dentistry professionals, the aim of this study was to carry out a literature review on the anatomy of the hypoglossal nerve and possible causes of injuries and ways to treat this type of complication. **Material and methods:** A literature review was carried out in the international Pubmed database. The literature review included 19 articles from 1965 to 2021. The keywords used were: "hypoglossus nerve", "injury". Of the 19 articles, 10 were used for this literature review. Among the 9 articles that were discarded, 5 did not address the objective of this work and 4 did not present the available text. All types of articles were considered (1 literature review, 6 case reports and 3 original articles). **Conclusion:** The knowledge of the hypoglossal nerve anatomy is for surgical interventions, partial resections, and tongue reconstructions. The causes listed in the present literature review are intubation, the covid-19, procedures performed in the carotid area and occipital condyle fracture. In relation to treatment approaches, no specific protocol has been invented until now.

Introduction

The hypoglossal nerve (HN), also known as the XII cranial nerve, is the tongue's motor supply. The HN trajectory can be separated into two main parts: intracranial and extracranial. Understanding the course of extracranial HN and its anatomical relationships with neurovascular structures and muscles, in addition to having some landmarks for nerve assessment, are essential in surgical procedures such as carotid endarterectomy, especially in high-plate stenosis, hypoglossofacial anastomosis or use of HN as a donor area for graft. In addition to neural control of tongue movement, HN also plays a role in breathing and swallowing. It is possible to prevent nerve damage by understanding the anatomy and its variations [1]. HN innervates all extrinsic and intrinsic muscles of the tongue, except the palatoglossus muscle, which is innervated by the accessory nerve [1].

Several HN injuries have been described as post-intubation complications. More frequent are pharyngeal and laryngeal lesions, such as edema or ulcerations, laryngeal chondromalacia, laryngeal or tracheal stenosis and vocal fold paralysis [8]. Although the etiology of these injuries is not well known, the chemical composition of the intubation tube or sterilization products used is believed to be the main cause. Pressure on adjacent tissues after oro-tracheal tube implantation has been described as another factor [8].

Few cases of HN injury secondary to airway anesthetic management have been reported. The cause of this type of injury is attributed to nerve neuropathy caused by compression after inflation of the cuff into the larynx or damage after hyperextension of the neck during difficult intubation [12].

Partial HN damage can cause tongue paralysis, leading to speech and chewing problems. Severe bilateral nerve trauma can affect the tongue's protruding movement, causing the tongue to fall backwards, possibly resulting in airway obstruction [2].

Considering the rarity of this type of injury, and that when it occurs it results in clinical implications that should be known by the Medical and Dentistry professionals, the aim of this study was to carry out a literature review on the anatomy of the HN (XII pair of cranial nerve) and possible causes of injuries and ways to treat this type of complication.

Material and methods

A literature review was carried out in the international Pubmed database. The literature review included 19 articles from 1965 to 2021. The keywords used were: "hypoglossus nerve", "injury". The articles were searched on August 30th, 2021.

Of the 19 articles, 10 were used for this literature review. Among the 9 articles that were discarded, 5 did not address the objective of this work and 4 did not present the available text.

All types of articles were considered (1 literature review, 6 case reports and 3 original articles).

Literature review

Hypoglossal nerve anatomy (XII cranial nerve pair)

Regarding the anatomy of the HN, there is little information in the present literature. The HN is described as a pure motor nerve that innervates all the tongue muscles [14]. Its trunk is divided into five segments: medullary, cisternal, skull base, nasopharyngeal and oropharyngeal, carotid space and sublingual [14].

Hypoglossal nerve's intracranial course is not explored in the articles that were included in the present literature review. Information focuses on the extracranial course, especially within the tongue.

The HN runs beneath the submandibular gland, the submandibular duct and the lingual nerve and enters the tongue body anterior to the hyoglossal muscle [9, 13]. Its intralingual course is simple, which regularly consists of a single, closed main trunk that can be followed to the tip of the tongue and then breaks into its terminal branch [9].

After the entry point, the first section of the main trunk of the HN always runs vertically, from lateral to medial to the lingual septum. The second section regularly points from the caudal to the cranial direction, the third section goes from the dorsal to the ventral direction and the fourth section remains in the same dorsoventral direction. The terminal branches disperse in the apical part of the tongue [9].

According to the dissections performed by Scheiderbauer *et al.* [9], thin lateral branches could only be traced in a few millimeters only from the first and second sections of the main trunk, which were isolated delicate branches distally, towards the base of the tongue (muscle branches).

As a topographic supplement, the main trunk of the hypoglossal nerve can be defined in relation

to the lingual artery [9]. The HN entry point is in front of and below the lingual artery entry point into the body of the tongue, which is noticeable as a reference point due to its pulsation. The HN crosses the artery in its first cut and runs in the second, third and fourth cuts between the artery and the artery of the lingual septum [9].

Causes of hypoglossal nerve injuries (XII cranial nerve pair)

From a literature review, some of the causes of HN injuries can be highlighted.

Intubation

Some articles reported HN injury during endotracheal intubation [4, 13, 14]. Another article reported an ipsilateral extracranial palsy of the hypoglossal nerve after nasotracheal intubation and throat packing [10].

Although cranial nerve injury has been reported as a rare complication following endotracheal intubation, it can happen in the pharyngolaryngeal region during general anesthesia, and the hypoglossal, lingual and recurrent laryngeal nerves are described as being the most frequently affected ones [4, 13, 14].

Ulusoy *et al.* [13] reported a case of combined neuropraxia of the hypoglossal and lingual nerves that was developed during the procedure of general anesthesia for septorhinoplasty surgery. Uña *et al.* [14] reported a case of bilateral palsy of the HN in a patient that underwent a diagnostic anterior mediastinotomy as a part of an investigation of a mediastinal mass. Janssen *et al.* [4] presented a case of a patient that showed HN injury as a complication of endotracheal intubation. Schmidt *et al.* [10] related a case of a patient with unilateral palsy of the hypoglossus and vagus nerves after intubation for reoperation for a mandibular fracture.

The signals of HN injury were described by Janssen *et al.* [4] as dyspnea, problems with swallowing and dysarthria, and elevation of the right pharyngeal arch and deviation of the tongue to the right.

Different explanations about the mechanism of HN injury are discussed in the articles. According to Uña *et al.* [14], it happens due to neuropathy of the nerve, that is provoked by compression following inflation of the cuff within the larynx, or damage after neck hyperextension during a difficult intubation. The authors ruled out injury to the HN caused by surgery because of the spatial distance between the HN and its branches and the

surgical or tumor site. So, they conclude that the cause of the HN injury was the neuropathy after prolonged compression of neighboring tissues by the oro-tracheal tube, which was transferred to the nerve [14].

Ulusoy *et al.* [13] listed several possible causes for the nerve's injury. They relate these injuries as an association of many factors, such as laryngoscopy, endotracheal intubation and tube insertion, cuff pressure, mask ventilation, the triple airway maneuver, the oropharyngeal airway, manner of intubation tube insertion, head and neck position and aspiration [13]. The authors suggest that, during the triple airway maneuver, the pressure effect on the tongue may have been increased. Another aspect that they consider is the cricoid pressure that was applied during laryngoscopy in order to improve visualization [13]. They describe that the endotracheal tube used was high pressure, low volume and non-flexiblered-rubber, and it was tightly attached. In their opinion, the simultaneous occurrence of these various factors may have facilitated nerve injuries [13].

Covid-19

De Gennaro *et al.* [3] reported two cases of patients who presented cranial neuritis, with hypoglossal involvement, after covid-19 pneumonia. In the first one, a 42-year-old male patient, it was detected severe bilateral denervation in HN, and in the second one, a 67-year-old male patient, it was observed left hypoglossus paresis. The signals observed in the second patient were dyslalia and deglutition difficulties [3]. In both their patients the neuropathic symptoms were developed 1 month after the covid-19 infection.

The exact pathogenesis of cranial neuropathy in the covid-19 infection is not well determined, but there are some theories. The hypotheses vary between an immune mechanism, or direct viral nervous system invasion. There is another explanation that is being considered, the inflammatory hypothesis, which assume that there is a late aberrant immune response after covid infection frequently associated to Miller Fisher syndrome and Guillain-Barré syndrome [3].

Surgeries in the carotid area

Another situation in which damage to the HN has been reported is in case of surgery in the carotid area.

Carotid body tumor (CBT) is a rare neoplasm that is generally encountered in level with the

hyoid bone, in the sternocleidomastoid muscle anterior, and has a close relationship to the X and XII cranial nerves [5]. The CBT excision surgery caused injury to the HN, as related by Kaygusuz *et al.* [5]. The authors reported 21 cases of patients with the diagnosis of CBT. Surgical treatment to totally excise the tumor was applied to 19 patients. Two of these patients (10.5%) had the HN damaged [5]. The authors relate that 1 of these patients was recovered 3 months after the surgery and the other one developed HN paralysis [5].

Procedures to restore the carotid patency are also related to cranial and peripheral nerves injury. Myrcha *et al.* [7] aimed to evaluate the incidence of injury to cranial and peripheral nerves after patency restoration of the internal carotid artery. According to the authors, from 543 procedures for restoration of patency of the internal carotid artery, 7 cases (1.4%) of HN injury were found after the operations [7]. Damage to the cranial nerves due to carotid patency restoration has been reported as frequent, but it has not been related to health risks and its regress is frequently spontaneously [7].

In addition, there has been related cranial nerve paralysis because of operations of the carotid artery. Krennmair *et al.* [6] searched for the presence and reversibility of cranial nerve palsy after carotid artery surgery, focusing in the facialis, hypoglossus and vagus nerves paresis. They reported 28 cases of cranial nerve injuries of which 6 cases involved the HN [6]. The authors also listed some of different reasons for cranial nerve damages, such as direct pressure, retraction and edema [6].

Occipital condyle fracture

A case of a 33-year-old man who presented hypoglossal nerve paresis after an occipital condyle fracture was described by Smejkal *et al.* [11]. The man suffered a car accident. The diagnosis was determined by computed tomography exam, based on the presented clinical signs, such as difficulty in swallowing, chewing and speaking owing to impaired mobility of the tongue [11]. The patient presented the left half of the tongue showing a marked hypertrophy and muscle weakness [11].

Clinical complications of hypoglossal nerve injuries (XII cranial nerve pair)

Regarding the clinical complications of HN injuries, the patients presented some symptoms that are related in the articles, such as difficulty or inability to swallow and to speak [3, 4, 11, 13,

14], sore throat and hoarseness [13], difficult to move the tongue, especially in sticking it out of the mouth, or deviation of the tongue [3, 4, 11, 13, 14] and edema in the tongue [13].

Clinical complications resulting from the HN injuries also lead to psychiatric problems as anxiety disorder and depression [13, 14]. Psychiatric symptoms can develop among with neurological symptoms, so the patient must be monitored during all rehabilitation [14].

Treatment approaches for hypoglossal nerve injuries (XII cranial nerve pair)

In the literature, there is no specific protocol applied in the treatment of HN injuries. Different approaches are used, and some of them are common to several cases.

The various approaches we can find in the literature are: speech and swallowing therapy [4, 13, 14], dietary modifications [4], use of steroid medications [13, 14] and vitamin administration as a supplement, including vitamins D, E, B1 and B6 [13, 14]. De Gennaro *et al.* [3] also reported the use of intravenously human immuno-globulin.

In general, the authors report that the prognosis is favorable [4, 6, 14].

Conclusion

The knowledge of the typical course of the HN can be important for surgical interventions, partial resections and tongue reconstructions.

In conclusion, the etiology of HN injuries is very varied. The causes listed in the present literature review are intubation, the covid-19, procedures performed in the carotid area and occipital condyle fracture. In relation to treatment approaches, no protocol has been invented until now. Different therapies are being applied aiming to solve these injuries.

References

1. Bademci G, Yaşargil MG. Microsurgical anatomy of the hypoglossal nerve. *J Clin Neurosci.* 2006;13(8):841-7.
2. Ballotta E, Da Giau G, Renon L, Narne S, Saladini M, Abbruzzese E et al. Cranial and cervical nerve injuries after carotid endarterectomy: a prospective study. *Surgery.* 1999;125(1):85-91.

3. De Gennaro R, Gastaldo E, Tamborino C, Baraldo M, Casula N, Pedrali M et al. Selective cranial multineuritis in severe covid-19 pneumonia: two cases and literature review. *Neurol Sci.* 2021;42(5):1643-8.
4. Janssen J, Swets M, de Jong M, Hassing LT, van Gageldonk BJHG, van der Zwan T. Uitval van de N. hypoglossus na orotracheale intubatie [Hypoglossal nerve injury following endotracheal intubation]. *Ned Tijdschr Geneesk.* 2020;164:D4592.
5. Kaygusuz I, Karlidag T, Keles E, Yalcin S, Yüksel K. Carotid body tumor: clinical features. *J Craniofac Surg.* 2015;26(7):e586-9.
6. Krennmair G, Moser G, Pachinger O, Deutsch M. Periphere Hirnnervenlähmungen als Folge von Operationen an der A. carotis [Peripheral cranial nerve paralysis as a sequela of operations of the carotid artery]. *Wien Klin Wochenschr.* 1995;107(10):309-12.
7. Myrcha P, Ciostek P, Szopiński P, Noszczyk W. Uszkodzenia nerwów czaszkowych i obwodowych po udroznieniu tętnicy szyjnej wewnętrznej [Damage to cranial and peripheral nerves following patency restoration of the internal carotid artery]. *Neurol Neurochir Pol.* 2001;35(3):415-21.
8. Reinhold H, Deloof T, Jortay A, Mathieu M, Vandesteene A. The risks of tracheal intubation. *Acta Anaesthesiol Belg.* 1978;29(1):69-84.
9. Scheiderbauer G, Pomaroli A, Emshoff R, Scheiderbauer A, Gerhard S. Verlauf des N. hypoglossus in der Zungenmuskulatur [Course of the hypoglossal nerve in tongue musculature]. *Mund Kiefer Gesichtschir.* 2001;5(4):239-44.
10. Schmidt T, Philipsen BB, Manhoobi Y, Bruun Christiansen EL. Vagus and hypoglossus palsy after nasotracheal intubation and throat packing. *Ugeskr Laeger.* 2018;180(27):V11170844.
11. Smejkal K, Lochman P, Holecek T. Poúrazová paréza n. hypoglossus po zlomenine kondylu okcipitální kosti - kazuistika [Post-traumatic hypoglossal nerve paresis due to occipital condyle fracture]. *Acta Chir Orthop Traumatol Cech.* 2009;76(4):335-7.
12. Tesei F, Poveda LM, Strali W, Tosi L, Magnani G, Farneti G. Unilateral laryngeal and hypoglossal paralysis (Tapia's syndrome) following rhinoplasty in general anaesthesia: case report and review of the literature. *Acta Otorhinolaryngol Ital.* 2006;26(4):219-21.
13. Ulusoy H, Besir A, Cekic B, Kosucu M, Geze S. Transient unilateral combined paresis of the hypoglossal nerve and lingual nerve following intubation anesthesia. *Braz J Anesthesiol.* 2014;64(2):124-7.
14. Uña E, Gandía F, Duque JL. Tongue paralysis after orotracheal intubation in a patient with primary mediastinal tumor: a case report. *Cases J.* 2009;2:9301.