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FELIPE CELESTRIN DE TOLEDO

O NERVO HIPOGLOSSO (XII PAR DE NERVO CRANIANO): CONSIDERAÇÕES ANATÔMICAS E COMPLICAÇÕES APÓS INJÚRIAS - UMA REVISÃO DE LITERATURA

THE HYPOGLOSSUS NERVE (XII CRANIAL NERVE PAIR): ANATOMICAL CONSIDERATIONS AND COMPLICATIONS AFTER INJURIES – A LITERATURE REVIEW

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Trabalho de Conclusão de Curso apresentado à Faculdade de Odontologia de Piracicaba da Universidade Estadual de Campinas como parte dos requisitos exigidos para obtenção do título de Cirurgião Dentista.

Undergraduate final work presented to the Piracicaba Dental School of the University of Campinas in partial fulfillment of the requirements for the degree of Dental Surgeon

Orientadora: Prof(a). Dr(a). Ana Cláudia Rossi

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PROF(A). DR(A). Ana Cláudia Rossi.

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RESUMO

O nervo hipoglosso (XII nervo craniano) é o suprimento motor da língua. A trajetória do nervo hipoglosso pode ser separada em duas partes principais: intracraniana e extracraniana. Considerando a raridade da lesão do nervo hipoglosso, e que quando ocorre resulta em implicações clínicas que devem ser do conhecimento dos profissionais da Medicina e Odontologia, o objetivo deste estudo foi realizar uma revisão da literatura sobre a anatomia do nervo hipoglosso e possíveis causas das lesões e formas de tratar esse tipo de complicação. Foi realizada uma revisão da literatura na base de dados internacional Pubmed. A revisão da literatura incluiu 19 artigos de 1965 a 2021. As palavras-chave utilizadas foram: “nervo hipoglosso”, “lesão”. Dos 19 artigos, 10 foram utilizados para esta revisão de literatura. Dentre os 9 artigos descartados, 5 não abordavam o objetivo deste trabalho e 4 não apresentavam o texto disponível. Todos os tipos de artigos foram considerados (1 revisão de literatura, 6 relatos de caso e 3 artigos originais). O conhecimento da anatomia do nervo hipoglosso destina-se a intervenções cirúrgicas, ressecções parciais e reconstruções de língua. As causas listadas na presente revisão da literatura são intubação, COVID-19, procedimentos realizados na região carotídea e fratura do côndilo occipital. Em relação às abordagens de tratamento, nenhum protocolo específico foi criado até agora.

Palavras-chave: Nervo hipoglosso; Anatomia; Prejuízo; Intubação; Língua.

ABSTRACT

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. 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. 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). 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 created until now.

Key words: Hypoglossal nerve; Anatomy; Injury; Intubation; Tongue.

SUMÁRIO

1 INTRODUÇÃO

O nervo hipoglosso (NH), também conhecido como XII par de nervo craniano, é o suprimento motor da língua. A trajetória do NH pode ser separada em duas partes principais: intracraniana e extracraniana. Compreender o curso do NH extracraniano e suas relações anatômicas com as estruturas neurovasculares e músculos, além de ter alguns marcos para avaliação do nervo, são essenciais em procedimentos cirúrgicos como a endarterectomia carotídea, principalmente em estenose com placas altas, anastomose hipoglossofacial ou utilização do NH como área doadora para enxerto. Além do controle neural do movimento da língua, o NH também desempenha um papel na respiração e na deglutição. É possível evitar danos ao nervo com a compreensão da anatomia e de seus variações (Bademci e Yaşargilb, 2006).

Para entender a anatomia topográfica do NH, é necessário primeiro ter algum conhecimento das estruturas adjacentes. Existem dois triângulos importantes descritos no pescoço em sua região anterior. O triângulo grande ou "anterior" é formado pela borda anterior do músculo esternocleidomastóideo posteriormente, o plano sagital mediano do pescoço anteriormente e a borda da mandíbula e o processo mastóide superiormente, e contém os ramos da alça cervical, que inervam os músculos infra-hióideos do pescoço. Do ponto de vista neurocirúrgico, o segundo ou ‘triângulo submandibular’ é a área mais importante descrita na região anterior do pescoço. É formado pela base da mandíbula e pelos ventres anterior e posterior do músculo digástrico (Skandalakis et al., 1979).

O NH inerva todos os músculos extrínsecos e intrínsecos da língua, exceto o músculo palatoglosso, que é inervado pelo nervo acessório (Bademci e Yaşargilb, 2006).

Várias lesões do NH foram descritas como complicações pós-intubação. Mais frequentes são as lesões da faringe e laringe, como edema ou ulcerações, condromalácia da laringe, estenose da laringe ou traqueia e paralisia das pregas vocais (Reinhold et al., 1978). Embora a etiologia dessas lesões não seja bem conhecida, acredita-se que a composição química do tubo de intubação ou dos produtos de esterilização utilizados seja a principal causa. A pressão sobre os tecidos adjacentes após o implante de tubo orotraqueal tem sido descrita como outro fator (Reinhold et al., 1978).

Poucos casos de lesão do NH secundária ao manejo anestésico das vias aéreas foram relatados. A causa desse tipo de lesão é atribuída à neuropatia do nervo provocada por compressão após insuflação do manguito dentro da laringe ou dano após hiperextensão do pescoço durante uma intubação difícil (Tesei et al., 2006).

A lesão parcial do NH pode causar paralisia da língua, levando a problemas de fonação e mastigação. Traumas graves e bilaterais do nervo podem afetar o movimento de protrusão da língua, fazendo com que ela caia para trás, possivelmente resultando em obstrução das vias aéreas (Ballotta et al., 1999).

Atrofia ou hipotrofia dos músculos da língua são observadas apenas quando os segmentos nucleares ou periféricos do NH estão envolvidos. Em sua posição distal à base do crânio, o NH pode ser afetado por aneurisma vascular, infecção local, procedimentos cirúrgicos como endarterectomia carotídea, órteses de trauma acidental (Brazis et al., 2001). Houve muitos casos de paralisia do nervo hipoglosso. Tommasi-Davenas et al. (1990) relatou uma série de 32 pacientes com paralisia do NH e atrofia de língua, apenas oito casos de paralisia do NH isolado sem envolvimento neurológico de outros nervos cranianos; na maioria dos casos, a causa foi um tumor, particularmente um tumor com metástase óssea. Poucos casos relacionados a procedimento cirúrgico ou administração de via aérea de anestesia foram relatados, e aqueles que foram relatados envolveram paralisia unilateral sem hipotrofia da língua em combinação com paralisia de outros nervos cranianos, como o ramo laríngeo recorrente do nervo vago (síndrome de Tapia) (Sommer et al., 2004). Embora um procedimento cirúrgico possa resultar em complicações, variando de episódios leves a inesperados e graves, essa neuropatia é rara (Gelmers, 1983).

Diante do exposto, o objetivo do presente trabalho foi realizar uma revisão de literatura sobre a anatomia do nervo hipoglosso (XII par de nervo craniano), possíveis causas de lesões deste nervo e formas de tratar este tipo de complicação.

2 ARTIGO: THE HYPOGLOSSUS NERVE (XII CRANIAL NERVE PAIR): ANATOMICAL CONSIDERATIONS AND COMPLICATIONS AFTER INJURIES – A LITERATURE REVIEW

Submetido no periódico Revista Sul Brasileira de Odontologia (RSBO) (Anexo 2)

Autores: Felipe Celestrin de Toledo[1], Beatriz Carmona Ferreira[1], Alexandre Rodrigues Freire[1], Felippe Bevilacqua Prado[1], Ana Cláudia Rossi[1]

1- Biosciences Department, Piracicaba Dental School, Anatomy division, University of Campinas, Piracicaba, Brazil.

Corresponding author: Profa. Dra. Ana Cláudia Rossi. Department of Biosciences, Anatomy Division, Piracicaba Dental School, University of Campinas. Avenida Limeira, nº 901 – Areião. CEP 13414-903, Piracicaba, São Paulo – Brazil. E-mail: rossianac01@gmail.com

Abstract

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. 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. 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). 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 created until now.

Keywords: Hypoglossal nerve; Anatomy; Injury; Intubation; Tongue.

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 orotracheal 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.

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.

1. Intubation

Some articles reported HN injury during endo-tracheal 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 endo-tracheal 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 pacient 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 oppinion, the simultaneous occurrence of these various factors may have facilitated nerve injuries [13].

2. 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].

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].

4. 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 hypotrophy 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.

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3 CONCLUSÃO

A partir da presente revisão de literatura conclui-se que:

O conhecimento do trajeto típico do nervo hipoglosso (XII par de nervo craniano) é importante para intervenções cirúrgicas, ressecções parciais e reconstruções da língua. Além disso, é essencial para aqueles profissionais que trabalham com intubação e, também, na região carotídea.

As causas das injúrias ao nervo hipoglosso foram: procedimento de intubação, a COVID-19, procedimentos realizados na área carotídea e em fratura do côndilo do osso occipital.

Em relação às abordagens de tratamento, nenhum protocolo foi criado até o momento. Diferentes terapias têm sido aplicadas com o objetivo de solucionar essas injúrias.

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[*] De acordo com as normas da UNICAMP/FOP, baseadas na padronização do International Committee of Medical Journal Editors - Vancouver Group. Abreviatura dos periódicos em conformidade com o PubMed.

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ANEXOS

Anexo 1 – Verificação de originalidade e prevenção de plágio

O NERVO HIPOGLOSSO (XII PAR DE NERVO CRANIANO): CONSIDERAÇÕES ANATÔMICAS E COMPLICAÇÕES APÓS INJÚRIAS - UMA REVISÃO DE LITERATURA

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Anexo 2 – Comprovante de submissão do Artigo