

Apparent Origin of Glossopharyngeal, Vagus and Accessory Nerves: An Aspect to Consider in Human Neuroanatomy Teaching

El Origen Aparente de los Nervios Glossofaríngeo, Vago y Accesorio:
Un Aspecto para Considerar en la Enseñanza de Neuroanatomía Humana

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SUMMARY: In various neuroanatomy texts and articles related to this area of knowledge, there is a conceptual vacuum associated with the precise sites where the roots of the cranial nerves emerge. The objective of the study was to establish the exact location of the apparent origin of the glossopharyngeal, vagus and accessory cranial nerves in the medulla oblongata of the human being 120 human brainstems, previously fixed in formalin solution at 10 % were assessed, the location where such nerve roots emerge was identified by direct examination and once the piamater was removed at both right and left sides as it has been stated in the literature. It was found that in 100 % of the studied brainstems their nerve roots emerge on average at about 2.63 mm behind the retro-olivary groove, different to what has been stated in the literature. Glossopharyngeal, vagus and accessory human nerves do not emerge directly from the retro-olivary groove, as commonly reported; instead, they emerge behind the said groove, specifically in the retro-olivary groove area, where they form a continuous line of nerve roots.

KEY WORDS: Cranial nerves; Origin; Apparent; Estate; Groove; Olive grove.

INTRODUCTION

When teaching neuroanatomy, textbooks are used as common references for the general study of this field of morphology. These texts contain several assertions about the apparent origin of glossopharyngeal, vagus and accessory nerves. For example, the following descriptions are found for the glossopharyngeal nerve. In the retro-olivary groove (Arana & Rebollo, 1979; Bustamante, 2007) or post-olivary fissure, the vagus nerve is found, which emerges behind the olive, as do the glossopharyngeal and accessory nerves (Carpenter, 1994). Along with the retro-olivary groove, a shallow groove located between the olive and the posterolateral surface of the bone, these three nerves emerge as a line of rootlets. The glossopharyngeal and vagus nerves emerge from the upper third of the backside of the olive (Arana & Rebollo; Tubbs *et al.*, 2011). The glossopharyngeal nerve arises from the posterior side of the olive as one or rarely two rootlets, caudal to the origin of the facial nerve (Bustamante). The glossopharyngeal nerve emerges between the inferior olive and the inferior cerebellar peduncle (Rubin & Safdieh, 2007; Snell, 2014). This nerve emerges from the lateral sulcus of the medulla, caudal to the facial nerve (Kahle

& Frotscher, 2003). The glossopharyngeal nerve emerges from the top of the posterior side groove (Carpenter; Legros *et al.*, 2000; Coello & Coello, 2009). The glossopharyngeal nerve is located in the retro-olivary groove (Arana & Rebollo; Bustamante; Policeni & Smoker, 2008; Sarrazin *et al.*, 2013) or post-olivary groove (Fix & High, 2000; Surek *et al.*, 2010). IX nerve emerges behind the olive (Tubbs *et al.*). The glossopharyngeal nerve emerges from the posterior side of the olive in its upper third (Chatain & Bustamante, 1986; Tubbs *et al.*). Glossopharyngeal nerve roots are located side of the medulla oblongata, between the inferior olive and the inferior cerebellar peduncle side. The glossopharyngeal nerve is located in the anterolateral region of the medulla oblongata (Drake *et al.*, 2005; Latarjet & Ruiz Liard, 2005).

The following descriptions are made with regard to the vagus nerve. The vagus nerve comes from the medulla oblongata, behind the olive (Sinelnikov, 1977) or lateral to it (Afifi & Bergman, 2006; Monkhouse, 2006; Snell), or in the upper third of its side (Rubin & Safdieh; Tubbs *et al.*). The vagus nerve emerges from the posterolateral sulcus of

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the medulla oblongata, below the glossopharyngeal nerve (Chatain & Bustamante; Snell; Garcia-Porrero & Hurlé, 2015). Vagus nerve fibers emerge from the retro-olive groove (Arana & Rebollo; Bustamante; Policeni & Smoker; Sarrazin *et al.*; Garcia-Porrero & Hurlé, 2015) or post-olive fissure (Carpenter). The emergence of the vagus nerve occurs by the collateral sulcus bulb (Legros *et al.*; Coello & Coello), between the glossopharyngeal and accessory nerves (Coello & Coello). The vagus nerve is located in the lateral sulcus of the medulla, in the anterolateral region of the medulla oblongata (Sinelnikov; Afifi & Bergman), the vagus nerve originates in the medulla (Legros *et al.*; Damodaran *et al.*, 2014). Vagus nerve roots are located in the ventral-lateral part of the medulla oblongata, between the inferior olive and the inferior cerebellar peduncle below the glossopharyngeal nerve. The accessory nerve arises behind the olive (Arana & Rebollo; Carpenter; Latarjet & Ruiz Liard; Sarrazin *et al.*).

Finally, the origin of the accessory nerve is described as follows: cranial roots of accessory nerve emerge from the lateral side of the olives (Snell; Afifi & Bergman), in its two lower thirds (Rubin & Safdieh; Sarrazin *et al.*). The accessory nerve is located in the retro-olivary groove (Sarrazin *et al.*; Policeni & Smoker). The accessory nerve becomes visible in the posterolateral sulcus, of the medulla oblongata (Chatain & Bustamante; Policeni & Smoker). The accessory nerve emerges from a groove that runs along the bulb behind the bulbar olive, immediately below the vagus nerve (Surek *et al.*). The roots of the accessory nerve arise from a post-olive position. The posterior collateral sulcus is the location of origin of the accessory nerve (Legros *et al.*; Coello & Coello). The accessory nerve emerges from the lateral sulcus of the medulla oblongata, below the vagus nerve (Testut & Latarjet, 1949).

In addition to the anatomical literature previously cited, in a different anatomy atlas the retro-olive groove is appointed as the apparent origin of the glossopharyngeal, vagus and accessory nerves (Higashida, 2001).

MATERIAL AND METHOD

A macroscopic descriptive study was performed on 120 adult human brainstems (240 retro-olive grooves), previously fixed with formalin solution at 10 %, from the Anatomy laboratories of the Autonomía University of Manizales, Universidad de Caldas and University of Applied and Environmental Sciences. This aimed to identify the apparent origin of the glossopharyngeal, vagus and accessory nerves in the medulla oblongata. Those parts exhibiting any deformation were not included. By dissection, the pia mater was removed to expose the areas of interest, mainly the retro-olivary groove

area on left and right sides. Then, a direct inspection was performed to verify the exact location where the roots of the glossopharyngeal, vagus and accessory nerves arise in the medulla oblongata. A digital calibrator was used to measure, in millimeters, the distance between the retro-olivary groove and the location where the nerve roots emerge. Finally, photographic records of the prepared pieces were made.

Ethical Considerations. Material amphitheaters Department of Biological Basic Sciences at the Autonomía University of Manizales, Universidad de Caldas and the Faculty of Medicine of the University of Applied and Environmental Sciences (UDCA) Bogota (Colombia) was used in carrying out this work, which was obtained based strictly on legal medical criteria contained in decree 786 of 1990 of Colombia. In addition, all the principles of the declaration of Helsinki for medical research were followed, ensuring respect to the parts obtained in the study and confidentiality of the data of the deceased, their dignity and Integrity treatment.

RESULTS

Out of the 120 brainstems studied, it was found that in all of them, namely 100 % of the neuro-anatomical pieces, corresponding to 240 retro-olivary grooves, the apparent source of the glossopharyngeal, vagus and accessory nerves, form a continuous line of nerve fibers that emerges from the medulla oblongata, oriented from top to bottom. Such condition occurs exactly behind the retro-olivary groove and not on it, as is often reported in the literature. In our work, we find that the left side nerve roots emerge 2.66 mm on average behind the retro-olivary groove, whereas the nerve roots of the right side emerge 2.61 mm, on average (Fig. 1).

DISCUSSION

Knowledge of the cranial nerves is essential for students in various health professions, among others, because of its intricate structure and functional aspects (Dickson & Stephens, 2015). Besides these aspects, the ones concerning the use of texts that are incorporated into the teaching of this topic should be considered, because multiple authors indicate that the apparent origin of the glossopharyngeal, vagus and accessory nerves are found in the retro-olivary groove (Arana & Rebollo; Bustamante; Policeni & Smoker; Sarrazin *et al.*) or post-olivary groove (Carpenter; Surek *et al.*), however, a more detailed inspection of the site of origin, as it was verified in this work reveals that such a description is not accurate.



Fig. 1. The nerve roots of the glossopharyngeal, vagus and accessory nerves forming a continuous line located in the retro-olivary area, not in the groove. 1. Olive, 2. nerve roots of the glossopharyngeal, vagus and accessory nerves, 3. retro-olivary groove, 4. olive, 5. Pyramid, 6. hypoglossal nerve, 7. Oblong medulla.

In the brainstem used for this work, it was found that in none of them the nerve roots of these cranial nerves emerge from the retro-olivary grooves. In 100 % of neuroanatomical parts analyzed, it was shown that the nerve roots make their appearance, both right and left, about 2.63 mm on average after the retro-olivary groove, particularly in the retro-olivary areas, without regard to the presence of any groove. Two of the referenced authors indicate that these three nerves originate in the posterior collateral groove of the medulla oblongata (Legros *et al.*; Coello & Coello). However, in our study we did not find the presence of such a groove and, on the other hand, in the Terminologia Anatomica is not registered this term (Terminologia Anatomica, 1998). It can also be seen that when two-dimensional images for teaching cranial nerves are used (Dickson & Stephens) in the texts, the subjective impression of being located in the retro-olivary groove is given, so it is necessary to corroborate what is indicated in texts by actual practices with brainstem, so there is no limitation in the use of two-dimensional images (Dickson & Stephens), as the demonstration by experimentation is an intelligent practical theoretical exercise, that allows students to undertake more objective and effective learning (Duque Parra & Barco Ríos, 2013).

Since neuroanatomical knowledge is of great importance in the training of health care students and specialists such as neurosurgeons, it is important to venture to the edge of the known universe of anatomical education (Paalman, 2000), part of which is emphasized in the text of teaching in university education, which in turn may limit its approach with a poor description of certain neuroanatomical aspects that require high precision in the neurosurgical field, as in this case with the apparent origin of the glossopharyngeal, vagus and accessory nerves.

CONCLUSIONS

In human brainstems, the nerve roots of the glossopharyngeal, vagus and accessory nerves have their origin apparently about 2.63 mm, on average, behind the retro-olivary groove, not directly over the groove as reported in the literature. At this point, the nerve roots form a continuous line located in retro-olivary areas, without evidence of any groove, as it is also reported in the literature. Therefore, the use of two-dimensional images for teaching neuroanatomy can lead to misinterpretations on the origin of the cranial nerves, added to this the use of some terms that are not registered in official Terminologia Anatomica.

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RESUMEN: En diversos textos de neuroanatomía y artículos relacionados con esta área del conocimiento, se evidencia un vacío conceptual asociado con los sitios precisos por donde emergen los pares craneales. El objetivo de este estudio fue establecer la ubicación exacta del origen aparente de los nervios craneales glossofaríngeo, vago y accesorio en el bulbo raquídeo de 120 tallos cerebrales humanos, previamente fijados en solución de formalina al 10 %. Fueron evaluados, el lugar donde surgen tales raíces nerviosas se identificó mediante examen directo y una vez que se retiró la piamadre tanto en el lado derecho como en el izquierdo como se ha dicho en la literatura. Se encontró que en el 100 % de los troncos cerebrales estudiados, sus raíces nerviosas emergen en promedio a unos 2,63 mm detrás del surco retroolivario, diferente a lo que se ha dicho en la literatura. Los nervios humanos glossofaríngeos, vago y accesorio no emergen directamente de la ranura retroolivario, como se informa comúnmente, sino que emergen detrás de dicha ranura, específicamente en el área de surco retroolivario, donde forman una línea continua de raíces nerviosas.

PALABRAS CLAVE: Nervios craneales; Origen; Aparente; Raíces; Surco; Olivar.

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