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Original Article

Anatomical and prospective clinical study of variant distribution of the glossopharyngeal nerve

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ABSTRACT

Background: Removal of lesions involving the jugular foramen region requires detailed knowledge of the anatomy and anatomical landmarks of the related area, especially the lower cranial nerves. The glossopharyngeal nerve (GPhN) courses along the uppermost part of the jugular foramen and is well hidden in the deep layers of the neck, making this nerve is the most difficult one to identify during surgery. The glossopharyngeal nerve can be compromised iatrogenically during the surgical procedures.

Aim of the work: Is to investigate the topography and branching pattern of the GPhN and to define the important landmarks that can help to identify this nerve during surgery. It also designed to evaluate the post-tonsillectomy pain and the role of the different patterns of distribution of the glossopharyngeal nerve branches within the tonsillar fossa in the perception of pain in the postoperative period.

Materials and Methods: Thirty glossopharyngeal nerves in fifteen cadaveric necks were dissected. The anatomic relation between the GPhN and the nearby structures, distribution and branching pattern of the GPhN were studied. Regarding the GPhN in the tonsilar fossa two anatomic distances were measured: A) distance from the posterosuperior tonsillar fossa to the main trunk of the GPhN and B) distance from the posteroinferior tonsillar fossa to the closest lingual branch of the glossopharyngeal nerve (LBG). The level of the post-operative pain was estimated in 70 patients at one and three hours, and one week after-tonsillectomy by numeric pain intensity scale Technique of anesthesia was similar for all patients. At the end of the procedure, a 1 ml mixture of Xylocain- Marcaine solution was infiltrated in the lower tonsillar pole on both sides.

Results: The GPhN can be divided into three portions: cisternal, jugular foramen and extracranial part. Tough dural septum separates the jugular part of the GPhN from both vagus and accessory nerves in 20% of the cadaveric specimens. The GPhN was anastomosed with the hypoglossal nerve in 40% and with the lingual nerve in 50%. The lingual branch of the glossopharygeal nerve (LBG) entered the tongue obliquely bifurcated into medial and lateral primary branches, with the former innervating most of the circumvallate papillae. In 30% the medial branches of LBG extended anteriorly beyond the sulcus terminalis and the circumvallate papillae. Tonsillar branches were originating from the GPhN in 60% and from the LBG in 40%. The mean distance from the posterosuperior tonsillar fossa and the main trunk of the glossopharyngeal nerve was 9.3 mm, and the mean distance from the posteroinferior tonsillar fossa and the closest lingual branch of the glossopharyngeal nerve was6.7 mm. Results of the clinical study showed statistically significant lower pain scores (according to VAS score) in the recovery room, 1and 3hours after surgery in the group that received local anesthetic infiltration compared with the other group that didn't receive any local anesthetic infiltration. Also 1 week postoperatively there was again a statistically significant lower pain scores in the group that received local anesthetic infiltration.

Conclusions: Accurate identification and exposure of the GPhN allow for its preservation during surgical resection of any pathological entities along its course. The results of the anatomical dissection study done points to the crucial role the glossopharyngeal nerve branching patterns in determining the level of the postoperative pain perception after tonsillectomy operation.

Key Words: Glossopharyngeal nerve, distribution, anatomical, prospective.

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INTRODUCTION

Removal of lesions involving the jugular foramen region requires detailed knowledge of the anatomy and anatomical landmarks of the related area, especially the lower cranial nerves (*Bejjani, et al 1998*). The glossopharyngeal nerve (GPhN) courses along the uppermost part of the jugular foramen and is well hidden in the deep layers of the neck, making this nerve is the most difficult one to identify during surgery. It may be involved in various pathological entities along its course (*Goodwine et al 1993 & Rhoton et al 2000*) The glossopharyngeal nerve can also be compromised iatrogenically during the surgical treatment of such lesions. Therefore, an anatomic knowledge of the landmarks of the GPhN is valuable for the surgeon (*Ayeni et al 1995*).

The glossopharyngeal nerve contains both motor and sensory fibers, and is distributed, as its name implies, to the tongue and pharynx. It is the nerve of ordinary sensation to the mucous membrane of the pharynx, fauces, palatine tonsil and the nerve of taste to the posterior part of the tongue. Stimulation of general somatic afferent glossopharyngeal fibers elicit swallowing, gagging, and vomiting. The glossopharyngeal nerve also contains general visceral efferent fibers that innervate the parotid gland. These fibers originate in the inferior salivary nucleus located within the floor of the fourth ventricle (*Ayeni et al 1995&Williams 1980*)

The glossopharyngeal nerve is attached by three or four filaments to the upper part of the medulla oblongata. The glossopharyngeal, vagus, and accessory nerves intracranially exit the medulla from the retro-olivary or posterior lateral sulcus. Each then crosses the cisternal space to the jugular foramen (*Goldenberg et al 1991& Williams 1980*).

The glossopharyngeal rootlets join to form a nerve that courses to the anterior compartment of the jugular foramen within its own dural sheath separated from the more posteriorly located vagus and accessory nerves. After exiting the skull base, the glossopharyngeal nerve courses posterior to the internal carotid artery but deep the styloid process and the muscles attached to it. It runs at the lower border of stylopharyngeus, then curves forward, forming an arch on the side of the neck and lying upon the stylopharyngeus and middle constrictor muscles. Then it passes deep to the hyoglossus muscle to terminate in the back of the tongue (*Ayeni et al 1995& Williams 1980*).

It is known that four cranial nerves innervate the tongue. The hypoglossal nerve (CN XII) provides the motor supply to the muscles of the tongue, except for the palatoglossus muscle. The lingual branch of the mandibular division of the trigeminal nerve (CN V) provides afferent fibers to the mucous membranes of the floor of the mouth, the lingual gingiva, and the anterior two-thirds of the tongue. The glossopharyngeal nerve (CN IX) supplies general and taste sensation to the posterior one-third of the tongue mucosa and similarly conveyed through the vagus nerve over minor portions of the posterior aspect of the tongue (*Karen 2004 et al & Shinohara 2010 et al*).

Tonsillectomy is one of the most frequently performed surgeries in the world and the most common problem is post-tonsillectomy pain. The control of the postoperative pain helps increase early dietary intake and prevent complications. One method for relieving pain is peritonsillar injection of an anesthetic, which has been shown to significantly reduce the postoperative pain. As it was observed clinically that the response to the post-tonsillectomy pain varied from one patient to another inspite of the same operative factors so a clinical study was conducted to study the patterns of glossopharyngeal nerve distribution into the tonsillar fossa to investigate its potential role in the perception of the postoperative pain after tonsillectomy operation (*Park 2015 & Bameshki, 2013*).

AIM OF THE WORK

The purpose of this study is to investigate the course, communications and distribution of the glossopharyngeal nerve. To define the important landmarks that can help to identify this nerve during surgery. It also designed to evaluate the post-tonsillectomy pain and the role of the different patterns of distribution of the glossopharyngeal nerve branches within the tonsillar fossa in the perception of pain in the postoperative period.

MATERIAL AND METHODS

Thirty glossopharyngeal nerves in 15 cadaveric necks were dissected. The specimens were obtained from Anatomy department, faculty of Medicine. Alexandria University. After the ramus of the mandible was removed by using a Gigli's wire saw, fine dissection was done to the muscles deep to the styloid process. the glossopharyngeal nerve was identified on the anterolateral surface of the stylopharyngeus muscle and was traced anteriorly to the tonsillar fossa and lingual base, where it bifurcates into the lingual and tonsillar branches. The anatomic relation between the glossopharyngeal nerve and the nearby structures, distribution and branching pattern of the glossopharyngeal nerve were studied. The intracranial opening of the jugular foramen was examined in all specimens, all the structures entered the foramen and their relations to each other were assessed. Two anatomic distances were measured in 10 dissected glossopharyngeal nerves of head and neck specimens. Distance (A) from the posterosuperior tonsillar fossa to the main trunk of the glossopharyngeal nerve and distance (B) from the posterinferior tonsillar fossa to the closest lingual branch of the glossopharyngeal nerve (Fig.1). Measurements were taken by placing a needle at right angle through the area to be measured in the tonsillar fossa. Vernier caliper was then used to measure the distance from the needle posteriorly to the nerve.

Clinical study

A protocol for a clinical prospective trial was designed to study the post tonsillectomy pain relief by infiltrating lower part of the tonsillar fossa with a mixture of Xylocain-Marcaine solution.

Patients

70 patients of age group 10-40 years were randomized into two groups of 35 patients each scheduled for tonsillectomy. Informed written individual consent was obtained for all the patients.

Group A: operation done the usual way with no local infiltration.

Group B: Received bilateral lower tonsillar pole infiltration of 1 ml Xylocain- Marcaine mixture.

Selection criteria

Inclusion criteria: patients scheduled for tonsillectomy operation older than 10 year of age.

Exclusion criteria: age below 10 years, patients undergoing additional adenoidectomy, Illiterate patients, acute infection, malignancy, allergy and bleeding disorders.

Method

All selected patients underwent tonsillectomy by the conventional method in the ENT department faculty of medicine Alexandria university; Technique of anesthesia was similar for all patients. At the end of the procedure, a 1 ml mixture of Xylocain- Marcaine solution was infiltrated in the lower tonsillar pole on both sides.

The level of the post-operative pain was estimated in all patients at 1 and 3 hours, and one week after surgery by numeric pain intensity scale (NPS) by a third party observer (other than the surgeon and any of the assistants) who was unaware of the group allocation. In NPS method, a horizontal scaled (0-100 mm) line was used and the patient was requested to show the degree of his/ her pain on this line with a number ranging from zero (no pain) to 10 (very severe pain). The patients should be able to count to 10 and understand the concept of them; therefore, literate patients older than 10 years were selected.

RESULTS

Anatomical Results

The jugular part of GPhN traveled through the jugular foramen in a channel below the opening of the cochlear aqueduct. The GPhN courses through this tunnel on the medial aspect of the jugular bulb (Figs.2, 3). Tough dural septum separates the GPhN from both vagus and accessory in 6 of the cadaveric specimens (20%) (Fig.4). The tympanic (Jacobson's) nerve originated from the inferior ganglion the GPhN (Fig.2). Arnold's nerve (auricular branch of the vagus) originated from the GPhN in 3specimens (10%) (Fig.2). The GPhN exited the jugular foramen posteromedial to the styloid process and styloid muscles (Fig.5).

In all specimens 9th, 10th and 11th cranial nerves observed as two nerve bundles after their exit from the jugular foramen. The first bundle, at the upper portion of the foramen and located deeper, belonged to the GPhN. The second, more superficial than the first, belonged to the vagus and accessory nerve complex. All of these nerves located medial to the IJV as they exit the jugular foramen (Fig.3).

The extra cranial portion GPhN located posteromedial to the styloid process and styloid muscles (Figs.5, 6). The nerve coursed deep to the stylopharyngeus muscle, innervated it. As it coursed along the stylopharyngeus muscle, the GPhN turned lateral then anterior to the muscle. (Figs.5, 6). The GPhN turned to the medial side of the stylopharyngeus muscle observed in 6 specimens (20%) (Fig. 7). The GPhN can be seen at the base of a pyramidal space just superior and medial to the hypoglossal nerve. The styloglossus muscle formed the anteromedial wall, the stylopharyngeus muscle formed the posteromedial wall, and the stylohyoid muscle formed the lateral wall of this space. GPhN is located medial to the stylohyoid ligament (Figs.8a, b).

A tiny branch from the GPhN joined with another division from the vagus nerve to compose Hering's (the carotid sinus) nerve, which innervated the wall of the carotid sinus (Figs.9, 10). High division of GPhN into lingual and pharyngeal branches observed in 9 specimens (30%) (Fig.7). While in 21 specimens (70%) the lingual and pharyngeal branches arised lower down (Fig.6).

The LBG entered the tongue obliquely running inferior to the styloglossus muscle just behind the hypoglossal nerve at the level of the root of the tongue in 27 specimens (90%) (Fig.11). The LBG entered the tongue in front the hypoglossal nerve in 3 specimens (10%) (Fig. 12). LBG bifurcates into medial and lateral primary branches, Distinct secondary and tertiary branches were seen furcating from both medial and lateral branches towards circumvallate papillae along the sulcus terminalis of the tongue (Fig.13). In 9 specimens (30%) the lateral branch of LBG are extended anteriorly beyond the sulcus terminalis and the circumvallate papillae (Fig.14). In 6 out of 30 specimens (20%) LBG runs transversely through the substance of the tongue (Fig.15). The anastomosis between the GPhN and the vagus nerve observed in 24 specimens (80%) (Figs.11,12).

The GPhN anastomosed also with the hypoglossal nerve in 12 specimens (40 %) (Fig. 14).and with the lingual nerve in 15 specimens (50%) (Fig.14). Anastomosis between the hypoglossal and the lingual was also detected in 6 specimens (20%) (Fig.13).

Tonsillar branches were originating from the GPhN in 18 specimens (60%). Their numbers ranging from 2 to 5 (Figs.6,7, 9) and from the LBG in 12 specimens (40 %). (Figs.6,14).The mean distance from the posterosuperior tonsillar fossa and the main trunk of the glossopharyngeal nerve was 9.3 mm, and the mean distance from the posteroinferior tonsillar fossa and the closest lingual branch of the glossopharyngeal nerve was 6.7mm (Table 1).

Clinical Results

Results of the present study showed statistically significant lower pain scores (according to VAS score) in the recovery room, 1 and 3hours after surgery in the group that received local anesthetic infiltration compared with the other group that didn't receive any local anesthetic infiltration.

Also 1 week postoperatively there was again a statistically significant lower pain scores in the group that received local anesthetic infiltration and the children were more relaxed and cooperative during the routine oral examination. The present study demonstrated that peritonsillar infiltration of xylocain-Marcain mixture provided adequate analgesia after pediatric tonsillectomy, however there were still some patients who received local infiltration of the tonsillar fossa but showed an elevated VAS score indicating that they are still perceiving high level of post-operative pain.

Statistical analysis

The Data was collected and entered into the personal computer. Statistical analysis was done using Statistical Package for Social Sciences (SPSS/version 20) software.

The statistical test used as follow:

Arithmetic mean, standard deviation for comparison between two groups t-test was used for parametric data. The level of significant was 0.05.

Table 1: Comparison between the distance from posterosuperior tonsillar fossa to the main trunk of glossopharyngeal nerve (Distance A) with distance from posteroinferior tonsillar fossa to lingual branch of glossopharygeal nerve (Distance B) in 10 dissected glossopharyngeal nerves of head and neck specimens

No. of specimens	Distance A in mm	Distance B in mm
1	8	6
2	8.5	5.5
3	10	8
4	9	8
5	8	6.5
6	10	6
7	9.5	6.5
8	10	7
9	9.5	6
10	10	7.4
Mean	9.3	6.7

Table 2: Comparison between the two studied groups regarding the Post-operative pain score

Post-operative pain score		Group I	Group II	P
1 hour				
	Range	7 - 9	2 - 7	
	Mean	7.63	4.18	0.0001*
	S.D.	0.69	1.29	
3 hours				
	Range	4 - 6	1 - 6	
	Mean	5.06	3.03	0.0001*
	S.D.	0.68	1.22	
1 week				
	Range	1 - 5	0 - 5	
	Mean	2.53	1.72	0.0001*
	S.D.	0.79	1.17	

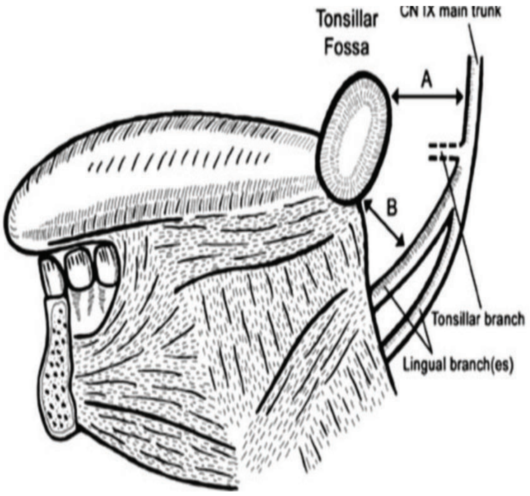

Fig. 1: Anatomic relation between glossopharyngeal nerve and tonsil. (A) distance from posterosuperior tonsillar fossa to main trunk of glossopharyngeal nerve; (B) distance from posteroinferior tonsillar fossa to Closest lingual branch of glossopharyngeal nerve (*Ford et al 2004*).

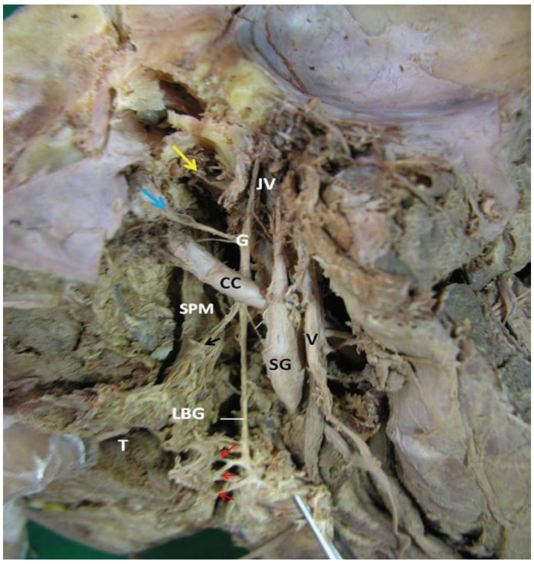

Fig: 2: A photograph of a dissected jugular foramen at the base of the skull showing the glossopharyngeal nerve (G) leaves the jugular foramen below the opening of the cochlear aqueduct. The tympanic (Jacobson's) nerve (yellow arrow) originates from the inferior ganglion. Arnold's nerve (auricular branch of the vagus) (blue arrow) was seen originating from the glossopharyngeal nerve (G). The lingual branch of the glossopharyngeal nerve (LBG) gives several branches (red arrows) to the tongue (T).
V: vagus neve.
JV: internal jugular vein
SG: sympathetic ganglion
CC: reflected common carotid artery.
SPM: stylopharyngeus muscle.

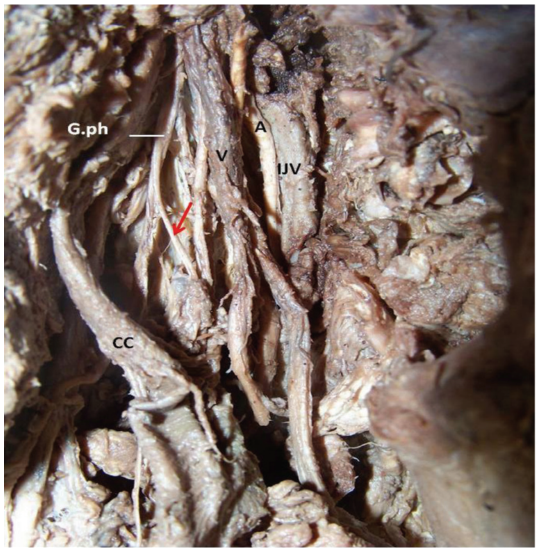

Fig: 3: A photograph of a dissected jugular foramen at the base of the skull showing the 9th, 10th and 11th cranial nerves are seen as two nerve bundles after their exit from the jugular foramen. The first bundle, located deeper, belongs to the glossopharyngeal nerve (G.Ph) The second, more superficial, belongs to the vagus(V) and accessory nerve (A) complex. All these nerves are located medial to the internal jugular vein (IJV) as they exit the jugular foramen. Notice the site of communication (→) between the glossopharyngeal nerve and the vagus nerve
CC: reflected common carotid artery.

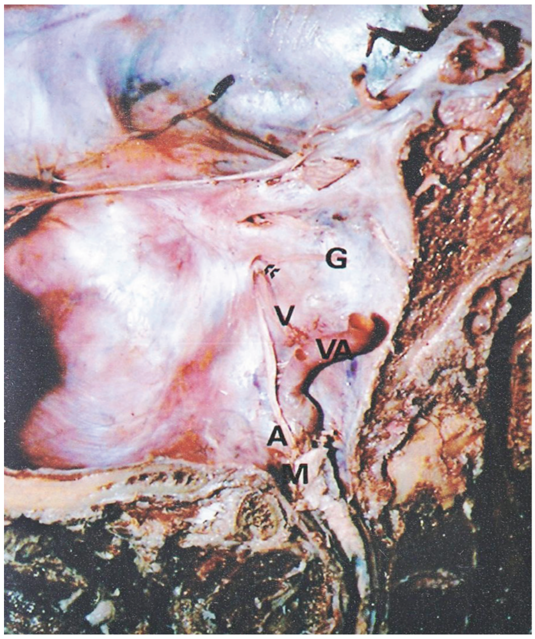

Fig. 4: A photograph showing an intracranial jugular foramen with a tough dural septum (arrow heads) separates the glossopharyngeal nerve (G) from both vagus (V) and accessory nerve (A).
VA: 4th part of the vertebral artery.
M: foramen magnum.

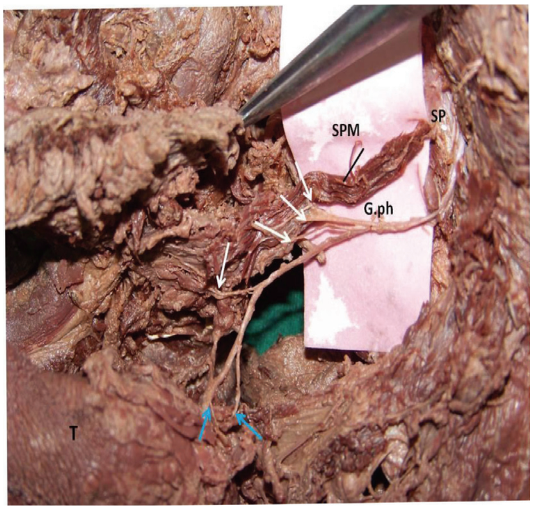

Fig. 5: A photograph showing the extracranial portion of the glossopharyngeal nerve (G.Ph) as it exits the jugular foramen posteromedial to the styloid process (SP) and styloid muscles. The nerve courses deep to the stylopharyngeus muscle (SPM). The G.Ph turns lateral then anterior to the muscle supplying it with several branches (white arrows). The glossopharyngeal nerve (G.Ph) gives branches (blue arrows) to the tongue (T)

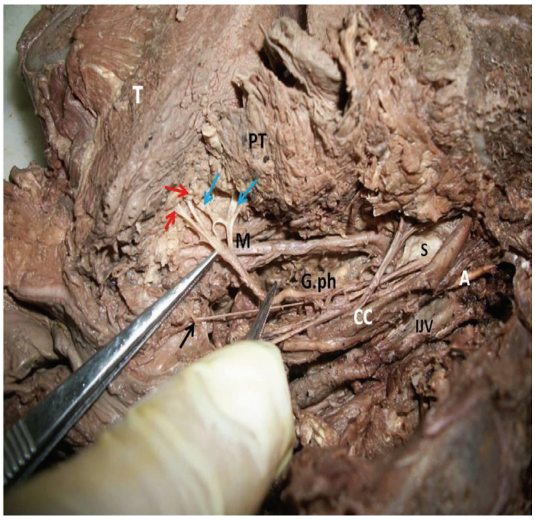

Fig. 6: A photograph showing the extracranial portion of the glossopharyngeal nerve (G.Ph) as it exits the jugular foramen posteromedial to the styloid process (S) and styloid muscles. The nerve courses deep to the stylopharyngeus muscle (M). The G.Ph turns lateral then anterior to the muscle supplying it. The glossopharyngeal nerve (G.Ph) gives branches (red arrows) to the tongue (T). It also gives 2 tonsilar branches (blue arrows) to the palatine tonsil (PT) and pharyngeal branch (black arrow) to the wall of the pharynx.
A: accessory nerve.
IJV: internal jugular vein
CC: common carotid artery.

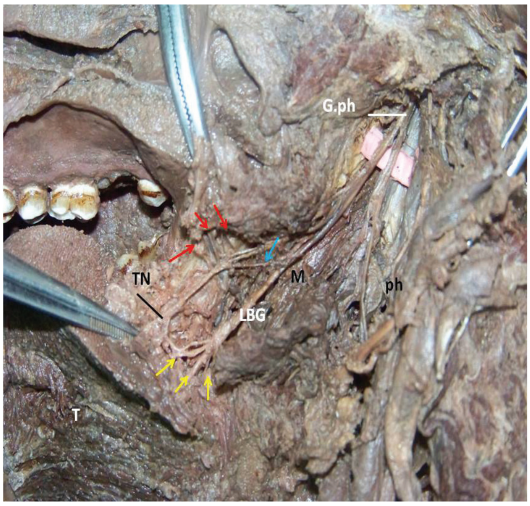

Fig. 7: A photograph showing the extracranial portion of the glossopharyngeal nerve (G.Ph) turns on the medial side of the stylopharyngeus muscle (M). The lingual branch of the glossopharyngeal nerve (LBG) gives branches (yellow arrows) to the tongue (TN). The glossopharyngeal nerve also gives 3 tonsilar branches (red arrows) to the palatine tonsil and pharyngeal branch (ph) to the wall of the pharynx.

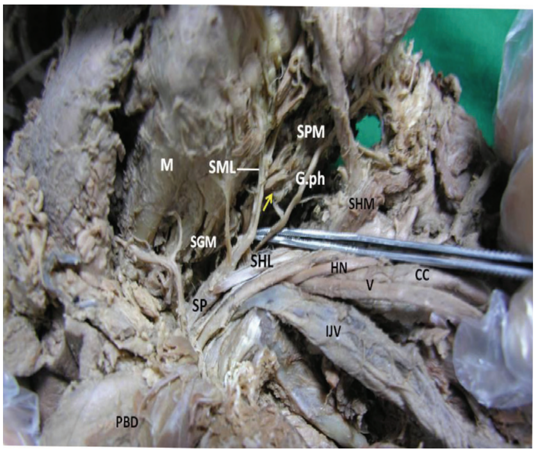

Fig. 8a: A photograph of a deeply dissected submandibular region showing the extracranial portion of the glossopharyngeal nerve (G.Ph) The GPhN can be seen at the base of a pyramidal space just superior and medial to the hypoglossal nerve (HN). The styloglossus muscle (SGM) forms the anteromedial wall, the stylopharyngeus muscle (SPM) forms the posteromedial wall, and the stylohyoid muscle (SHM) forms the lateral wall of this space. GPhN is located medial to the stylohyoid ligament (SHL).
M: mandible
SP: styloid process
SML: stylomandibular ligment
CC: common carotid artery
IJV: internal jugular vein
V: vagus nerve PBD: reflected posterior belly of digastrics muscle
Notice: the muscular branche (yellow arrow) of the glossopharyngeal nerve (G.Ph) the stylopharyngeus muscle (SPM) to

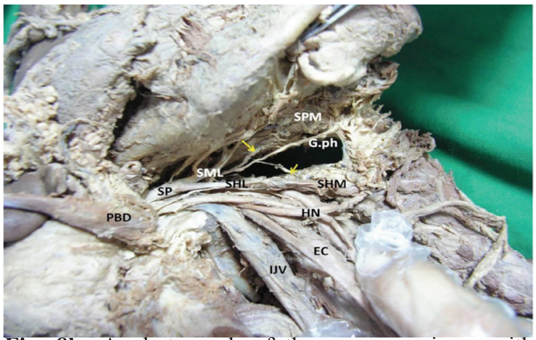

Fig. 8b: A photograph of the same specimen with deeper dissection shows several muscular branches (yellow arrows) of the glossopharyngeal nerve (G.Ph) to the (SPM) stylopharyngeus muscle.

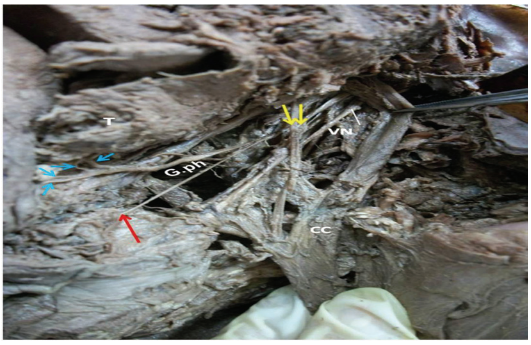

Fig. 9: A photograph of a dissected extracranial portion of the glossopharyngeal nerve (G.Ph). A branch from the GPhN joins with another division from the vagus nerve (VN) to compose Hering's (the carotid sinus) nerve (yellow arrows) which innervates the wall of the carotid sinus (CC). The GPhN also gives 4 tonsilar branches (blue arrows) to the palatine tonsil (T) and pharyngeal branch (red arrow) to the wall of the pharynx.

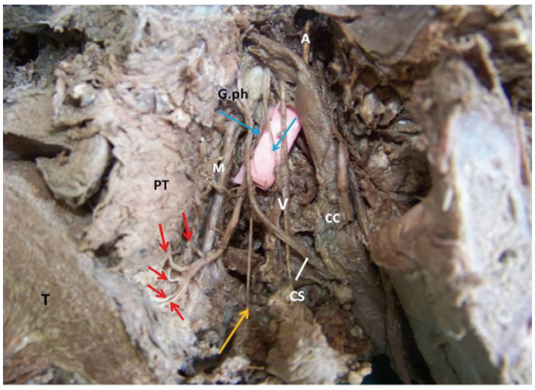

Fig. 10: A photograph of a dissected extracranial portion of the glossopharyngeal nerve (G.Ph) showing a branch from the GPhN (blue arrow) joins with another division(blue arrow) from the vagus nerve (V) to compose Hering's (the carotid sinus) nerve (CS) which innervates the wall of the carotid sinus(CC). The GPhN also gives 5 tonsilar branches (red arrows) to the palatine tonsil (PT) and pharyngeal branch (yellow arrow) to the wall of the pharynx.
T: tongue
A: accessory nerve.

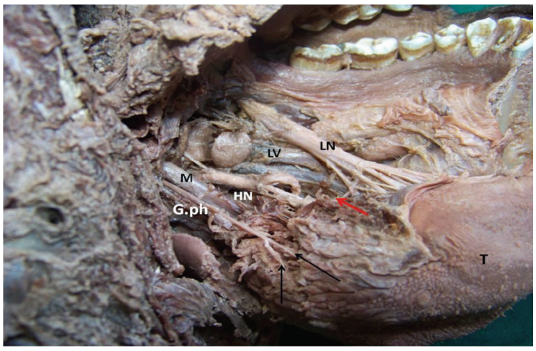

Fig. 11: A photograph showing a site of anastomosis (red arrow) between and the hypoglossal nerve (HN) and the lingual nerve (LN). The glossopharyngeal nerve (G.Ph) gives branches (black arrows) to the tongue (T).
LV: lingual vein.
M: the stylopharyngeus muscle.

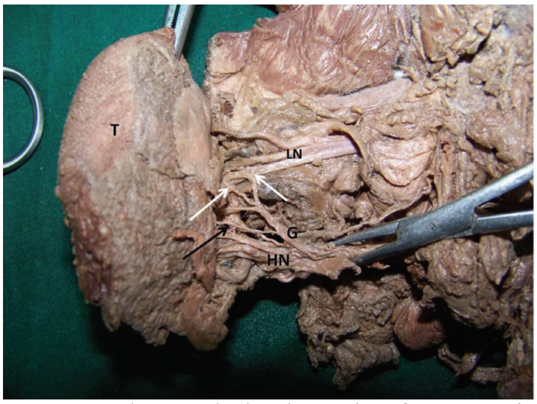

Fig. 12: A photograph showing a site of anastomosis (black arrow) between the glossopharyngeal nerve (G) and the hypoglossal nerve (HN) and another site of anastomosis (white arrows) with the lingual nerve (LN).
(T): tongue.

Fig. 13: A photograph showing the lingual branch of the gloss pharyngeal nerve (LBG) bifurcates into medial (M) and lateral (L) primary branches, both giving secondary branches (red arrows). The secondary branches of the medial one innervating most of the circumvallate papillae along the sulcus terminalis (ST) of the tongue (T) and the lateral one advancing in a lateral direction. Distinct tertiary branches (black arrows) were seen furcating from both medial and lateral branches.

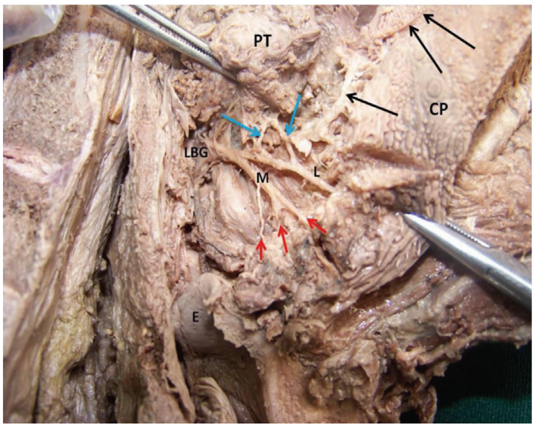

Fig. 14: A photograph showing the lateral division (L) of the lingual branch of the glossopharyngeal nerve (LBG) gives branches (black arrows) which extended anteriorly beyond the sulcus terminalis and the circumvallate papillae (CP). The lingual branch of the glossopharyngeal nerve (LBG) gives tonsilar branches (blue arrows) to the palatine tonsil (PT). (red arrows): secondary branches originating from the medial division. E: epiglottis.

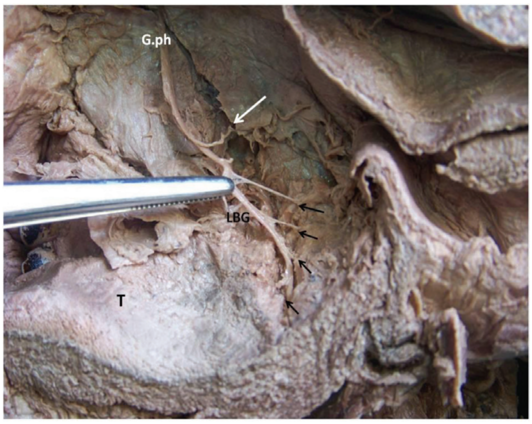

Fig. 15: The lingual branch (LBG) of the glossopharyngeal nerve (G.Ph) runs transversely through the substance of the tongue (T). It gives branches (black arrows) to the tongue (T). It also gives tonsilar branches (white arrow) to the palatine tonsil.

DISCUSSION

The GPhN may be difficult to identify during surgery or may be confused with small pharyngeal branches of the vagus nerve (*Bejjani GK 1998 & Goldenberg RA1993*) It is at risk especially when dissection is carried deep to the posterior belly of the digastric muscle, in the region of the axial plane connecting the mastoid tip and the angle of the mandible (*Özveren, 2003*) Recognizing the landmarks of the GPhN can minimize its risk of injury. In the present study tough dural septum separated the GPhN from both vagus and accessory observed in 6 of the cadaveric specimens (20%).This dural septum that forms two meatuses on the intracranial side of the jugular foramen; these have been named the glossopharyngeal meatus and the vagal meatus (*Sen et al. 2000*) stated that the dural septum that separates the GPhN from the fascicles of the vagus and accessory nerves at the dural entrance of the GPhN into the jugular foramen is a consistent structure .This structure forms an important landmark of the GPhN in the subarachnoid space.

In all the present study specimens 9th, 10th and 11th cranial nerves observed as two nerve bundles after their exit from the jugular foramen. The first bundle, located deeper, belonged to the GPhN. The second, more superficial than the first, belongs to the vagus and accessory nerve complex, lesions involving the jugular foramen generally affect these nerves as in jugular foramen syndromes (*Lang 1991 & Robbins 1980*). Arnold's nerve was seen originating directly from the GPhN in 10% of the dissected specimens. (*Özveren et al 2003*) reported that Arnold's nerve is the auricular branch of the superior ganglion of the vagus, and also consists of branches from the GPhN. The present study showed that the extracranial part of GPhN detected at the base of a pyramidal space just superior and medial to the hypoglossal nerve. Three styloid muscles bounded this space. The styloglossus muscle anteromedially, the stylopharyngeus muscle posteromedially and the stylohyoid muscle laterally. The GPhN located at the base of this pyramid. (*Özveren et al.2003 & Lang 1991*) named this space the styloid pyramid because the styloid process and the styloid muscles bounded it. They added that the styloid pyramid serves as a landmark of the GPhN in the extracranial region. The present study revealed that three structures served as landmarks of the GPhN at the extracranial region, the base of the styloid process, the base of the styloid pyramid, and at its exit the transverse process of the atlas.

High division of GPhN into lingual and pharyngeal branches observed in 9 specimens (30%) of the present study. (*Ford et al.2004*) was in agreement with our finding. The findings also revealed that the mean distance from the posterosuperior tonsillar fossa to the main trunk of the glossopharyngeal nerve was 9.3 mm, and the mean distance from the posteroinferior tonsillar fossa to the closest lingual branch of the glossopharyngeal nerve was 6.7mm. Depending on this data(*Tomita et al. 2002*) suggested that taste disturbance in patients after tonsillectomy might be due to indirect damage to the LBG as it had intimate relation to the tonsillar fossa. The main trunk of the glossopharyngeal nerve was thought to be intact as the gag response, swallowing, movement ,positions of the soft plate and uvula in these patients were normal. (*Shinoharaet al. 2010*) reported that three cases out of eleven patients seen for dysgeusia at a taste clinic were attributed to tonsillectomy. Taste disturbance in these patients was attributed to be direct or indirect damage to the LBG. Such patients should be informed of the risk of postoperative taste disturbance after tonsillectomy as being one of the rare complications of this surgery.

In the present study, the GPhN anastomosed with the hypoglossal nerve in 12 specimens (40 %) and with the lingual nerve in 15 specimens (50 %). Anastomosis between the hypoglossal and the lingual was seen in 6 cases (20%) (*Shinoharaet al. 2010*) et al observed this communication in 8 cases (26.6%). This communication explains the 'neck-tongue' syndrome, where compression of the first and second cervical nerves results in lingual paresthesia and oropharyngeal pain (*Ford et al 2004*).

In 9 specimens of the present study (30%) the lateral branch of LBG extended anteriorly beyond the sulcus terminalis and the circumvallate papillae of the tongue than generally appreciated. This supports descriptions of (*Richard Doty, et al. 2009*), as well as functional studies employing electrogustometry (*Rhoton 2000*). This observation is of both basic and applied significance, providing a better understanding of the sensory innervation of the dorsal tongue.

The present findings appears to be in conflict with the embryological understanding of the pharyngeal arch apparatus, which confines distribution of glossopharyngeal nerve to the third pharyngeal arch derivative, i.e. the posterior third of the tongue. The basis of this apparent conflict is not known, although it is possible that it reflects the inaccurate anatomical description of the 'posterior third of the tongue.' While commonly assumed to parallel the sulcus terminalis at the level of the circumvallate papillae. Although this present study demonstrated that fine branches of GPhN extend beyond the boundaries commonly associated with GPhN projection, it is not clear how important such anterior extension are for gustatory function. On the other hand (*Tomita et al.1994*) reported that electrical taste disappears in a considerable segment of the anterior tongue following GPhN anesthesia, it is possible that such 'electrical taste' reflects activation of afferents GPhN independently of sensory receptors. In other words, electrical stimulation could activate nerve projections that do not innervate taste bud-related receptors.

The present study was designed to evaluate the post-tonsillectomy pain and the role of the different patterns of distribution of the glossopharyngeal nerve branches within the tonsillar fossa in the perception of pain in the postoperative period.

The clinical findings of the present study suggested that the more the branching pattern of the glossopharyngeal nerve in the tonsillar bed, the more will be expected the postoperative pain and the more it will be likely to use more than one medication to control the postoperative pain.

In the present study a quite large number of patients undergoing tonsillectomy experience unacceptable intense postoperative pain, especially during the first day after surgery whereas some other patients don't show that degree of postoperative pain despite the same operative technique, this must have been due to the variability of the glossopharyngeal nerve branching patterns within the tonsillar fossa.

The treatment of postoperative pain after tonsillectomy presents a challenge (*Arnautovic et al 2002*) Opioids play a fundamental role in the management of post-tonsillectomy pain, their use is associated with a number of side effects, including nausea, vomiting, and respiratory depression. Therefore, it is necessary to develop an effective approach to control post-tonsillectomy pain by combining treatment modalities that can block different pain mechanisms (*Bameshki 2013*)

It has been published that application of a local anesthetic agent may control the post-tonsillectomy pain by blocking the sensory nerve endings and thus preventing the painful impulses (*Bameshki et al 2013 & Aydin et al 2000*)

There is a wide number of clinical studies in which a local anesthetic has been applied to the tonsillar fossa aiming to get a better control of the post-operative pain after tonsillectomy operations. The mode of applying the local anesthetic is usually by infiltration

The infiltration of peritonsillar beds for post-tonsillectomy pain control was suggested by (*Allen et al 1953*) Drugs which were given by this route such as pethidine (*Kerekhanjanarong et al 2001*) ketamine, tramadol and bupivacaine provided a long-lasting and satisfactory postoperative analgesia compared with their intravenous counterparts and the placebo.

The side-effects of commonly used pain medications are known to be the reasons that could lead to inadequate postoperative pain treatment (*Cupero TM et al 2003*).

CONCLUSION

The present study revealed that the mean distance from the posterosuperior tonsillar fossa and the main trunk of the glossopharyngeal nerve was 9.3 mm, and the mean distance from the posteroinferior tonsillar fossa and the closest lingual branch of the glossopharyngeal nerve was 6.7mm. So an accurate identification and exposure of the GPhN and its lingual branch allow for its preservation during surgical resection of any pathological entities along its course. The clinical findings of the present study suggested that the more the branching pattern of the glossopharyngeal nerve in the tonsillar bed, the more will be expected the postoperative pain and the more it will be likely to use more than one medication to control the postoperative pain.

REFERENCES

Allen, R.T. 1953. New method for relieving postoperative pain following tonsillectomy. AMA Archives of Otolaryngology, 57(1):86.

Arnautovic, K.I., Al-Mefty, O. 2002. Primary meningiomas of the jugular fossa. Journal of Neurosurg, 97: 12–20

Aydin, K., Maya, M.M., Lo, W.W. et al 2000. Jacobson's nerve schwannoma presenting as middle ear mass. Americal Journal of Neuroradiology, 21: 1331–1333

Ayeni, S.A., Ohata, K., Tanaka, K. et al 1995. The microsurgical anatomy of the jugular foramen. Journal of Neurosurg, 83: 903–909.

Bameshki, A.R., Razban, M., Khadivi, E., Razavi, M. Bakh haee, M. 2013. The effect of local injection of epinephrine and bupivacaine on post-tonsillectomy pain and bleeding. Iranian Journal of Otorhinolaryngology, 25: 209-214.

Bejjani, G.K., Sullivan, B., Salas-Lopez, E., et al. 1998. Surgical anatomy of the infratemporal fossa: the styloid diaphragm revisited. Neurosurgery, 43: 842–853.

Cupero, T.M., Kim, S.Y., Silva, A.B. et al. 2003. The effects of a preoperative steroid/anesthetic injection on post-tonsillectomy pain. Ear, Nose, & Throat Journal, 82: 305-308.

Doty, R.L., Daniel, M. 2009. Lingual distribution of the human glossopharyngeal nerve. Acta Oto-Laryngologica, 129: 52-56.

Ford, L.C., Cruz, R.M. et al. 2004. Bilateral Glossopharyngeal Nerve Paralysis after Tonsillectomy: Case Report and Anatomic Study. Laryngoscope, 114: 2196–2199.

Goldenberg, R.A., Gardner, G. et al. 1991. Tumors of the jugular foramen: surgical preservation of neural function. Otolaryngology -- Head and Neck Surgery, 104: 129.

Goodwin, W.J. Jr., Arnold, D., Wachholz, J. et al. 1993. Surgical anatomy of the glossopharyngeal nerve. Laryngoscope, 103: 1302–1304.

Karen, Z.U.R., Lancai, M.U., Sanders, I.R.A. et al. 2004. Distribution Pattern of the Human Lingual Nerve. Clinical Anatomy, 17: 88 –92.

Kerekhanjanarong, V., Tang-On, N., Supiyaphun, P., Sastarasadhit, V. et al. 2001.

Tonsillar fossa steroid injection for reduction of the post-tonsillectomy pain. Journal of the Medical Association of Thailand, 84(Suppl 1): S391-395.

Lang, J. 1991. Clinical Anatomy of the Posterior Cranial Fossa and Its Foramina. New York: Thieme Medical Publishers, pp 92–96.

Liu, C.M., Su, C.Y. et al. 1996. Post-operative pain control with topical steroid injection after hot dissection tonsillectomy. The Journal of Laryngology and Otology, 110: 1038-1040.

Ohtsuka, K., Tomita, H., Murakami, G. 1994. Anatomical study of the tonsillar bed: the topographical relationship between the palatine tonsil and the lingual branch of the glossopharyngeal nerve. Nippon Jibiinkoka Gakkai Kaiho, 97: 1481–1493.

Ozveren, M.F., Türe, U., Ozek, M.M., Pamir, M.N. 2003 Anatomic landmarks of the glossopharyngeal nerve: A microsurgical anatomic study. Neurosurgery, 52: 1400-1410.

Park, S.S., Kim, D.H., Nam, I.C., Lee, I.H., Hwang, J.W. et al. 2015. The effectiveness of pregabalin for post-tonsillectomy pain control: a randomized controlled trial. PloS One, 10: e0117161.

Rhoton, A.L. 2000. Jr Jugular foramen. Neurosurgery, 47(Suppl 3): S267–S285.

Robbins, K.T., Fenton, R.S. 1980. Jugular foramen syndrome. Journal of Otolaryngology, 9: 505-516.

Sen, C., Hague, K., Kacchara, R., Jenkins, A., Das, S., Catalano, P. 2001. Jugular foramen: microscopic anatomic features and implications for neural preservation with reference to glomus tumors involving the temporal bone. Neurosurgery, 48: 838–848.

Shinohara, H., Mataga, I., Kageyama, I. 2010. Discussion of clinical anatomy of the lingual nerves. Okajimas Folia Anatomica Japonica, 87: 97–102.

Tomita, H., Ohtuka, K. 2002. Taste DisturbanceAfter Tonsillectomy Acta Oto-Laryngeology, 122: 164-172.

Williams, P.L., Warwick, R. 1980. Gray's Anatomy, ed 36. New York: Churchill Livingstone, pp 1075, 1076, 1083, 1200, 1462.

دراسة تشريحية ومنظور إكلينكى للتوزيعات المختلفة للعصب اللسانى البلعومى

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ملخص البحث

المقدمة: إزالة الآصابات الخاصة بمنطقة الثقب الوداجى تتطلب معرفة تفصيلية للتشريح والمعالم التشريحية للمنطقة ذات الصلة وخاصة الأعصاب الدماغية السفلية. وجود العصب اللسانى البلعومى فى الجزء العلوى من الثقب الوداجى ومختفيا فى الطبقات العميقة من الرقبة يجعل تحديده أكثر صعوبة أثناء الجراحة ولهذا من المحتمل تعرضه للإصابة أثناء العمليات الجراحية.

الهدف: تحديد نمط التفرعات المختلفة والمعالم الهامة للعصب اللسانى البلعومى التى تساعد على التعرف عليه أثناء الجراحة لتقييم الألم بعد استئصال اللوزتين و تحديد دور أنماط التوزيعات المختلفة الناشئة من فروع العصب اللسانى البلعومى داخل الحفرة اللوزية فى الإحساس بالألم فى فترة ما بعد الجراحة.

مواد وطرق البحث: تم تشريح ثلاثون عصب لسانى بلعومى فى خمسة عشر رقاب جثث ادمية وتم دراسة نمط التفرعات المختلفة وعلاقة العصب اللسانى البلعومى بالمنطقة المحيطة وبخصوص الحفرة اللوزية تم قياس مسافتين فى الحفرة اللوزية. بينها وبين الجذع الرئيسى للعصب وأقرب فرع لسانى منه ويقدر مستوى الألم بعد استئصال اللوزتين بواسطة مقياس الألم الرقمى مع العلم أن تقنية التخدير من الألم ما بعد الجراحة كانت مماثلة لجميع المرضى وهى إعطاء واحد مليمتير من خيط الماركين والزيلوكين للقطب السفلى للوزتين.

النتائج: يمكن تقسيم العصب اللسانى البلعومى إلى ثلاثة أجزاء: صهريجى و جزء يمر بالثقب الوداجى وجزء خارج القحف. وقد وجد حاجز جافى صعب يفصل بين العصب اللسانى البلعومى وكل من العصب الحائر والعصب الدماغى الإضافى فى 20% من العينات. و وجد اتصال تشابكى بين العصب اللسانى البلعومى والعصب تحت اللسانى فى 40% من العينات ومع العصب اللسانى فى 50% منها. وقد وجد أن التفرع اللسانى للعصب اللسانى البلعومى يدخل اللسان بشكل مائل منقسما إلى تفرعات أولية أنسية ووحشية (التفرعات الأنسية تغذى الحلمات الكاسية وفى 30% من العينات وجد انها امتدت لما بعد الأخدود النهائى والحلمات الكاسية) التفرعات اللوزية الناشئه من العصب اللسانى البعلومى فى 60% من العينات ومن التفرع اللسانى فى 40% من الحالات. وكانت متوسط المسافة من الحفرة اللوزية خلفى علوى والجذع الرئيسى للعصب اللسانى البلعومى هى 9,3 مليميتر وكانت متوسط المسافة من الحفرة اللوزية خلفى سفلى وأقرب فرع لسانى من العصب اللسانى البلعومى هى6,7 مليميتر. قد أظهرت الدراسة الإكلينيكية دلالة إحصائية لانخفاض ملحوظ فى درجات الألم فى المجموعة التى تلقت مخدر موضعى ساعة وثلاثة ساعات وأسبوع بعد الجراحة بالمقارنة بالمجموعة الأخرى التى لم تتلقى أى مخدر موضعى.

الخلاصة: المعرفة الدقيقة والكشف عن العصب اللسانى البعلومى يسمح بالمحافظة عليه خلال الاستئصال الجراحى لأى كيانات مرضية على طول مجراه وقد أسفرت النتائج التشريحية عن الدور الهام لتفريعات العصب اللسانى البلعومى فى تحديد مستوى الإحساس بالألم بعد عملية استئصال اللوزتين.