

Glossopharyngeal Neuralgia and its Surgical Management

MUHAMMAD ARSHAD

Department of Neurosurgery

Quaid-e-Azam Medical College / Bahawal Victoria Hospital, Bahawalpur

ABSTRACT

Objective: The purpose of the study was to evaluate the surgical management of Glossopharyngeal Neuralgia.

Materials and Methods: It a retrospective study of seven (7) cases of Glossopharyngeal Neuralgia who were surgically managed at Department of Neurosurgery Quaid-e-Azam Medical College / Bahawal Victoria Hospital Bahawalpur. It is retrospective study with study period of eight (8) years from January 2003 to December 2010 with follow up period of two years.

Results: Four (4) were female and three (3) were male patients. Age range was 40 to 60 years with average age of 45 years. In all the patients except one, IX nerve sectioning alongwith sectioning of upper rootlets of X nerve was performed in the posterior fossa through retrosigmoid approach. In one patient, Microvascular Decompression was performed for the pain syndrome. There was recurrence of same pain in that patient after six months of surgery. Second surgery was done in that patient to section the IX nerve only in the posterior fossa. All cases were that of "IDIOPATHIC GLOSSOPHRYNGEAL NEURALGIA". In all the patients there was satisfactory relief of pain after surgery with no significant complications related to the procedure.

Conclusion: So the sectioning of The Glossopharyngeal Nerve is a useful procedure for the relief of this pain syndrome. Another good alternative is Microvascular Decompression of this nerve at root entry zone in the posterior fossa.

Key Words: Glossopharyngeal Neuralgia, root entry zone, posterior fossa, pain syndrome.

Abbreviations: GPN = Glossopharyngeal Neuralgia, MVD = Microvascular Decompression.

INTRUDUCTION

Glossopharyngeal neuralgia is an episodic, paroxysmal, severe lancinating pain in the distribution of Glossopharyngeal Nerve.

Glossopharyngeal neuralgia is not just a painful condition. At times, it may be life – threatening as a result of associated cardiovascular consequences. Even in the absence of life-threatening consequences, it can be a severe debilitating disease with depression, suicidal tendencies, fear of swallowing, loss of weight and under – nutrition.

Amongst the lower 6 cranial nerves, the glossopharyngeal nerve is the smallest in terms of nerve diameter, importance and clinical significance. When compared with the facial, vestibulocochlear, vagus, accessory and hypoglossal nerves, the glossopharyngeal nerve appears to dwarf in comparison.

The glossopharyngeal nerve has both sensory and motor components. It receives somatic sensory fibers from the oro-pharynx, posterior third of the tongue, Eustachian tube, middle ear and mastoid. The sensory supply to the middle ear and mastoid passes along the tympanic branch or Jacobson's nerve. The glossopharyngeal nerve also receives special sensory fibers for taste in the posterior third of the tongue as well as chemoreceptor and baro-receptor afferent inputs from the carotid body and carotid sinuses respectively.

The motor component supplies the striated muscle stylopharyngeus and secretomotor parasympathetic fibers to the parotid gland. The tympanic branch or Jacobson's nerve is a very important branch of the glossopharyngeal nerve. It carries somatic sensory fibers which receive pain and touch from the middle ear and mastoid, and secretomotor parasympathetic fibers to

the parotid gland. It does not supply the external ear canal or pinna. The Jacobson's nerve emanates from the petrous ganglion of the glossopharyngeal nerve at or above the level of the jugular foramen. It runs to the tympanic plexus lying on the promontory on the medial wall of the middle ear. Glossopharyngeal neuralgia was first described by Weisenburg⁴ in 1910 as "tic douloureux". His patient had presented with the classical symptoms of lancinating pain in the ear and neck. It was only discovered 6 years later when the patient died and an autopsy was performed, that the patient had a cerebellopontine angle tumour. The tumour was noted to be compressing the trigeminal nerve and stretching the glossopharyngeal nerve at autopsy.

Ten years later in 1920, Sicard and Robineau⁵ described three patients who had "algie velo-pharyngee essentielle" i.e. pain in the distribution of the glossopharyngeal nerve without any known cause. Their patients developed suicidal tendencies after treatment with sedatives or physical agents did not work. However, sectioning of the glossopharyngeal nerves through the cervical approach was successful in relieving the pain in all three of their patients.

A year later, Harris⁶ coined the term "glossopharyngeal neuralgia", describing it as a painful syndrome characterised by paroxysms of unilateral and severe lancinating pain occurring in the distribution of the nerve, and which may be elicited by stimulation of trigger points in regions supplied by the nerve. The pain may be spontaneous or precipitated by a variety of actions that stimulate the region supplied by the glossopharyngeal nerve namely yawning, coughing, swallowing and talking.

Glossopharyngeal neuralgia has been divided into two clinical types⁸ based on the distribution of pain:

1. **Tympanic type** which affects mainly the ear.
2. The **Oropharyngeal type** which affects mainly the oropharyngeal area.

Lymphatic Type

The presence of pain in the ear is attributed to the somatic sensory supply of the tympanic membrane, middle ear and mastoid by the Jacobson's nerve, which branches off the glossopharyngeal nerve at the petrous ganglion.

Surgical Procedure

1. MVD: Microvascular Decompression.
2. Sectioning of Routes.

The importance of differentiating between the two

clinical types lie in making the choice between a low or high approach to sectioning the glossopharyngeal nerve. A high approach avulses the nerve at or proximal to the petrous ganglion, or even at the nerve root entry zone at the brainstem. This is used for lymphatic type. A low approach avulses the nerve distal to the petrous ganglion, thus leaving the Jacobson's nerve intact. This is used for oropharyngeal type.

Etiology

Idiopathic Glossopharyngeal Neuralgia.

Glossopharyngeal neuralgia usually occurs without any obvious cause. When good results were reported for microvascular decompression of the glossopharyngeal nerve^{12,13} in 1977, it became apparent that most of these cases of "idiopathic" glossopharyngeal neuralgia could be caused by **vascular compression** of the glossopharyngeal nerve at the nerve root entry zone, causing a hyperactive rhizopathy. The implicating vessel is usually the posterior inferior cerebellar artery (PICA)¹⁴ which frequently also compresses on the rootlets of the vagus nerve.

Secondary Glossopharyngeal Neuralgia

Before embarking on an intracranial explorative procedure, it is important to exclude **secondary** causes of glossopharyngeal neuralgia. Any sort of compression or irritation to the glossopharyngeal nerve can result in neural hyper-excitability and neuralgia. The most common secondary cause of neuralgia is the **Eagle's syndrome**¹⁷⁻²⁰ or **styalgia**. It is a glossopharyngeal nerve hyper-excitability syndrome caused by compression of the nerve against an elongated or fractured²¹ **styloid process** or a **calcified** stylo-hyoid ligament.²²

Other causes of **secondary glossopharyngeal neuralgia** include: cerebellopontine angle tumours,^{4,23} parapharyngeal space lesions,²⁴ metastasis to petrous temporal bone from breast carcinoma,²⁵ post-tonsillectomy,²⁶ local infection,^{27,28} carcinoma of the parapharyngeal space^{28,29} carcinoma of the pharynx,^{6,30} nasopharyngeal carcinoma,³¹ posterior fossa arterio-venous malformation.³²

MATERIAS AND METHODS

It is a retrospective study of seven (7) cases of Glossopharyngeal Neuralgia which were surgically treated at the Department of Neurosurgery Quaid-e-Azam Medical College / Bahawal Victoria Hospital Bahawalpur. Study period is eight (8) years from January 2003 to December 2010, with follow up period of two years.

Table 1: Sex Incidence.

Sex	Number	Percentage
Male	3	42.85
Female	4	57.15
Total	7	100

Table 2: Age Incidence.

Age	Minimum	Maximum	Mean
Age in Years	40	60	45

Table 3: Surgical Groups.

Group	Number	Percentage	Surgical Procedure
Group A	6	86%	Surgical Rhizotomy
Group B	1	14%	MVD
Total	7	100%	

Group A

In six (6) patients, Glossopharyngeal nerve section alongwith sectioning of upper fibers of Vagus nerve was performed through posterior fossa approach by doing retrosigmoid craniectomy, opening of dura and identifying the IX and X cranial nerves.

Group B

In one patient, Microvascular Decompression was performed for the Glossopharyngeal nerve through the same posterior fossa approach.

RESULTS

Sex Incidence

Four (4) were female and three (3) were male patients.

Table 4: Outcome.

Groups	Surgical Procedure	Number	Percentage	Outcome	Complication
Group A	Surgical Rhizotomy of IX and Xth Roots	6	86	Excellent	Nil
Group B	MVD	1	14	Initially good for 6 months	Recovered

Age Incidence

Age range was 40 – 60 years with average age of 45 years.

Total patients were seven (7) in number. Group A: In six (6) patients, in which IX nerve sectioning alongwith cutting of upper rootlets of X nerve was performed, all patients except one were pain free during the follow up period.

One patient out of six (6), had recurrence of same pain but with less intensity, one year after surgery. But his pain remained under good control with simple medications for pain and second surgery was not required for him.

Group B: In one patient out of seven (7), Microvascular Decompression was performed for IX nerve to relieve the pain. Patient did well for 6 months but pain recurred with same intensity as before, six months after surgery. Second time surgery was planned in that patient and now only the IX nerve was cut in the posterior fossa without cutting the X nerve fibres. Patient again has satisfactory relief of pain after surgery and remained pain free during follow up period.

Complications

There were no other significant complication in these patients except recurrence of pain in two patients as mentioned above, who were treated accordingly with very good outcome.

DISCUSSION

There is no specific medical treatment for glossopharyngeal neuralgia. The treatment of choice and the one which produces excellent results is the intracranial sectioning of the involved 9th cranial nerve proximal to its enter into the jugular foramen. The operation can be performed with a little risk through unilateral sub-occipital craniotomy / craniectomy.¹

Microvascular decompression is currently the most effective operation to treat Glossopharyngeal neuralgia. If exploratory surgery does not identify an offending vessel, sectioning of cranial nerve IX and

the upper rootlets of the cranial nerve X is an option.² In our case series we did sectioning of IX and X nerves in almost all the cases with good results. In one of our cases, Microvascular Decompression was performed but the patient came with recurrence of same severe pain, 6 months after surgery and we have to do sectioning of IX cranial nerve with very good outcome.

Extra-cranial nerve ablation was one of the first procedures attempted for treatment of GPN.^{43,57} This approach was abandoned due to its high morbidity and pain recurrence due to a lack of supraganglionic ablation. Dandy¹⁰ performed some of the first intracranial rhizotomies of the glossopharyngeal nerve with good results. Even though short-term results were good after these procedures, long-term pain recurrence was frequent. Rhizotomy of the vagus sensory rootlets improved long-term outcomes.^{5,41} Intracranial rhizotomies of cranial nerves IX and X were the preferred surgical procedure until the 1970s. Based on his intra-operative observations, Dandy⁹ proposed vascular compression of the root entry / exit zones of the cranial nerves as a possible cause for cranial nerve hyperactivity syndromes. Jannetta²²⁻²⁵ further investigated this mechanism and published the first series of patients with GPN treated with MVD.³⁹ Since that time, this operation has gained greater acceptance than the traditional rhizotomy procedures and many series have been published regarding its efficacy.^{15-17,26,30,34,39,45-47,50,56,60,67}

Sectioning the upper rootlets of cranial nerve X to improve pain control is based on clinical observations rather than careful, reliable anatomical / functional studies.⁵² The vagus nerve does not have a craniocaudal sensorimotor organization, and in fact, the sensory fibers might be located dorsally and the motor fibers ventrally.⁶² However, accumulated experience from older series (not considering MVD as an option) has demonstrated a high pain recurrence rate when cranial nerve IX and X rhizotomies are not performed simultaneously. Physiologically, sectioning the upper rootlets of the vagus nerve increases the pharyngeal sensory loss already caused by cranial nerve IX rhizotomy, potentially resulting in paralysis of the ipsilateral vocal cord and motor arc of the gag reflex. Most authors describe rhizotomy of the upper rootlets of cranial nerve X as benign, leading only to an irritative cough, foreign body sensation in the throat, and transient hoarseness or dysphagia.^{8,31,54} However, it appears that rhizotomy leads to slightly better pain control at the expense of higher postoperative permanent cranial nerve dysfunction.

CONCLUSION

Glossopharyngeal Neuralgia is a very severe pain which disturbs the daily activities of the patient. Medical treatment does not provide any satisfactory relief of the pain usually and if it fails surgical management is a best choice. It may be in the form of sectioning of IX nerve with cutting of upper fibers of X nerve or Microvascular Decompression may also be performed to treat the condition. In our experience however, sectioning of IX nerve with cutting of upper rootlets of X nerve proved to be a good procedure.

Address for Correspondence:

Dr. Muhammad Arshad

Associate Professor of Neurosurgery

Quaid-e-Azam Medical College /

Bahawal Victoria Hospital, Bahawalpur

Mobile: 0300-9686964, 0308-8886964

REFERENCES

1. Acosta C, Clark K: Glossopharyngeal neuralgia associated with cardiac arrest. Case report. *J Neurosurg* 1970; 32: 706-707.
2. Arbit E, Krol G: Percutaneous radiofrequency neurolysis guided by computed tomography for the treatment of glossopharyngeal neuralgia. *Neurosurgery* 1991; 29: 580-582.
3. Barbash GI, Keren G, Korczyn AD, Sharpless NS, Chayen M, Copperman Y, et al.: Mechanisms of syncope in glossopharyngeal neuralgia. *Electroencephalogr Clin Neurophysiol*, 1986; 63: 231-235.
4. Barrow DL: *Surgery of the Cranial Nerves of the Posterior Fossa* New York, Thieme, 1993.
5. Bohm E, Strang RR: Glossopharyngeal neuralgia. *Brain* 1962; 85: 371-388.
6. Bruyn GW: Glossopharyngeal neuralgia. *Cephalalgia* 1983; 3: 143-157.
7. Ceylan S, Karakuş A, Duru S, Baykal S, Koca O: Glossopharyngeal neuralgia: a study of 6 cases. *Neurosurg Rev*, 1997; 20: 196-200.
8. Chawla JC, Falconer MA: Glossopharyngeal and vagal neuralgia. *BMJ*, 1967; 3: 529-531.
9. Dandy WE: Concerning the cause of trigeminal neuralgia. *Am J Surg*, 1934; 24: 447-455.
10. Dandy WE: Glossopharyngeal neuralgia (tic doloureux). Its diagnosis and treatment. *Arch Surg*, 1927; 15: 198-214.
11. De Simone R, Ranieri A, Bilo L, Fiorillo C, Bonavita V: Cranial neuralgias: from physiopathology to pharmacological treatment. *Neurol Sci*, 2008; 29: Suppl 1S69-S78.
12. Esaki T, Osada H, Nakao Y, Yamamoto T, Maeda M, Miyazaki T, et al.: Surgical management for glosso-

- pharyngeal neuralgia associated with cardiac syncope: two case reports. *Br J Neurosurg*, 2007; 21: 599–602.
13. Evans RW, Torelli P, Manzoni GC: Glossopharyngeal neuralgia. *Headache*, 2006; 46: 1200–1202.
 14. Ferrante L, Artico M, Nardacci B, Fraioli B, Cosentino F, Fortuna A: Glossopharyngeal neuralgia with cardiac syncope. *Neurosurgery*, 1995; 36: 58–63.
 15. Ferroli P, Fioravanti A, Schiariti M, Tringali G, Franzini A, Calbucci F, et al.: Microvascular decompression for glossopharyngeal neuralgia: a long-term retrospective review of the Milan – Bologna experience in 31 consecutive cases. *Acta Neurochir (Wien)*, 2009; 151: 1245–1250.
 16. Fraioli B, Esposito V, Ferrante L, Trubiani L, Lunardi P: Microsurgical treatment of glossopharyngeal neuralgia: case reports. *Neurosurgery* 1989; 25: 630–632.
 17. Gaul C, Hastreiter P, Duncker A, Naraghi R: Diagnosis and neurosurgical treatment of glossopharyngeal neuralgia: clinical findings and 3-D visualization of neurovascular compression in 19 consecutive patients. *J Headache Pain*, 2011; 12: 527–534.
 18. Giorgi C, Broggi G: Surgical treatment of glossopharyngeal neuralgia and pain from cancer of the nasopharynx. A 20 – year experience. *J Neurosurg*, 1984; 61: 952–955.
 19. Harries AM, Dong CCJ, Honey CR: Use of endotracheal tube electrodes in treating glossopharyngeal neuralgia: technical note. *Stereotact Funct Neurosurg*, 2012; 90: 141–144.
 20. Headache Classification Subcommittee of the International Headache Society: *The International Classification of Headache Disorders: 2nd edition*. Cephalalgia 24 Suppl, 2004; 1: 9–160.
 21. Isamat F, Ferrán E, Acebes JJ: Selective percutaneous thermocoagulation rhizotomy in essential glossopharyngeal neuralgia. *J Neurosurg*, 1981; 55: 575–580.
 22. Jannetta PJ: Arterial compression of the trigeminal nerve at the pons in patients with trigeminal neuralgia. *J Neurosurg* 1967; 26: 1 Suppl, 159–162.
 23. Jannetta PJ: Microsurgery of cranial nerve cross-compression. *Clin Neurosurg*, 1979; 26: 607–615.
 24. Jannetta PJ: Neurovascular compression in cranial nerve and systemic disease. *Ann Surg*, 1980; 192: 518–525.
 25. Jannetta PJ: Observations on the etiology of trigeminal neuralgia, hemifacial spasm, acoustic nerve dysfunction and glossopharyngeal neuralgia. Definitive microsurgical treatment and results in 117 patients. *Neurochirurgia (Stuttg)*, 1977; 20: 145–154.
 26. Kandan SR, Khan S, Jeyaretna DS, Lhatoo S, Patel NK, Coakham HB: Neuralgia of the glossopharyngeal and vagal nerves: long-term outcome following surgical treatment and literature review. *Br J Neurosurg*, 2010; 24: 441–446.
 27. Kanpolat Y, Kahilogullari G, Ugur HC, Elhan AH: Computed tomography – guided percutaneous trigeminal tractotomy – nucleotomy. *Neurosurgery*, 2008; 63: ONS147–ONS155.
 28. Kanpolat Y, Savas A, Batay F, Sinav A: Computed tomography – guided trigeminal tractotomy – nucleotomy in the management of vagoglossopharyngeal and geniculate neuralgias. *Neurosurgery*, 1998; 43: 484–490.
 29. Katusic S, Williams DB, Beard CM, Bergstralh E, Kurland LT: Incidence and clinical features of glossopharyngeal neuralgia, Rochester, Minnesota, 1945–1984. *Neuroepidemiology*, 1991; 10: 266–275.
 30. Kawashima M, Matsushima T, Inoue T, Mineta T, Masuoka J, Hirakawa N: Microvascular decompression for glossopharyngeal neuralgia through the transcondylar fossa (supracondylar trans-jugular tubercle) approach. *Neurosurgery, Suppl Operative* 2010; 66 (6): 275–280.
 31. King J: Glossopharyngeal neuralgia. *Clin Exp Neurol*, 1987; 24: 113–121.
 32. Kitchener JM: Glossopharyngeal neuralgia responding to pre-gabalin. *Headache* 2006; 46: 1307–1308. (Erratum in *Headache* 2006; 46:1474.
 33. Kobata H, Kondo A, Iwasaki K, Nishioka T: Combined hyperactive dysfunction syndrome of the cranial nerves: trigeminal neuralgia, hemifacial spasm, and glossopharyngeal neuralgia: 11-year experience and review. *Neurosurgery* 1998; 43: 1351–1362.
 34. Kondo A: Follow-up results of using microvascular decompression for treatment of glossopharyngeal neuralgia. *J Neurosurg* 1998; 88: 221–225.
 35. Kong Y, Heyman A, Entman ML, McIntosh HD: Glossopharyngeal neuralgia associated with bradycardia, syncope, and seizures. *Circulation* 1964; 30: 109–113.
 36. Koopman JSHA, Dieleman JP, Huygen FJ, de Mos M, Martin CGM, Sturkenboom MCJM: Incidence of facial pain in the general population. *Pain* 2009; 147: 122–127.
 37. Koopman JSHA, Huygen FJ, Dieleman JP, de Mos M, Sturkenboom MCJM: Pharmacological treatment of neuropathic facial pain in the dutch general population. *J Pain* 2010; 11: 264–272.
 38. Kunc Z: Treatment of essential neuralgia of the 9th nerve by selective tractotomy. *J Neurosurg* 1965; 23: 494–500.
 39. Laha RK, Jannetta PJ: Glossopharyngeal neuralgia. *J Neurosurg* 1977; 47: 316–320.
 40. Lazorthes Y, Verdier JC: Radiofrequency coagulation of the petrous ganglion in glossopharyngeal neuralgia. *Neurosurgery* 1979; 4: 512–516.
 41. Love JG: Diagnosis and surgical treatment of glossopharyngeal neuralgia. *Surg Clin North Am* 1944; 24: 959–962.
 42. Luef G, Poewe W: Oxcarbazepine in glossopharyngeal neuralgia: clinical response and effect on serum lipids. *Neurology* 2004; 63: 2447–2448.
 43. Mairs AP, Stewart TJ: Surgical treatment of glossopharyngeal neuralgia via the pharyngeal approach. *J Laryn-*

- gol Otol 1990; 104: 12–16.
44. Manzoni GC, Torelli P: Epidemiology of typical and atypical craniofacial neuralgias. *Neurol Sci* 2005; 26: Suppl 2s65–s67.
 45. Matsushima T, Goto Y, Natori Y, Matsukado K, Fukui M: Surgical treatment of glossopharyngeal neuralgia as vascular compression syndrome via transcondylar fossa (supracondylar transjugular tubercle) approach. *Acta Neurochir (Wien)* 2000; 142: 1359–1363.
 46. Michelucci R, Tassinari CA, Samoggia G, Tognetti F, Calbucci F: Intracranial microvascular decompression for “cryptogenic” hemifacial spasm, trigeminal and glossopharyngeal neuralgia, paroxysmal vertigo and tinnitus: II. Clinical study and long-term follow up. *Ital J Neurol Sci* 1986; 7: 367–374.
 47. Patel A, Kassam A, Horowitz M, Chang YF: Microvascular decompression in the management of glossopharyngeal neuralgia: analysis of 217 cases. *Neurosurgery* 2002; 50: 705–711.
 48. Pollock BE, Boes CJ: Stereotactic radiosurgery for glossopharyngeal neuralgia: preliminary report of 5 cases. *Clinical article. J Neurosurg* 2011; 115: 936–939.
 49. Reddy K, Hobson DE, Gomori A, Sutherland GR: Painless glossopharyngeal “neuralgia” with syncope: a case report and literature review. *Neurosurgery* 1987; 21: 916–919.
 50. Resnick DK, Jannetta PJ, Bissonnette D, Jho HD, Lanzino G: Microvascular decompression for glossopharyngeal neuralgia. *Neurosurgery* 1995; 36: 64–69.
 51. Ringel RA, Roy EP III: Glossopharyngeal neuralgia: successful treatment with baclofen. *Ann Neurol* 1987; 21: 514–515.
 52. Robson JT, Bonica J: The vagus nerve in surgical consideration of glossopharyngeal neuralgia. *J Neurosurg* 1950; 7: 482–484.
 53. Rozen TD: Trigeminal neuralgia and glossopharyngeal neuralgia. *Neurol Clin* 2004; 22: 185–206.
 54. Rushton JG, Stevens JC, Miller RH: Glossopharyngeal (vagoglossopharyngeal) neuralgia: a study of 217 cases. *Arch Neurol* 1981; 38: 201–205.
 55. Salar G, Ori C, Baratto V, Iob I, Mingrino S: Selective percutaneous thermolesions of the ninth cranial nerve by lateral cervical approach: report of eight cases. *Surg Neurol* 1983; 20: 276–279.
 56. Sampson JH, Grossi PM, Asaoka K, Fukushima T: Microvascular decompression for glossopharyngeal neuralgia: long-term effectiveness and complication avoidance. *Neurosurgery* 2004; 54: 884–890.
 57. Sicard R, Robineau J: Communications et présentations: Part I—algie vélopharyngée essentielle: traitement chirurgical. *Rev Neurol* 1920; 36: 256–257.
 58. St John JN: Glossopharyngeal neuralgia associated with syncope and seizures. *Neurosurgery* 1982; 10: 380–383.
 59. Stanic S, Franklin SD, Pappas CT, Stern RL: Gamma knife radiosurgery for recurrent glossopharyngeal neuralgia after microvascular decompression. *Stereotact Funct Neurosurg* 2012; 90: 188–191.
 60. Taha JM, Tew JM: Long-term results of surgical treatment of idiopathic neuralgias of the glossopharyngeal and vagal nerves. *Neurosurgery* 1995; 36: 926–931.
 61. Taha JM, Tew JM Jr, Keith RW, Payner TD: Intraoperative monitoring of the vagus nerve during intracranial glossopharyngeal and upper vagal rhizotomy: technical note. *Neurosurgery* 1994; 35: 775–777.
 62. Tarlov IM: Section of the cephalic third of the vagus – spinal accessory complex: clinical and histological results. *Arch Neurol Psychiatry* 1942; 47: 141–148.
 63. Thomson JL: Glossopharyngeal neuralgia accompanied by unconsciousness. *J Neurosurg* 1954; 11: 511–514.
 64. Titlic M, Jukic I, Tonkic A, Grani P, Jukic J: Use of lamotrigine in glossopharyngeal neuralgia: a case report. *Headache* 2006; 46: 167–169.
 65. Tubbs RS, Mortazavi MM, Loukas M, Shoja MM, Cohen – Gadol AA: Intra-operative and anatomical descriptions of intracranial connections between the glossopharyngeal and vagus nerves: clinical implications. Laboratory investigation. *J Neurosurg* 2011; 115: 179–181.
 66. Uihlein A, Love JG, Corbin KB: Intracranial section of the glossopharyngeal nerve; sensory changes observed postoperatively. *AMA Arch Neurol Psychiatry* 1955; 74: 320–324.
 67. Wakiya K, Fukushima T, Miyazaki S: Results of microvascular decompression in 16 cases of glossopharyngeal neuralgia. *Neurol Med Chir (Tokyo)* 1989; 29: 1113–1118, (Japan).
 68. Wallin BG, Westerberg CE, Sundlöf G: Syncope induced by glossopharyngeal neuralgia: sympathetic outflow to muscle. *Neurology* 1984; 34: 522–524.
 69. Xiong NX, Zhao HY, Zhang FC, Liu RE: Vagoglossopharyngeal neuralgia treated by microvascular decompression and glossopharyngeal rhizotomy: clinical results of 21 cases. *Stereotact Funct Neurosurg* 2012; 90: 45–50.
 70. Yomo S, Arkha Y, Donnet A, Régis J: Gamma Knife surgery for glossopharyngeal neuralgia. Report of 2 cases. *J Neurosurg* 2009; 110: 559–563.
 71. Yoshioka J, Ueta K, Ohmoto T, Fujiwara T, Tabuchi K: Combined trigeminal and glossopharyngeal neuralgia. *Surg Neurol* 1985; 24: 416–420.