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A cadaveric study on the course and relations of the lingual nerve

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ABSTRACT

Background: The lingual nerve (LN) arises as a branch of the posterior division of the mandibular nerve in the infratemporal fossa, in front of the inferior alveolar nerve (IAN). It passes anteriorly near the mandibular lingual alveolar crest and appears on the side of the tongue resting on the hyoglossus. Finally, it winds around the submandibular duct (SMD) from lateral to medial side. LN was found damaged in 89% of paresthesia cases after the IAN block. The nerve can be injured during third molar tooth extraction, and during surgery in the submandibular region. Hence, understanding the relations of the nerve help to avoid injury. **Aims and Objectives:** To study the relation of LN with the IAN at their origin, the lower 3rd molar tooth, and the SMD. **Materials and Methods:** A cross-sectional cadaveric study was conducted in the Department of Anatomy, Government Medical College Kottayam for 6 months on 40 head and neck specimens. **Results:** The average anteroposterior distance between the nerves at the level of mandibular foramen was found to be 0.57 cm with Range 0.1 cm–1 cm. The average vertical distance between the poster part of the alveolar crest of the lower 3rd molar and the LN was 0.88 cm. In 22% of specimens, the nerve ran on the retromolar mandibular surface. In 95.45% of specimens triple relation was observed between LN and SMD. **Conclusion:** A thorough knowledge of the relations of LN will help clinicians to avoid injury during surgeries and nerve blocks.

Key words: Inferior alveolar nerve; Chorda tympani; Foramen ovale

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INTRODUCTION

The lingual nerve (LN), a branch of the posterior division of the mandibular (PDM) nerve, has great clinical significance. At its origin in the infratemporal fossa, the LN is often in a common stem with the inferior alveolar nerve (IAN) and lies anterior to it.[1] It runs downward between the lateral pterygoid muscle and tensor veli palatini muscle. Chorda tympani, a branch of the facial nerve, joins its posterior border at an acute angle. After passing between the medial pterygoid muscle and the ramus of the mandible LN comes in direct contact with the mandible about 1 cm below and behind the lower third molar teeth. Here it is covered only by the mucous membrane of the gum and becomes palpable against the mandible. From there, it crosses the styloglossus and appears on the side of the tongue resting on the hyoglossus muscle. The submandibular ganglion is suspended by 2 roots from the LN. The posterior root supplies the submandibular gland (SMG) and the anterior root provides secretomotor fibers to the sublingual and anterior lingual glands.[2] Further anteriorly, it crosses below the submandibular duct (SMD) from lateral to medial direction. The terminal branches supply the anterior 2/3rd of the tongue.[3]

LN has 3 functional components – general somatic afferents, Special visceral afferents,and General visceral efferents. It carries general sensations from the mucosa of the anterior 2/3rd of the tongue, the floor of the mouth, and the lingual gingivae of the mandibular teeth of the same side.[4] Across its communication with the chorda tympani nerve, it also conveys taste sensation from the

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anterior 2/3rd of tongue and conveys postganglionic parasympathetic secretomotor fibres to the submandibular and sublingual glands.

Sensory changes following LN injury can manifest as anesthesia, paresthesia, hypoesthesia, or dysesthesia.[5] This can cause burning sensation, pain, speech changes, and tongue biting (loss of proprioception). Loss of taste from the anterior 2/3rd of the tongue, sensory loss from the lingual gingivae, and difficulty in speaking or eating due to decreased salivation are also observed.

LN is highly susceptible during the IAN block. LN was found damaged in 89% of paresthesia cases after the IAN block.[6] The LN tends to be unifascicular and has a thick perineurium, making it less capable of supporting trauma from edema and hemorrhage. It is located only 5–6 mm below the mucosal surface and lacks osseous protection.[7]

LN neuropathy can occur during third molar tooth extraction through the lingual flap technique. The incidence of LN injury after 3rd molar extraction was 0–11%[8] of which 0.5–0.6% had permanent dysfunction.[9] Unfortunately, present treatment options yield minimal success in restoration of function of the LN following injury. Hence, it is important to understand the anatomy of the nerve to avoid injury. LN injury can occur as a complication of orthognathic surgery, periodontal surgery, pre-prosthetic surgery, and sagittal split ramus osteotomy (SSRO). The incidence of LN injury after SSRO is 9–19.4%.[10]

LN injury at the lateral edge of the tongue base can occur after prolonged compression of the nerve from the endotracheal tube, laryngeal mask airway, or laryngoscope used for endo-laryngeal microsurgery.[11] The etiology of LN damage associated with general anesthesia is multifactorial and can occur following complicated and forced laryngoscope, several attempts of the laryngoscope, anterior displacement of the jaw for a long period, compression of the tongue, macroglossia, placing a drain plug in the throat and mandibular retraction.[12] The LN stretches taut and is fixed underneath the interpterygoid fascia.

Injury to the LN might occur iatrogenically while giving local anesthesia to block the nerve or excision of the nerve during the removal of a tumor of the SMG or during partial or total resection of the tongue or during removal of sialolith from the duct of SMG or during ductoplasty.

Aims and objectives

The aim of the present study is to describe the relation of the LN with the IAN, 3rd molar tooth, and SMD.

The first objective is to measure the anteroposterior distance between LN and IAN at the mandibular foramen. The second objective is to measure the distance between LN and the most posterior part of the alveolar crest of lower 3rd molar tooth. Third objective is to describe relation between LN and SMD.

MATERIALS AND METHODS

A cross-sectional cadaveric study was conducted in the Department of Anatomy, Government Medical College Kottayam for a period of 6 months from March 2019 to August 2019 after obtaining approval from the Institutional Review Board (IRB No: 23/2019). Head and neck specimens with intact 3rd molar tooth were selected. Cadavers with crush injuries, severe burns, gross malformations, and pathologies, such as tumors involving the head-and-neck were excluded.

A total of 40 adult human head and neck specimens (80 LNs) of both sexes were dissected. The study was carried out by standard dissection method and dissection instruments.[13] Infratemporal fossa was dissected. The zygomatic arch along with the masseter muscle was cut and reflected downward. The coronoid process along with the temporalis muscle was reflected upward. The neck of the mandible was cut horizontally. Another horizontal cut was made in the ramus of the mandible just above the mandibular foramen. After removing the lateral pterygoid muscle the origin and course of the LN was explored. The relation between the LN and IAN at the origin was noted. The level of origin of the LN in relation to foramen ovale (FO) was noted. The anteroposterior distance between LN and the IAN at the level of mandibular foramen was measured.

Next, the mandible was cut in the midline and the course of the nerve in the floor of the mouth was studied. The relation between the 3rd molar tooth and LN was noted by measuring the distance between LN and the most posterior part of the alveolar crest of the lower 3rd molar tooth. The relation between the SMD and the LN was noted before the nerve crossing the duct, at the point of crossing, and after the crossing. The observations were recorded and photographs were taken using a digital camera.

Statistical analysis

Data analysis was done using descriptive statistics – the range, mean, and percentage (%) of each parameter observed was calculated. The software used was Jamovi version 2. The results were compared with the previous results.

RESULTS

In the present study, out of the 80 LN specimens examined one nerve was found to originate by 2 roots – the anterior root from the anterior division of mandibular nerve (ADM) and a posterior root from the PDM nerve. 90% of specimens showed standard bifurcation in which the two nerves originated from the PDM nerve below the FO in the infratemporal fossa. In 6.25% of specimens, both nerves originated above the FO and showed high bifurcation. In 3.75% of specimens, there were communicating branches between the two nerves below the FO suggesting communicating bifurcation (Figure 1).

The average anteroposterior distance between LN and IAN at the level of mandibular foramen was found to be 0.57 cm with a range of 0.1–1 cm. In IAN block, injury to the LN has been reported more often than injury to the IAN due to their close proximity (Figure 2).

The average vertical distance between the most posterior part of the alveolar crest of lower 3rd molar tooth and the LN was 0.88 cm. In 22% of specimens, the nerve ran in the retromolar region on the mandibular surface. The average anteroposterior distance between the nerve in the retromolar region and the midpoint of the posterior part of the third molar alveolar crest was measured to be 0.7 cm.

The relation with the SMD was also variable. In 95.45% of specimens, a triple relation was observed where the LN descends lateral to the SMD, then passes inferior to it and finally ascends medial to it (Figure 3).

In 1 specimen, the nerve did not wind around the submandibular duct. Instead, it divided into terminal branches at that level [Figure 4]. In 2 cases, accessory SMDs were noted and the nerve crossed only one duct. The terminal branching pattern of the LN was studied. In 1.25% of cases, there was only one terminal branch. In 28.75% of cases, the nerve terminated by giving 2 branches, in 42.5% of cases, it had 3 terminal branches, and in 27.5% of cases, it had 4 terminal branches.

DISCUSSION

In the present study, out of the 80 LN specimens examined one nerve was found to originate by 2 roots – the anterior root originated from ADM nerve and the posterior root from the PDM nerve. The chorda tympani nerve joined the trunk of the LN that formed by the union of the two roots, as usual. In the study conducted by Premakumari and Dhyaneshwar in 20 embalmed cadavers, one of the LNs was found to be arising from 2 roots. The anterior root was

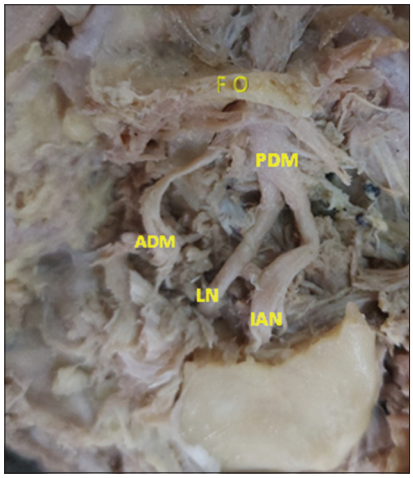

Figure 1: The relation between lingual nerve and Inferior alveolar nerve at origin. LN: Lingual nerve, IAN: Inferior alveolar nerve, FO: Foramen ovale, ADM: Anterior division of mandibular nerve, PDM: Posterior division of mandibular nerve, communication between LN and IAN also can be seen

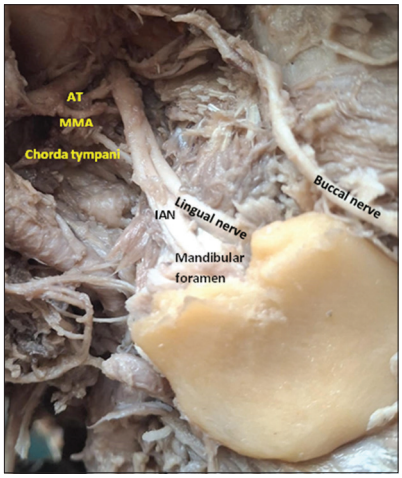

Figure 2: The close relation between the lingual nerve and inferior alveolar nerve at the mandibular foramen. ATN: Auriculotemporal nerve, MMA: Middle meningeal artery

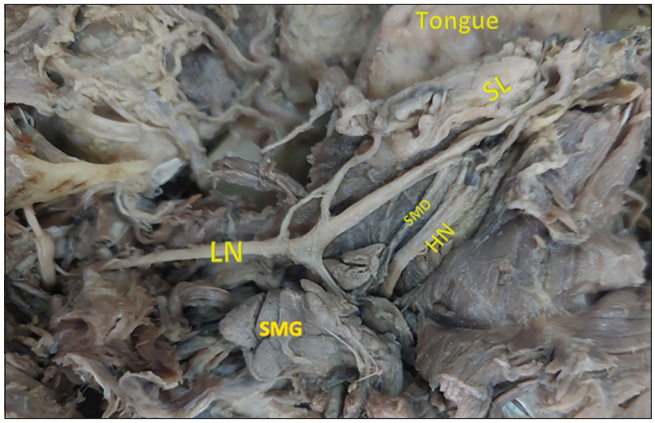

Figure 3: The relation of lingual nerve with Submandibular gland, submandibular duct (triple relation), hypoglossal nerve and sublingual gland. LN: Lingual nerve, SMG: Submandibular gland, SMD: Submandibular duct, HN: Hypoglossal nerve, SL: Sublingual gland

arising from the ADM nerve and the posterior root was from IAN at the same point where chorda tympani was joining the posterior aspect of the LN.[14] A study by Racz and Maros in 24 human heads from embalmed cadavers found that in 4.1% specimens LN originated by 2 roots.[15] Daimi et al., reported a variation in a 65-year-old Male cadaver in which LN was formed by 2 roots – posterior root originated directly from mandibular nerve while anterior root was a branch from the common trunk which originated from mandibular nerve and divided into 2 branches – one as anterior root of LN and the other as IAN.[16]

It was observed that 90% of specimens showed standard bifurcation in which the LN and IAN originated from the PDM nerve below the FO in the infratemporal fossa. In 6.25% of specimens, both nerves originated above the FO and showed high bifurcation. In 3.75% of specimens, there were communicating branches between the two nerves below the FO suggesting communicating bifurcation.

Shinohara et al., studied the relation of the bifurcation between LN and IAN s close to the oval foramen in fifteen embalmed head specimens. Three types of bifurcation were observed, a standard bifurcation, a high bifurcation, and a communicating bifurcation (Table 1).

The standard bifurcation was observed in 70.1% of cases.

Figure 4: The submandibular duct medial to the lingual nerve. The lingual nerve divides into terminal branches without winding around the submandibular duct. SMD: Submandibular duct, LN: Lingual nerve, HN: Hypoglossal nerve

Table 1: The types of bifurcation between the lingual and inferior alveolar nerves at the origin

Type of bifurcation	Present study (%)	Study of Shinohara et al., (%)
Standard bifurcation	90	70.1
High bifurcation	6.25	16.6
Communicating bifurcation	3.75	13.3

The high bifurcation was observed in 16.6% of the cases. The communicating bifurcation was observed in 13.3% of cases.[17]

In IAN block, injury to the LN has been reported more often than injury to the IAN. In the study of Iwanga et al., the distance between the posterior edge of the LN and the anterior edge of the IAN at the level of mandibular foramen ranged from 1.62±8.36 mm with a mean of 5.33±1.88 mm.[18] In this study, the average anteroposterior distance between LN and IAN at the level of mandibular foramen was found to be 0.57 cm with Range 0.1–1 cm.

Behnia et al., found that in 14.05% of cases, the nerve passed above the mandibular lingual plate and in one case it ran in the retromolar region accurately on the mandibular surface. In 85.8% of the cases, the nerve was in its typical position, and in 149 cases (23.27%) it was in direct contact with the lingual plate of the jaw in the alveolar process.[19] There was no difference in the LN position in male and female and no correlation between the LN positions at each side, with both presenting independent topographies (Table 2).

Ethnicity may be a major factor leading to this difference since the data were obtained from different populations.

Pogrel et al., found one case where the nerve passed above the mandibular lingual plate. In this position, the LN is vulnerable to trauma, may suffer injury during gingival detachment in the retromolar region and is difficult to reach even in procedures that do not involve sharpened instruments in the lingual plate of the mandible.[20] Edentulousness and mandibular atrophy with loss of muscle mass causes LN to rest in a superficial position compared to dentated individuals. The LN will be more cranial in position if there is a short distance between the mandibular ascending ramus and the third molar.

Bataineh investigated the sensory impairment of the lingual and IAN s after removal of impacted mandibular third molars under local anesthesia and found 2.6% of the patients presenting paresthesia in the LN region, with increased incidence associated with increased lingual flap.[21]

The relation between the LN and the SMD or Wharton's duct is very important during surgical procedures involving the SMG. In our study, triple relation was observed in 95.45% of specimens where the LN descends lateral to the SMD, then passes inferior to it, and finally ascends medial to it. In 1 specimen, the SMD was seen at a very low level and the nerve did not wind around it. In 2 cases, accessory SMDs were noted and the nerve crossed only one of the ducts. Mendes et al., noted a triple relation between the LN and the SMD in 62.5% of specimens. In the remaining

Table 2: Population differences in the incidence of Mean vertical distance of lingual nerve from the third molar alveolar crest

Study	Country	Methodology	Sample size	Mean vertical distance (mm)
Behnia et al., (2000)	Iran	Dissection	669	3.01
Holzle and Wolff (2001)	Germany	Dissection	86	7.83
Mendes et al., (2014)	Brazil	Dissection	24	16.8
Pogrel et al., (1995)	USA	Dissection	40	8.32
Present study (2023)	India	Dissection	80	8.8

37.5% LN crosses above the duct.[22] According to Holzle and Wolff, in 4 specimens out of 34 specimens the SMD runs deep in the floor of the mouth and LN.[23]

In the present study, in 1.25% of cases, there was only one terminal branch. In 28.75% of cases, the nerve terminated by giving 2 branches, in 42.5% of cases, it had 3 terminal branches and in 27.5% of cases, it had 4 terminal branches. The branching pattern of the LN studied by Al-Amery et al., showed that in 50% of specimens, there were 2 terminal branches. In 28.6% of specimens, the number of terminal branches were 3, in 14.3% of specimens, there were 4 terminal branches and only one branch was there in 1 specimen.[24]

Limitations of the study

Age and sex of the cadaveric specimen could not be ascertained.

CONCLUSION

LN shows significant variations in different cadavers. Thorough knowledge on the course and relations of the LN will provide a useful reference and help to reduce the complications after injecting local anesthesia or following surgeries.

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Authors' Contributions:
RS – Definition of intellectual content, Literature survey, Prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation, submission of article. **SP** – Review Manuscript, Literature survey, Preparation of figures.

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