

Branching pattern of mental nerves in south Indian population: A cadaveric dissection study

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Abstract

Introduction: Knowledge of branching pattern of mental nerve (MN) at mental foramen (MF) along with prevalence of accessory mental foramen (AMF) exhibiting accessory mental nerve (AMN) is an obligatory consideration in orthodontics like osteotomy reconstructive procedures, placement of implants, nerve blocks. It has been reported to show population differences regarding these in various osteological studies. However no cadaveric study is reported in South Indian population so far.

Aim: To analyze the branching pattern of MN at its emergence, to determine the location of MF in relation to mandibular teeth and to study the frequency of occurrence of AMF with the structures emerging through it in South Indian population.

Materials and Methods: 30 cadavers were dissected bilaterally, exposing the mental foramen. Terminal branches of MN at the foramen were carefully dissected and their distribution was noted. The position of MFs and AMFs were noted in relation to mandibular teeth. The AMN (if present) was carefully dissected and noted. The mean distance between accessory mental foramen and mental foramen was also measured.

Results: A single MN was noted in all the cadaveric specimens (n= 60). The MN most commonly branched into two branches in 51.66% of cases. The location of MF was found to be inferior to the second premolar on either side in 66% cases. The AMF with AMN passing through it was found only in 3.3% of cases.

Conclusion: The commonest pattern of MN observed was MN dividing into 2 branches at the MF. Though high prevalence of AMF noted, not all AMF exhibited AMN.

Keywords: Mental foramen, Accessory mental foramen, Orthodontics, Mental nerve, Accessory mental nerve, Nerve block.

Introduction

With increasing trends in usage of dental implants, root canal treatments, and various orthodontic surgeries, the mental foramen (MF) has become a clinically and surgically important landmark. The mental nerve (MN) emerging through it serves an important point of administration of anesthesia for nerve block in surgeries involving the mandible.¹ Thus identification of MN along with its cutaneous branches is of paramount importance during presurgical evaluation to achieve effective anesthesia and prevent post operative neurosensory loss by iatrogenic injury. The MN branches show variation from zero to four which supplies the chin, mucous membrane and skin of lower lip and gingiva.²⁻⁵ The number and position of MF, the branches of MN at its exit has been described to exhibit variability in different ethnic groups.⁶ In addition to this, the possible occurrence of accessory mental nerve in the vicinity of MN also requires consideration during procedures like dental implant insertion; implant related bone grafting, genioplasty, mandibular anterior segmented osteotomy to prevent unintended injury to it. This accessory mental foramen (AMF) is an infrequent anatomical variation which has been reported to have a prevalence ranging from 1.4 to 10%.⁷ Occasionally the AMF gave passage to few capillaries only without accessory mental nerve (AMN).⁸ The knowledge of branching pattern of MN along with AMN if present is necessary to avoid any inadvertent intraoperative

complications. Studies so far are largely based on osteological findings and case reports with not many supportive cadaveric dissections. Thus we feel the cadaveric observations under gross inspection might help in validating with the osteological data in South Indian population. Thus the aim of this study is to observe the branching pattern of MN in this population along with prevalence of AMF and nature of structures passing through it.

Materials and Methods

This study was carried out in department of Anatomy of our institution after approval from Institutional Review Board. A total of 60 hemi faces (30R, 30L) with intact lower mandibular teeth and no deformity were dissected for this study. All the cadavers were of South Indian origin being donated to the department for the purpose of teaching and research. The MF was exposed reflecting the skin flap by means of three incisions. One vertical midline incision extending from symphysis menti to middle of lower lip, two lateral horizontal incisions from the midpoint of lower lip to angle of mouth close to mandibular alveolar border and one along the lower border of mandible from symphysis menti. The MF was located by careful skin reflection. Its position was noted in relation to lower teeth. The MN was carefully dissected and the initial and terminal branching pattern was noted. The presence of AMF was looked for and if

present was noted, along with the structures emerging from it. The distance between AMF and MF was measured and its position in relation to MF was noted. The data collected was analyzed using Microsoft Excel 2007. The frequency and percentage of various branching pattern, location of MF in respect to lower tooth was determined.

Results

In the current study, the position of MF was observed to be most commonly located directly inferior to the second premolar in 66.66% of cases followed by inferior to first premolar in 26.66%. [Table 1] Table 2 shows the various position of AMF in respect to lower mandibular teeth. Though AMF was found in 6 cases, only one case (3.3%) was seen transmitting the AMN through it which was located 3mm infero lateral to MF in between second premolar and first molar. The incidence of AMF in current was found to be 10%. [Table 2] The prevalence of AMF was more on the right side [13.3%] than left in current study. [Table 2]

Out of 60 cadaveric dissection on mandibular area (30 right and 30 left), a single MN was noted to be emerging in all the cadavers on both sides. The MN divided immediately at the emergence or close to it (1-2mm) into branches which varied from two to four. These branches finally terminated supplying areas over chin, gingival, and mucous membrane of lower lip and

angle of mouth. Based on number of branches given by each mental nerve immediately at its emergence, the pattern of branching was classified into 3 types i.e. Type I, Type-II, and Type-III. [Table 3] In type I, two branches were given, the medial branch further divides to supply the area over chin and mucous membrane of medial side of lower lip and lateral one divided to innervate the gingiva and angle of the mouth. [Fig. 1, A] In type -II, MN seen dividing into three branches the medial branch was given to mental region, second branch terminated on mucous membrane of lip and gingiva and the lateral one supplied the angle and sometimes the gingiva. [Fig. 1, B] In type III, the MN divided into 4 separate branches which innervated mental area, mucous membrane of lip, gingiva and angle of mouth respectively. [Fig. 1, C] Type I was observed in 51.66% of cases followed by 30% cases showing type II. Only in 18.34% of cases the MN was noted to split into four separate branches i.e. type III. [Table 3] In one side (3.3%) where the AMN was present, it supplied the area over the mental region independently with the MN seen splitting into three branches at MF, which innervated mucous membrane of lower lip, gingiva and angle of mouth. [Fig. 2, A] Out of 6 AMFs noted, 5 (showed without any corresponding nerve transmitted through them. [Fig. 2, B]



Fig. 1: Photographs showing branches of mental nerve; 1A: 2 branches; 1B: 3 branches; 1C: 4 branches

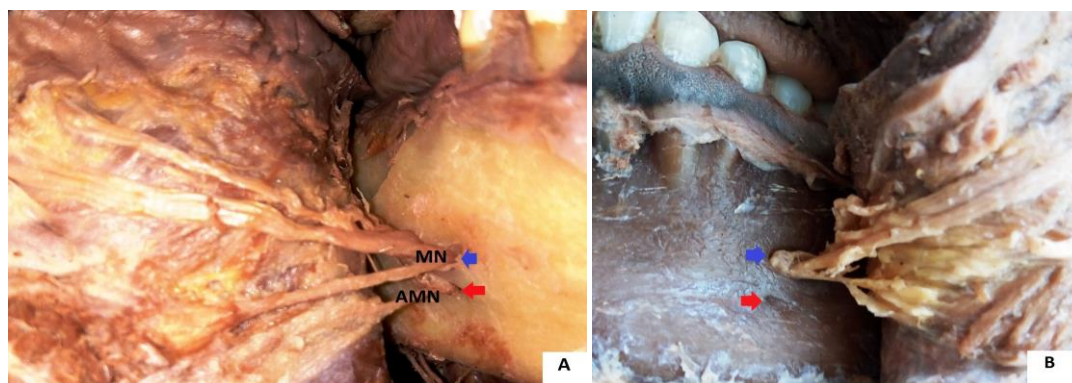


Fig. 2: Photograph showing mental and accessory mental foramina; 2A: Accessory mental nerve (AMN) coming from accessory mental foramen and mental nerve (MN); 2B: Presence of accessory mental foramen (red arrow head) without any significant structure passing through it.

Arrow head (blue) – Mental nerve emerging at mental foramen

Table 1: Mental foramen location

Mental foramen	Right (n=30)	Left (n=30)	Total (n=60)
PM1	08 (26%)	08 (26%)	16 (26.66%)
PM2	20 (66%)	20 (66%)	40 (66.66%)
PM1 & PM2	02 (6.6%)	02 (6.6%)	04 (6.66%)

PM1 – First premolar

PM2 – Second premolar

Table 2: Location of accessory mental foramina

Location	Right (n=30)	Left (n=30)	Total (n=60)
Canine	2	1	3 (5%)
Canine & PM1	1	0	1 (1.66%)
PM2	0	1	1 (1.66%)
PM2 & M1	1	0	1 (1.66%)
Total	4 (13.3%)	2(6.6%)	6(10%)

PM1 – First premolar

PM2 – Second premolar

Table 3: Number of branches of mental nerve at its emergence

Number of branches from MN	Right (n=30)	Percentage (%)	Left (n=30)	Percentage (%)	Total (n=60)
Double (Type I)	14	46%	17	56%	51.66%
Triple (Type-II)	09	30%	09	30%	30%
Four (Type- III)	07	23.34%	04	13.34%	18.34%

Discussion

The knowledge about likely variations in position, course and pattern of emergence of MN at MF is essential in gaining adequate nerve block of MN during surgical procedures. Many potential inadvertent complications of neurosensory alterations in the chin and lower lip can be avoided by locating MF with emerging neurovascular bundle.⁹ The position of MF with MN branching pattern has been described to show racial variations.¹⁰ The current study thus observed the possible variations with MF, AMF and neurovascular structures emerging via cadaveric dissection on South Indian population. Findings of current study will help validating findings available on South Indian population obtained through osteological studies.

The most frequent location of MF in the current study was found to be inferior to the second premolar tooth (66%). This is in accordance with the previous studies which also found the location of MF in relation to second premolar tooth in various ethnic groups.¹¹⁻¹³ An osteological study done on South Indian population by Sankar et al (2011) found 54.1% of MF present at the apex of second premolar similar to the current study.¹⁴ The neurovascular bundle emerging from it has been found very crucial from surgical point of view. In the current study, a single mental nerve was found to be emerging at MF in all dissected cadavers on both sides. A single MN was found emerging from corresponding foramen in all the cadavers on both sides. No instances

of unilateral or bilateral absence of MN were noted as reported in previous studies.¹⁵

Though mental nerve is seen emerging as a single trunk, the prevalence of double mental nerves is not rare. It has been documented within a range of 1 to 10.6% of cases.^{16,17} Even though few osteological studies have reported presence of double mental nerves, its validation under gross cadaveric observation was essential. A cadaveric dissection on 60 hemi faces revealed a prevalence of 4.7% occurrence of double mental nerves in Kenyan population.¹⁸ The current study however didn't reveal any occurrence of double mental nerve on dissection which is a variance from above literatures. This might be suggestive of low incidence of double mental nerves in South Indian population.

The MN after emerging from MF, branches of to supply the chin and lower lip and gingiva.¹⁹ Multiple failed attempts of nerve block of lower jaw can be prevented by proper knowledge about mode of branching of MN. The current study revealed the MN dividing into two to four branches at its emergence from MF. The most common pattern observed was division of the MN into two branches on both sides (51.66%) within 1-2mm of MF followed by division of MN into three branches (30%). The medial branch further divided into two branches to innervate mental region and the medial side of mucous membrane of lower lip. The lateral branch further divides into two and supplied the lateral side of lip and angle of mouth.

The gingival branches were seen to be given from either of the labial branches. The branches of mental nerve have been reported to vary from one to four as reported in previous studies.² Hu et al (2007) divided the branching pattern of MN into 5 types based on its distribution area and number of nerve branches.²⁰ He described 4 terminal branches of the mental nerve as angular, medial inferior labial, lateral inferior labial, and mental branches. The common type was the MN dividing into 3 initial branches where two medial branches supply the chin and medial part of lower lip independently while the lateral one further divides further into two smaller branches for lateral part of lip and corner of mouth. A similar cadaveric dissection study done on Kenyan population which described the initial and terminal branching pattern of MN also showed MN dividing into 1 to 4 initial branches.¹⁸ The MN divided into 2 branches in 39% cases while in 19% it continued as a single trunk. However in the current study, MN continuing as a single trunk was not seen. This is similar to findings of Hu et al (2007) and Alsaad et al (2003) who also noted the MN was seen splitting into 2 to 4 branches.^{18,21} The characteristic pattern of MN dividing into three branches was only noted in 30% of cases on both the sides as compared to 61.3% of Korean and 55.6% of Ireland population.^{20,22} This suggests a possibility of high level of ethnic variation among different population regarding the branching pattern of MN.

The mental foramen in human is usually single in number. Any additional foramen thus found in the vicinity of MF is termed as AMF. AMF usually forms when MN branches prior to formation of MF which gives passage to a branch of MN or a branch of inferior alveolar nerve.²³ Different variants of AMF might have occurred due to epigenetic traits undergoing modifications during ontogeny with variable degrees of expression. Hence it is suggested that genetic modifications might be responsible for variations encountered in AMF regarding its number, size, position and shape.²⁴ These variability has been described by osteological, cadaveric dissections and radiological studies on different population. The incidence reported is around 1.5% in Russians, 2.6% in French, 2.8% in Israeli population 3% in Hungarians, 3.3% in Greeks, 3.6% in Egyptians, 4% - 5.7% in Americans, 9.7% in Melanasiens, 12.5% in Polynesians.^{1,25-27} An osteological study revealed an incidence of 8.85% of AMF, indicating a high prevalence of its occurrence in South Indian population.²⁸ The current cadaveric study reported an incidence of 10% AMFs which is in accordance with this osteological data. These AMFs were most frequently found on the right side (13.3%) which is similar to data obtained by Pokhrel et al (2013), where out of 166 sides examined, right side AMFs seen in 11.3% cases of males and 3.3% cases of females.²⁹ Voljevic et al (2015) also described the presence of all

four AMF to be situated on the right side of the mandible.³⁰ Toh et al (1992) suggested the same with his findings of two right sided AMF out of three cases.²³ On the contrary, few osteological studies done on Indian population by Singh and Srivastav (2010),³¹ Udhaya et al (2013) on South Indian population also showed the occurrence of AMFs on left side.²⁶ A similar study on 260 dry mandibles by Rajkohila et al(2018) also found the AMFs to be mostly located on the left side than the right side.²⁸ This discrepancy could be due to small sample size in the current cadaveric study.

The distribution of AMF has reported to show variability in relation to lower teeth. It can be located below the first molar tooth^{31,32} second premolar²⁸ or between second premolar and first molar. In the present study, while it was present in various locations, out of 6 AMFs, 3 (5%) found below the canine. Despite the fact that six AMFs were found, AMN was seen transmitted through it only in one case (3.3%). This AMF was situated between second premolar and first molar. This proposes that AMF in this region was of clinically relevant.

The distribution of AMN over mental region can be related to position of AMF in respect to MF because the fibers of AMF seem to supplement some areas which are not supplied by MN.³³ The AMN can branch off directly from inferior alveolar nerve or may be given as a terminating branch of MN. In the presence of AMN, the MN was seen to divide into 3 main branches in current study. The only innervation to mental area was seen coming from branches of AMN. Although six AMF were noted in the current study, not all AMF exhibited the AMN emerging from it. In only one case a single AMN was noted emerging through AMF and it innervated the mental area separately. On a similar cadaveric dissection the prevalence of AMN in Kenyan population was found to be 1.6%.¹⁸ Several other osteological studies described its prevalence in different population as 2.6% in French, 1.5% in Russia, and 12.5% in Polynesians and 1.4%- 5.7% in Americans.^{1,25-27} Nevertheless the presence of AMFs on dry mandibular study cannot confirm the nature of structures passing through it. In fact Fuakami et al (2011) reported cases where few capillaries were only seen traversing through the foramen without AMN.⁸ The current study also confirmed the observations of Fuakami et al.

The AMN when present described to supply the mucous membrane of lip to corner of mouth.²³ The precise knowledge about the location of MF with AMF and territory of innervations of AMN in relation to MN is essential during planning of dental implant procedures and selection of osteotomy sites.³⁴ The osteological study by Rajkohila et al (2018) showed the location of AMF mostly either inferolateral or superomedial to MF within a mean distance of 2.96mm from MF. Some previous studies reported the mean

distance between the AMF and MF as 3.3mm, 2.86 mm and 2.54 mm respectively,³⁵⁻³⁷ while some authors noted the mean MF-AMF distance as high as 6.3 mm and 5.2 mm, respectively.^{16,38} The current study found the single case of AMF with AMN emerging through it at 3 mm infero lateral to MF in between second premolar and first molar which falls within the range of previous findings. The distance of AMF and MF plays a decisive role while planning for any implant in mandibular region to avoid injury to neurovascular structures exiting AMF.

Conclusion

In South Indian population, a single MN was observed emerging from MF on dissection on both sides without any absence or double MNs. It was found to divide into two main branches close to foramen in most cases. The prevalence of AMFs although described high in this population, cadaveric dissection confirmed that not all AMFs exhibit AMN through it. This report would provide surgeons a better understanding of neurovascular structures over this area during dental procedures in regards to South Indian population.

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