



## ANATOMY OF SUCCESSFUL INFERIOR ALVEOLAR NERVE BLOCK

**Subhra Mandal**

Associate Professor, Dept of Anatomy, Medical College Kolkata, West Bengal, India.

**Arindam Samaddar\***

Final Year MD PGT, Medical College Kolkata.\*Corresponding Author

**Prabir Mandal**

Medical Officer, MRBangur Dist Hospital, Kolkata.

**ABSTRACT**

The Mandibular Foramen (MF) is an opening on the internal surface of ramus of mandible leading into mandibular canal (MC). The Inferior alveolar vessels & nerves enter through the mandibular foramen, pass through mandibular canal, give branches to all mandibular teeth and exit through mental foramen (MeF) as mental vessels and nerves. The position of MF is an important anatomical landmark for effective anaesthesia in Dentistry by Inferior Alveolar Nerve Block (IANB) for many surgical procedures like lower jaw dental extraction, reduction of mandibular fractures as well as placing mandibular implants. The accomplishment of successful anaesthesia in IANB depends on the proximity of the needle tip to the MF at the time of injection of local anaesthetic agent. Aim of our study is to examine and evaluate the position of MF relative to four (4) bony landmarks in 100 dry samples of adult dentulous human mandibles.

**Materials and Methods:** Dry human Mandibles were obtained from Department of Anatomy, Medical College, Kolkata (India). Parameters were measured by digital vernier callipers. The data was tabulated and statistically analysed.

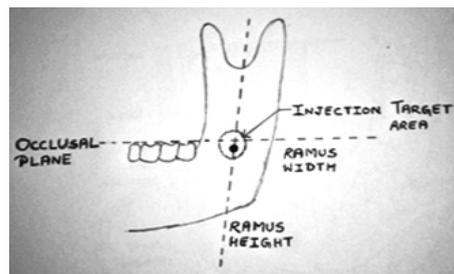
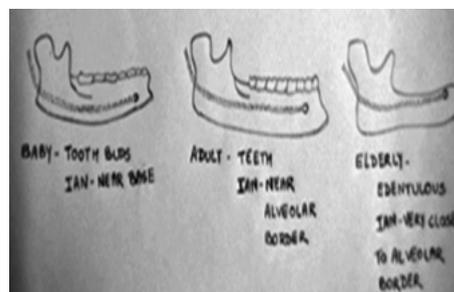
**Results:** The mean distance between the Mandibular Foramen (MF) and the respective landmarks were noted as (17.06±2.567) mm, (9.75±1.68) mm, (22.71±3.41) mm, and (13.58±2.116) mm for the anterior, posterior, inferior and superior border (mandibular notch) respectively for the right side. Likewise distances on the left sides were—(17.17±1.647) mm, (9.80±1.546) mm, (22.635±3.53) mm, and (13.52±2.026) mm for the anterior, posterior, inferior and superior border (mandibular notch) respectively. Statistically, there was no significant difference in the distance between mandibular foramen and respective four landmarks of both the sides.

**Conclusion:** Our study revealed almost bilateral symmetry for all the landmarks taken under consideration. We conclude that the failures in the anaesthesia of Inferior alveolar nerve are mainly due to operator's error and not due to anatomical variations. Though the knowledge of minor anatomical variations definitely will help the dental surgeons during local anaesthesia involving IANB for Orthodontic procedures.

**KEYWORDS:** Mandibular foramen (MF), Mandibular canal (MC), Mental foramen (MeF), Inferior alveolar nerve block (IANB), Mandibular implants, Orthodontic procedures.

**INTRODUCTION**

Adequate anaesthesia is essential for achieving maximum success in majority of Dentistry procedures. In reality, most of the patients select their dentist based on their efficiency to provide a painless dental treatment. Inferior alveolar nerve block (IANB) is the most frequently used technique for achieving local anaesthesia while performing restorative and surgical procedures in the mandibular region. The Mandibular foramen (MF) is an irregular opening on the internal surface of ramus of mandible, a few millimetres above the occlusal plane of the molars, in the immediate vicinity of coronoid notch<sup>1</sup>. (Occlusal Plane 2—an imaginary surface which is related anatomically to the cranium and on which theoretically the inferior alveolar nerve (IAN) touches the incisal edges of the incisors and the tips of the occluding surfaces of the posterior teeth. It is not a plane in the true sense, but represents the mean of the curvature of the occlusal surface.) Mandibular canal (MC)<sup>1</sup> starts at MF and descends obliquely forwards in the ramus and later in the body up to the mental foramen containing the inferior alveolar neurovascular bundle. The Inferior alveolar nerve (IAN) is a branch of posterior trunk of mandibular nerve which descends behind the lateral pterygoid muscle and then pass between the sphenomandibular ligament and ramus of mandible. The inferior alveolar vessels and nerves enter through the MF, traverse the MC provide branches to all the mandibular teeth, gingiva of mandible and lower lip and then exits through mental foramen dividing into two terminal branches incisive and mental nerve along with vessels<sup>1</sup>. In 2005, Dr K Narayana's study published in Hong Kong Dental Journal revealed that MF was located above the centre of the ramus on medial surface. He also added, "In children aged 3 years, MF is 4.12 mm below the occlusal plane; in 9 year old it has reached the occlusal plane; in adults it is 4.16 mm above the occlusal plane"<sup>3</sup>.

**FIGURE-1 showing the Occlusal Plane****Figure-1****FIGURE-2 showing the Age associated changes in the relation of Inferior Alveolar Nerve to Alveolar process of mandible****Figure-2**

Inferior alveolar nerve block (IANB) is the most frequently used local nerve block technique used in dental practice where inferior alveolar nerve is anaesthetized before it enters the mandibular foramen. A conventional IANB involves the injection of local

anaesthetic agent into the pterygomandibular space where the inferior alveolar nerve enters the mandibular foramen. Consequently, the entry in to the mandibular foramen is considered to be the key factor for the success of the IANB, and many studies have been performed to assess the exact location of the mandibular foramen for successful IANB. The mandibular foramen is mostly located at the anteroposterior midpoint and two-thirds of the length of the medial surface of the ramus, and the position changes in relation to the occlusal plane and age. For example, the position in children is lower while the position in older edentulous patients is higher. Approximately 20 to 25% of failure rate of IANB is owing to inappropriate positioning of the needle, caused by inaccurate localisation of MF5. Some important causes of IANB failure include poor anaesthetic techniques and anatomical variations such as differences in the mandibular ramus width and height, mandibular foramen position, neighbouring musculature, and adipose tissue. Other potential explanations for IANB failure include a lowered pH of inflamed tissues, nerves with altered resting potentials, anaesthetic-resistant sodium channels, and accessory innervations (mylohyoid nerve, cervical nerve, and auriculotemporal nerve) as well as the patient's anxiety level. Nevertheless, awareness about anatomy of mandibular foramen certainly is responsible for successful IANB; Alongwith it also helps in dentoalveolar surgery and endodontic treatments.

**AIMS and OBJECTIVES**

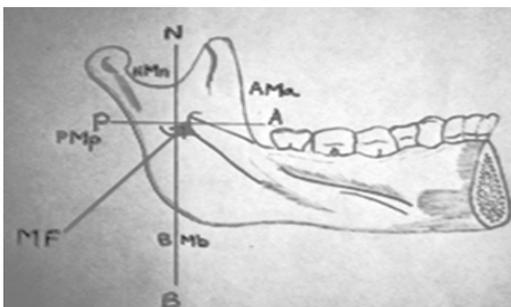
The purpose of our study was to measure the important anatomical parameters that would provide the most reliable and a predictable indicator of the exact position of Mandibular foramen. The knowledge of position of MF in relation to the occlusal plane of mandibular teeth helps the dentist to select the site of needle insertion for anaesthetizing the inferior alveolar nerve during IANB.

**MATERIALS AND METHODS**

Present study was carried out in the Department of Anatomy, Medical College, Kolkata, India for a period extending for two years from November 2015 to November 2017. A total of 100 dry human mandibles were analysed under four parameters. All the parameters were measured to the nearest millimetres by digital vernier callipers. Following four parameters were measured:-

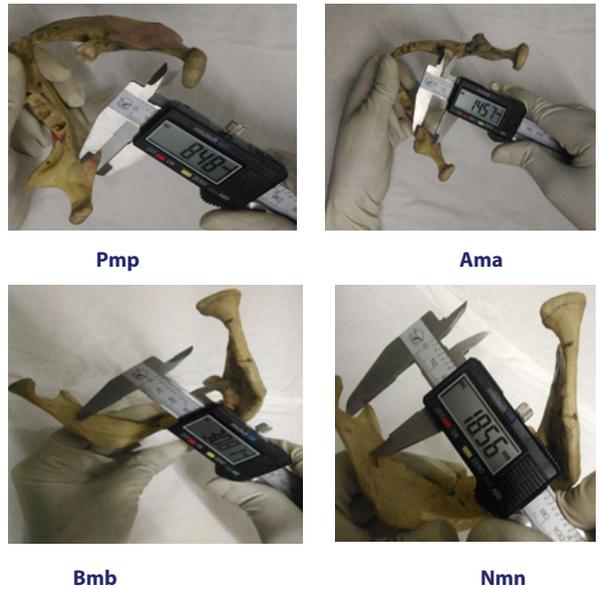
- 1) AMa :- Distance from the anterior border of the ramus of the mandible to the medial margin of mandibular foramina (MF) at lingual level.
- 2) PMp :- Distance from the posterior border of the ramus of the mandible to the lateral margin of mandibular foramina (MF) at lingual level.
- 3) Bmb :- Distance from the inferior border of the ramus of the mandible to the lower margin of mandibular foramina (MF).
- 4) NMn :- Distance from the mandibular notch to the upper margin of the mandibular foramina (MF).

FIGURE-3 showing the four parameters measured for localisation of Mandibular foramen'



**Figure-3**

PHOTOGRAPHS-Showing procedure of measuring the four parameters- 1) PMp, 2) AMa, 3) Bmb, 4) NMn



**OBSERVATIONS- Mandibular Foramen(MF) Parameters**

**HORIZONTAL MEASUREMENTS**

Parameters(mm)	AMa		PMp		
	Rt	Lt	Rt	Lt	Lt
Mean(mm)	17.06	17.17	9.75	9.80	
SD(mm)	1.65	1.65	1.68	1.55	
Total (mean)	17.12		9.78		
Total(SD)	1.65		1.62		

**II) VERTICAL MEASUREMENTS**

Parameters(mm)	Bmb		NMn		
	Rt	Lt	Rt	Lt	Lt
Mean(mm)	22.71	22.64	13.58	13.53	
SD(mm)	3.41	3.53	2.12	2.03	
Total(Mean)	22.68		13.56		
Total(SD)	3.47		2.08		

**MEAN PARAMETERS OF MANDIBULAR FORAMEN (MF) RESULTS**

To locate the mandibular foramen four specific parameters were measured. The Mean distance of Mandibular Foramen from different landmarks in (mm) as well as the standard deviation values of various parameters are shown in the following table:

<b>RIGHT SIDE</b>	<b>LEFT SIDE</b>
AMa-(17.06±1.65)	AMa-(17.17±1.647)
PMp-(9.75±1.68)	PMp-(9.80±1.546)
BMb-(22.71±3.41),	BMb-(22.635±3.53)
NMn-(13.58±2.116)	NMn-(13.52±2.026)

Present study revealed that there was no noteworthy statistical difference between the right and left side against the above mentioned parameters. More or less, bilateral symmetry of MF was observed, which is consistent with the work done by preceding researchers.

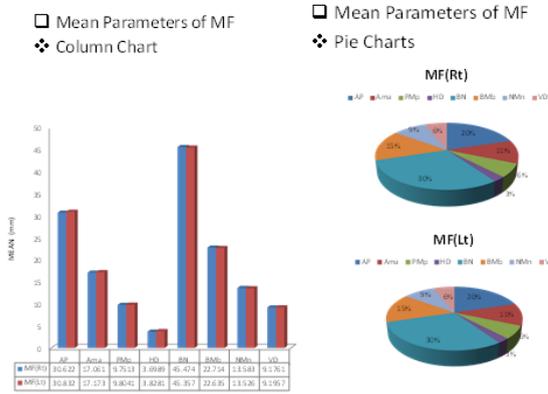
**DISCUSSION AND REVIEW OF LITERATURE**

**The Mandibular Foramen (MF) :**

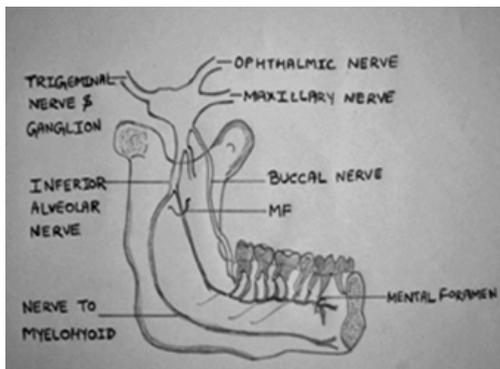
It is an irregular foramina (through which the inferior alveolar nerve bundle passes to gain access to mandibular canal) is located midway between the anterior and posterior borders of the ramus about level with the occlusal surfaces of the teeth. It is overlapped anteromedially by a thin sharp, triangular spine, the lingula, to which

the sphenomandibular ligament is attached and which is also the landmark for an inferior alveolar local anesthetic block injection<sup>1</sup>.

### OBSERVATIONS-II



The Mandibular Canal(MC):The MF leads into the mandibular canal which runs downwards and forwards within the ramus, gently curving inferiorly within the body under the roots of the molar teeth with which it communicates by small openings and ascending in the premolar region to the mental foramen. Near the mental foramen, the Inferior alveolar nerve ( IAN ) branches into Mental nerve which ultimately leaves the mandible, via the mental foramen and, the Incisive nerve, which remains within the bone and supplies the anterior teeth<sup>1</sup>. Inferior alveolar nerve (IAN) (Dental Nerve): IAN arises from posterior trunk of mandibular nerve(mainly sensory),descends behind lateral pterygoid muscle and at its lower border ,passes between sphenomandibular ligament and mandibular ramus,entering the MC via the MF, accompanied by the Inferior alveolar vessels.Just before entering the MC,IAN gives off a small myelohyoid branch, that pierces the sphenomandibular ligament and enters a shallow groove on the medial surface of mandible lying between myelohyoid and anterior belly of digastrics(supplying both of it).Also it provides slender nerve filaments to supply the skin over the point of chin.<sup>1</sup> In the MC, the IAN runs downwards and forwards, below the apices of teeth, until below the first and second premolars, it divides into terminal Incisive and Mental branches. The incisive branch continues forwards in a bony canal or in a plexiform arrangement, giving off branches to the first premolar, canine and incisor teeth, and the associated labial gingivae. The mental nerve passes upwards, backwards and outwards to emerge from the mandible via the mental foramen, between and just below the apices of the premolar teeth. It then divides into three branches, two of which passes upwards and forwards to form an incisor plexus, labial to teeth, and ends by supplying the skin of lower lip and chin.Branches of mental nerve also communicate with terminal filaments of mandibular branch of facial nerve.<sup>1</sup>



**FIGURE-4 Inferior Alveolar Nerve (Schematic Representation)**  
 Figure-4

One of the commonest local anaesthetic technique used in dental practice is IAN block but the failure rate is high due to inadequate

localization of the mandibular foramina (MF)<sup>5</sup>. The branching pattern of the inferior alveolar nerve (IAN ) may also show several variations within the mandibular canal. It may either run as single trunk giving branches to the molar and premolar teeth or give a major and minor trunk near the MF, the major trunk after traversing through the mandibular canal comes out through the mental foramen whereas the minor trunk after innervating molar and premolar teeth becomes incisive nerve. The IAN may also give branches for molar and premolar teeth, for canine and incisor teeth and for mental foramen near the chin and lower lip<sup>1</sup>.

### INFERIOR ALVEOLAR NERVE BLOCK

The inferior alveolar nerve block(IANB) or mandibular block is one of the most commonly employed techniques in mandibular regional anesthesia.In routine dentistry IANB is the anaesthesia of choice in following situations :-

- 1) Pulpal anaesthesia for extraction and restorative purpose
- 2) Lingual Periodontal anaesthesia
- 3) Facial Periodontal anaesthesia of anterior mandibular teeth and

### premolars

IANB is remarkably helpful when multiple mandibular teeth in one quadrant,(as well as buccal periodontium anterior to mental foramen), necessitate treatment. In successful IANB, local anaesthetic agent is deposited in the pterygomandibular space and alongwith inferior alveolar nerve ; lingual ,mental and incisive nerves are also anaesthetised<sup>6</sup>.

Comparison of the present study results with previous research works is shown in the following table:

Knowledge of position of mandibular foramen within the pterygomandibular space and its location on the ramus of mandible is essential for successfully accomplishing local anaesthesia of the inferior alveolar nerve using classical Halsted's method<sup>18</sup>.He used cocaine solution for IANB for the first time in 1885 .Murphy et al.(1969)<sup>18</sup> analysed the role of position of mandibular foramen in IANB, accessory foramina in the ramus of mandible and variability of lower dental innervations including the course of the inferior neurovascular bundle. Hayward et al.(1977)<sup>19</sup> reported that distance of mandibular foramen from anterior border of the ramus of mandible was greater as compared to that of the distance from the posterior border. They did not find significant differences between the size of the ramus of mandible and location of the mandibular foramen, depending on the side, sex or race.

Nicholson M (1985)<sup>20</sup> study for position of the mandibular foramen in Indians revealed its position below the bite plane of inferior teeth. He postulated that it's the variability of the position of mandibular foramen which is mainly responsible for the failure in anesthesia of inferior alveolar nerve.

Mbajiorgu (2000)<sup>21</sup> researched on mandibles of black Zimbabwean population And elucidated that frequently the mandibular foramen is variable in its position and is rarely located exactly in the middle of the ramus of mandible .

Keros et al.(2001)<sup>22</sup> defined location of mandibular foramen with respect to the mandibular notch, mandibular angle, anterior and posterior borders of ramus of mandible using orthopantomographic pictures.They used negatives obtained from patients with incomplete and complete successful anesthesia of inferior alveolar nerve. They estimated correlation between length of the mandibular axis, distance between mandibular foramen and the posterior border of the mandibular ramus, and effect of anesthesia of the inferior alveolar nerve .Das et al.(2004)<sup>23</sup> reported that mandibular foramen is placed slightly above the midpoint of the mandibular ramus.Author mentioned possible occurrence of accessory canals, most of which were localized on the medial surface of mandibular ramus.He also stated ,in a situation when they were placed on the external surface of ramus, they may serve as foramina for buccal, mylohyoid nerves, or an accessory branch of

the inferior alveolar nerve..

Wadhvani et al. (2008)<sup>24</sup> described double right-sided mandibular canal. The canal started with two openings located on the medial surface of mandibular ramus, and then united on the level of the right second molar. On the left side triple canal existed.

Authors postulated that vigilant reporting of the oral pantomographic plates should be done before going for IANB.

Juodzbalys et al.(2010)<sup>25</sup> observed possible duplication of mandibular canal during its course through the mandible, while only one mandibular foramen existed. Duplication of mandibular canal in horizontal plane limits application of orthopantomographic examinations. Authors postulated prior computer tomography of mandible, as absolutely mandatory before implantation procedures, to evaluate variability of the course of inferior alveolar nerve. Lipski et al.(2013)<sup>26</sup> postulated variability of position of mandibular foramen depending on sex of individual and explained its position within the pterygomandibular space.

AUTHORS	PARAMETERS	SIDES & MESUREMENTS(mm)							
		AMa		PMp		Bmb		NMn	
		RT	LT	RT	LT	RT	LT	RT	LT
Renato R.S Braga et al.20147	MEAN	11.36	12.26			21.68	21.22	14.76	15.30
	SD	2.376	2.728			4.103	3.716	2.756	3.193
Oguz O et al. 20028	MEAN	16.9	16.78	14.09	14.37	30.97	29.75	22.37	22.17
	SD	2.27	2.99	2.27	2.56	7.71	3.35	3.64	4.41
Kilarkaje N et al. 20059	MEAN	18.5	18.5					21.6	21.6
	SD	1.9	2.0					3.1	3.4
Ennes JP et al. 200910	MEAN	9.4-20.3	6.9-20.6	8.6-18.2	8.4-17.7			18.3-32.5	17.5-33.7
	SD								
Varma et al.11 Lavanya et al.12 2011	MEAN	16	16	13	13			20-25	20-25
	SD								
Thangavelu K et al.20122	MEAN	18.9	18.88	14.31	14.39	27.62	27.3		
	SD	2.14	2.34	1.82	1.79	4.20	4.19		
Versha Shenoy et al.201213	MEAN	16.1	16.3	11.71	11.3			23.6	23.6
	SD								
Prajnaparamita Samanta et al.201314	MEAN			13.29	12.73			22.70	22.27
	SD			1.74	2.0			3.0	2.62
Hoque et al. 201315	MEAN	16.34	16.27	14.14	14.04			22.29	22.18
	SD								

Padmavat	MEAN	16.8	16.9	11.7	12.			22.0	22.3
	SD								
B Lalitha et al. 201617	MEAN	16.52	17.77	14.05	13.90	27.41	26.76	20.14	19.85
	SD	2.25	2.51	2.191	2.35	4.16	4.14		3.15
Present study	MEAN	17.06	17.17	9.75	9.80	22.71	22.64	13.58	13.53
	SD	1.65	1.65	1.68	1.55	3.41	3.53	2.12	2.03

**CONCLUSION**

Prior knowledge of localisation parameters of MF from anterior border and occlusal plane is utilised by dental surgeon to localise precisely the inferior alveolar nerve entry into mandibular foramen,during IANB and neurectomy surgeries.Dentist can select the proper site of needle insertion in the vertical plane and associated neurovascular bundle damage can be apprehended. During anthropological assessment as well as reconstructive mandibular surgeries we need to be familiar with the anatomy of MF. Clinicians can exploit this knowledge for studying dental Xrays and modernise inferior alveolar nerve block techniques.

Our study revealed the mandibular foramen(MF) is almost always at the level of the occlusal plane or below the occlusal plane. Therefore, deposition of anaesthetic solution above the foramen level should result in complete anaesthesia of the area supplied by Inferior alveolar nerve. Present study reports localised MF as positioned at a mean distance of 17.12 mm (with SD 1.65 mm) from the coronoid notch of anterior border of ramus(there was no significant difference between the right and left side).Therefore deposition of solution should be done around 21 mm (mean 17+4 mm)from the anterior border of ramus for successful Inferior alveolar nerve block. Henceforth we conclude, though variations in the anatomic landmarks used in identifying the MF/IAN complex makes clinical delivery of IAN anaesthesia challenging ,yet its mainly the operator error (like deeper needle penetration),which is significantly responsible for failure of effective IANB.

**CONFLICTS OF INTERESTS-None**

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