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Original Article

Dentistry Section

# Evaluation of Relative Position of Mandibular Foramen in Children as a Reference for Inferior Alveolar Nerve Block using Orthopantamograph

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## ABSTRACT

**Introduction:** The Mandibular Foramen (MF) is a landmark for administering local anaesthetic solution for Inferior Alveolar Nerve Block (IANB). The position of MF shows considerable variation among different ethnicity, ages and on either sides even within the same individual. Failure to achieve IANB leading to repeated injection of the local anaesthetic solution will not only pose a behaviour problem in children but can also lead to systemic toxic level of anaesthetic solution being administered.

**Aim:** To determine the relative position of the mandibular foramen in 7 to 12-year-old children in relation to the mandibular occlusal plane and the deepest point on coronoid notch.

**Materials and Methods:** Ninety orthopantamograph of 7 to 12-year-old children were selected from the database and were divided into three groups: Group 1 (G1): seven to eight-year-old, Group 2 (G2): 9 to 10-year-old and Group 3 (G3): 11 to 12-year-old. The radiographs were traced on acetate paper, anatomical landmarks were marked and linear measurements were noted from the Mandibular Lingula (ML) to the occlusal plane, and to the deepest point on coronoid notch. The data obtained was tabulated and subjected to statistical analysis. One way ANOVA test followed by Bonferroni post hoc analysis and Student's paired t-test were used.

**Results:** Mandibular foramen is approximately, 2-3 mm above the occlusal plane and 11.6-13.0 mm from deepest point of coronoid notch for seven to eight-year-old children, 3-4 mm above the occlusal plane and 13.0-13.9 mm from deepest point of coronoid notch for 9-10 year age group and 5.5-6.5 mm above the occlusal plane and 11.9-12.2 mm from deepest point of coronoid notch for children of the ages 11-12 years. The linear distance from the deepest point of coronoid notch to the mandibular lingula showed statistical significance in G2 vs G3 on right side G1 vs G2 and G2 vs G3 on the left side. The variance of this distance for either side showed statistical significance for G1 and G2.

**Conclusion:** The distance from the mandibular lingula to the occlusal plane showed gradual increase in all the three groups, which was statistically significant. The position of the mandibular foramen is not bilaterally symmetrically for any of the considered age groups.


**Keywords:** Local anaesthetic technique, Mandibular lingula, Mandibular nerve

## INTRODUCTION

Pain control is an important aspect in behaviour management of paediatric dental patients. Local anaesthesia is still a widely used technique for pain control in paediatric dental treatment [1]. For anaesthetizing mandibular teeth, the inferior alveolar nerve has to be blocked. The landmarks considered for IANB are the external oblique ridge, coronoid notch, pterygomandibular raphe and the occlusal plane on the ipsilateral side [2]. The mandibular foramen present on the medial aspect of mandibular ramus is protected anteriorly by a bony tongue like protrusion known as mandibular lingula [3]. By following these landmarks the anaesthetic solution is delivered as close as possible to the mandibular foramen. However the mandibular foramen location shows variation among people of different ethinicity, age and even within the same individual on two sides. Many studies have been conducted analysing the position of mandibular foramen in adult population [4] but studies aiming paediatric population are scarce. According to Olsen NH, in children the mandibular foramen is at a lower level than the occlusal level of the primary teeth and therefore the injection in children has to be administered at a point lower and posterior to the position in adults [5], whereas, Benham NR recommended the administration of the local anaesthetic agent near mandibular foramen either at or slightly above the occlusal plane in primary dentition [6]. In a study conducted by Hwang TJ et al., it was concluded that the position of foramen in children is more inferoanterior compared with adults [7]. Casamassimo PS et al., mentioned that the mandibular foramen is located at the midline of the ramus and changes with age [8]. In children, repeated injection of the local anaesthetic solution due to failure of IANB can be a tedious task as it may result in a negative behaviour of the child and there exists the risk of administering the solution above the recommended safe dose.

There are only few studies whereby the location of mandibular foramen has been assessed in children of different age groups belonging to the Indian population [9]. Hence the aim of this study was to evaluate the relative position of the mandibular foramen using orthopantamograph to provide data for IANB technique in children.

## MATERIALS AND METHODS

This radiographic study was done in the Department of Paedodontics and Preventive Dentistry, Rajarajeswari Dental College and Hospital, Bengaluru, Karnataka, India. Ethical clearance was obtained prior to the commencement of the study by the Scientific and Ethical Committee of the Institution. The study was completed in a span of three months from May 2016 to July 2016 from the initial research design to the tabulation of the results. From the available database of the institution ninety Orthopantamographs (OPG) were randomly selected of children ranging from 7-year-old to 12-year-old age group. The growth and development of the mandible at the mandibular ramus results in variation of position of the mandibular foramen until the completion of growth of an individual. For a

clinician to administer IANB this anatomical landmark is of clinical significance especially when treating children, as the success of IANB depends on the exact location of the mandibular foramen of different ages in growing children unlike adults where more or less it remains the same. We have considered these age groups as only limited studies are available assessing the position of mandibular foramen in the considered age group. All the OPGs were recorded by a single orthopantamogram machine (ORTHOPHOS XG5, Sirona, Germany). Only radiographs without any gross anatomical abnormalities and with acceptable mandibular occlusal plane were included to the study. OPGs which showed poor image quality, or with anatomical abnormalities or mandibular teeth which were submerged or supra-erupted which affected mandibular occlusal plane were excluded from the study. Three groups were allocated based on the age criteria. Group 1 (G1): 7 to 8-year-old, Group 2 (G2): 9 to 10-year-old and Group 3 (G3): 11 to 12-year-old. The orthopantamographs were placed on a view-box and traced on an acetate matte paper. The tracing of the OPGs followed by the marking of points and lines was done by an initial examiner. The following anatomic points were marked: the highest point on mandibular lingula (P1), the distal most point on the crown of fully erupted distal molar (P2), and the deepest point on the coronoid notch (P3). Using the anatomic points following lines were drawn: A horizontal line passing through point (P1) and parallel to the orbital plane, a vertical line passing through point (P2), and the occlusal plane passing through the cusp tip of the fully erupted molar and that of the canine. All the points and lines were drawn on either sides [Table/Fig-1]. A second examiner was included in the study for the measurement of distances and all these distances were recorded in millimeters. The magnification factor was adjusted for all the readings.

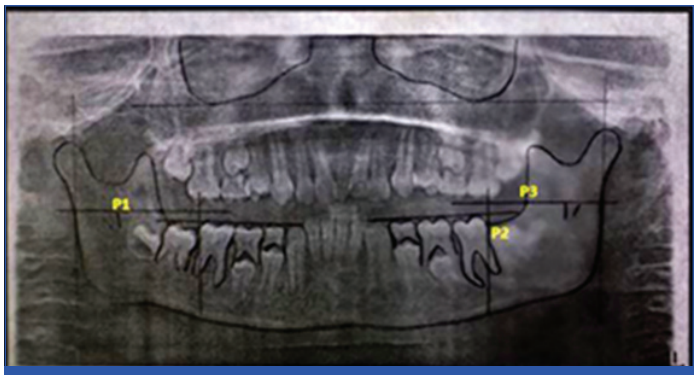
## STATISTICAL ANALYSIS

All the data of the study were tabulated and analysed using SPSS software version 22.0. One way ANOVA test followed by Bonferroni post-hoc analysis was used to compare the mean linear measurement of relative position of ML from the mandibular occlusal plane and the deepest point of the coronoid notch on either side. Student paired t-test was used to compare the relative position of the ML of both sides from the occlusal plane and the deepest point of coronoid notch in each group.

## RESULTS

On comparing the mean linear measurement of relative position of ML to the mandibular occlusal plane for both sides, statistical significance (p-value <0.001) was found among the three groups on either sides [Table/Fig-2].

The linear measurements of relative position of ML from the coronoid notch on comparison showed statistical significance between G2 vs G3 on right side and between G1 vs G2 and G2 vs G3 on the left side [Table/Fig-3]. The relative position of the ML of both sides from the occlusal plane and the deepest point of coronoid notch in each group was compared.




**[Table/Fig-1]:** An example of a traced orthopantamograph with the three anatomic points marked and the planes drawn.

**Group 1:** No statistical significance was found between both sides when the distance between ML and occlusal plane was considered. However, the distance between ML and deepest point of coronoid notch showed statistical significance among right and left side (p-value <0.001) [Table/Fig-4].

**Group 2:** No statistical significance was found among both sides when the distance between ML and occlusal plane was considered. However, the distance between ML and deepest point of coronoid notch showed statistical significance among right and left side (p-value=0.03) [Table/Fig-5].

**Group 3:** No statistical significance found among both sides when the distance between ML and occlusal plane and ML and deepest point on coronoid notch was considered [Table/Fig-6].

## DISCUSSION

Administering successful IANB is a difficult task to accomplish in paediatric patients. Major factors which lead to failure of this block in children are: accessory innervations of the mandibular dentition and the most common one, fault in the placement of the needle due to improper recognition and evaluation of anatomic landmarks [10]. The position of the mandibular foramen in children is highly influenced by the growth and development of the child. In a growing individual the mandible is seen to undergo a constant phase of remodeling. Different areas show varied differential growth pattern. The factors which play an important role in the bone remodeling process particularly at the anterior border of the ramus and the crest of the alveolar bone is the eruption and shedding of teeth; which indirectly influences the position of the mandibular foramen and hence the IANB procedure in children [9]. In this study the relative position of the mandibular foramen in paediatric population was determined by considering the occlusal plane of the mandibular teeth and the deepest point on the coronoid notch. The vertical

| RIGHT SIDE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Study Groups | N | Mean | SD | Min | Max | F | p-value | Sig. Diff | p-value |
| Group 1 | 30 | 2.3 | 2.7 | -3 | 10 | 18.479 | <0.001* | G1 Vs G3 | <0.001* |
| Group 2 | 30 | 3.7 | 1.8 | 1 | 8 | | | G2 Vs G3 | 0.001* |
| Group 3 | 30 | 5.8 | 2.2 | 1 | 10 | | | | |
| **LEFT SIDE** | | | | | | | | | |
| Study Groups | N | Mean | SD | Min | Max | F | p-value | Sig. Diff | p-value |
| Group 1 | 30 | 3.0 | 2.2 | 0 | 6.5 | 20.280 | <0.001* | G1 Vs G3 | <0.001* |
| Group 2 | 30 | 4.1 | 2.1 | 2 | 10 | | | G2 Vs G3 | <0.001* |
| Group 3 | 30 | 6.5 | 2.1 | -1 | 10 | | | | |

**[Table/Fig-2]:** Comparison of mean linear measurement (in mm) of relative position of mandibular lingula to the mandibular occlusal plane on right and left sides using one way ANOVA test followed by Bonferroni Post hoc analysis.
* - Statistically Significant
Note: G1 - Group 1; G2 - Group 2; G3 - Group 3

| RIGHT SIDE | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Study Groups | N | Mean | SD | Min | Max | F | p-value | Sig. Diff | p-value |
| Group 1 | 30 | 13.0 | 1.9 | 8 | 16 | 5.150 | 0.008* | G2 Vs G3 | 0.006* |
| Group 2 | 30 | 13.9 | 1.6 | 10 | 18 | | | | |
| Group 3 | 30 | 12.2 | 2.3 | 9 | 20 | | | | |
| LEFT SIDE | | | | | | | | | |
| Study Groups | N | Mean | SD | Min | Max | F | p-value | Sig. Diff | p-value |
| Group 1 | 30 | 11.6 | 1.7 | 8 | 15 | 6.107 | 0.003* | G1 Vs G2 | 0.004* |
| Group 2 | 30 | 13.0 | 1.8 | 7 | 15 | | | G2 Vs G3 | 0.04* |
| Group 3 | 30 | 11.9 | 1.2 | 9 | 15 | | | | |

**[Table/Fig-3]:** Comparison of mean linear measurement (in mm) of relative position of mandibular lingula to the horizontal distance from the deepest point of coronoid notch on right and left side plane using one way ANOVA test followed by Bonferroni Post hoc analysis.
* - Statistically Significant
Note: G1 - Group 1; G2 - Group 2; G3 - Group 3

| Position | Sides | N | Mean | SD | Mean Diff | t | p-value |
|---|---|---|---|---|---|---|---|
| Occlusal Plane | Right | 30 | 2.3 | 2.7 | -0.7 | -1.765 | 0.08 |
| | Left | 30 | 3.0 | 2.2 | | | |
| Deepest Point | Right | 30 | 13.0 | 1.9 | 1.4 | 4.630 | <0.001* |
| | Left | 30 | 11.6 | 1.7 | | | |

**[Table/Fig-4]:** Comparison of mean linear measurement (in mm) between the right and left side in Group 1 for relative position of mandibular lingula to the mandibular occlusal plane and horizontal plane from the deepest point of coronoid notch using student paired t test.
* - Statistically Significant

| Position | Sides | N | Mean | SD | Mean Diff | t | p-value |
|---|---|---|---|---|---|---|---|
| Occlusal Plane | Right | 30 | 3.7 | 1.8 | -0.4 | -1.373 | 0.18 |
| | Left | 30 | 4.1 | 2.1 | | | |
| Deepest Point | Right | 30 | 13.9 | 1.6 | 0.9 | 2.326 | 0.03* |
| | Left | 30 | 13.0 | 1.8 | | | |

**[Table/Fig-5]:** Comparison of mean linear measurement (in mm) between the right and left side in Group 2 for relative position of mandibular lingula to the mandibular occlusal plane and horizontal plane from the deepest point of coronoid notch using student paired t test.
* - Statistically Significant

| Position | Sides | N | Mean | SD | Mean Diff | t | p-value |
|---|---|---|---|---|---|---|---|
| Occlusal Plane | Right | 30 | 5.8 | 2.2 | -0.6 | -1.941 | 0.06 |
| | Left | 30 | 6.5 | 2.1 | | | |
| Deepest Point | Right | 30 | 12.2 | 2.3 | 0.3 | 0.753 | 0.46 |
| | Left | 30 | 11.9 | 1.2 | | | |

**[Table/Fig-6]:** Comparison of mean linear measurement (in mm) between the right and left side in Group 3 for relative position of mandibular lingula to the mandibular occlusal plane and horizontal plane from the deepest point of coronoid notch using student paired t test.

distance from the mandibular foramen to the occlusal plane gives us an approximate height of insertion of the needle to administer the local anaesthetic agent. Whereas, the horizontal distance from the deepest point of the coronoid notch to the mandibular foramen gives us its relative position in relation to the anterior border of the ramus of mandible. It was found that the mandibular foramen is approximately 2-3 mm above the occlusal plane for seven and eight-year-old children, 3-4 mm above the occlusal plane for 9 to 10-year-old age group and 5.5 to 6.5 mm above the occlusal plane for children of the ages 11 and 12 years. No statistical significance was found between left and right sides in measuring the vertical distance between the occlusal plane and the MF. This finding was similar in lines to the study conducted by Kanno CM et al., on 7 to 10-year-old Brazilian children where there was a gradual increase with age in the linear distance between mandibular lingula and the occlusal plane [11].

In the year 1976, Benham NR with the use of lateral cephalograms had analysed the distance between the mandibular foramen and the occlusal plane in children of the age group ranging from 5 to 11 years. It was concluded by him that there was no significant difference in the distance between the mandibular foramen and occlusal plane in seven to nine-year-old age group of children, however an increase in this distance was evident in 9 to 11-year-old age group [6].

Patricia do Nascimento Pereira PN et al., conducted a study on Brazilian children, suggested that in children younger than eight-year-old the needle should be inserted below the occlusal plane and those over eight years the point of insertion should be above the occlusal plane [12].

Poonacha K et al., in a study done on Indian population concluded a good success rate of IANB by placing the needle at the level of occlusal plane in children of the age group of 3 to 13 years [9].

A study by Afsar A et al., opposed to the findings of our study concluded that there was no difference in the linear distance between the mandibular foramen and the occlusal plane in terms of age and sex [13].

However, the horizontal distance from the deepest point on the coronoid notch to the mandibular foramen in our study showed an upward trend on comparing G1 vs G2 which was statistically significant on the left side. Whereas, G2 vs G3 shows statistically significant downward trend on either sides being assessed. The reason for it could be explained by the difference in regional growth at different directions of the jaws during Hellman's stages of dental development.

Tsai H reported a variation in the difference between the distance from the mandibular foramen to the anterior and posterior border of mandible in children [14].

According to Hwang TJ et al, in the children in 3, 5, 7, 9, 11 age group the mandibular foramen showed a gradual translocation from the inferior third to the middle third in accordance to the mandibular ramus height with a more anterior position from the anterior border of mandibular ramus [7].

Our study also showed that there is variance in position of the mandibular foramen on either sides in every subjects. However, this difference was not statistically significant in any of the three groups. Regarding the use of OPG in our study, it is the simplest of the modalities which has been widely used for radiodiagnosis in paediatric dentistry. In addition the radiation dose of computed tomography is higher in comparison to conventional radiographs. Many researchers like Larheim TM and Svanaes DB, and Kositbowornchai S et al., validated the use of OPG in metrical analysis as it preserves or reproduces near anatomical measurements [15,16].

## LIMITATION

The limitation of our study would be based on the fact that the radiographs were obtained from the database hence the nutritional status and the general health of each subject could not be assessed. Nutritional status and general health of the child does play an influence on his or her growth and development. This study also missed out to assess the location of mandibular foramen on the gender basis as well as on the ethnic grounds other than the South Indian population.

In future there is scope for assessing the position of mandibular foramen in children of various age groups with advanced diagnostic aids like CBCT imaging and other emerging technologies.

## CONCLUSION

From our study it can be concluded that the mandibular foramen is approximately, 2-3 mm above the occlusal plane and 11.6-13.0 mm from deepest point of coronoid notch for seven to eight-year-old children; 3-4 mm above the occlusal plane and 13.0-13.9 mm from deepest point of coronoid notch for 9-10 year age group and 5.5-6.5 mm above the occlusal plane and 11.9-12.2 mm from deepest point of coronoid notch for children of the ages 11-12 years. The position of the mandibular foramen is not bilaterally symmetrical in the considered age group.

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