Variations of Inferior Alveolar Nerve and Mental Nerve Using Cone Bean Ct-Scan, 120 Case Studies: A Research Article

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Abstract
The maxillofacial surgeon should have the precise knowledge of course of the inferior alveolar canal to overcome surgical complications outcome. Injury to the lingual nerve is more often noticed than the injury to the inferior alveolar nerve. We aimed to establish the variations of course of inferior alveolar nerve incompletely dentate patients, to identify the linear relationship of the IAC to the Buccal and Lingual cortex (BCP/LCP) of the mandible and to the peri apex of the teeth as well as to assess the presence and course of the anterior loop in the mental foramen region according to the gender and side, using Cone Beam Computerized Tomography (CBCT).Researched on 78 patients with 120 CBCT images helps in determining the variations in the course of the mandibular nerve may be important for the micro surgical anastomosis of damaged inferior alveolar nerves that occur as a result of the increase in the number of mandibular osteotomies and other reconstructive operations.

Introduction
The mandibular nerve is the largest branch of the trigeminal nerve. It originates from the foramen ovale and continues its course through the infra temporal fossa. The main distribution of the inferior alveolar nerve is to the mandibular teeth and their supporting structures, there being molar and incisive branches. An inferior alveolar nerve variation provides the knowledge for various minor and major surgical procedures, i.e. helpful while determining the pathway for ontological or neurological surgeries. Variations in the branching pattern or topographical relationships of the mandibularnerve often account for failure to obtain adequate local anesthesia for routine oral and dental procedures, and for the unexpected injury to branches of the nerve during operations [1].

Risk of inadvertent IAN injury is associated with various surgical interventions in the area including sagittal split osteotomies, dental implant insertion, bone grafting or placement of fixation screws. It has been reported that IAN damage may causes sensory deficits up to 8.3% to 77.8% depending on the type of surgery [2, 3].

Materials and Methods
This cross- sectional study is performed on 78 patients with 120 CBCT images conducted on Rama Dental College, hospital and Research Centre, Kanpur for the duration of 3 years between years Nov.2017 to 2020.

Using the axial, coronal and sagittal sections, the exact location of the position of the IAC and AMF if present, was identified for the study. Linear measurements were made in cross-sections.

Patients consent was not required as this was only data collection and analysis study. At no point patient contact was required for the study. For the same reason ethical approval also was not required.

Inclusion Criteria-
1. Completely Edentulous Patient.
2. Absence of radiological evidence of skeletal or dental malocclusion that could have altered the position of mandibular molars and premolars or IAN.

Exclusion Criteria-
1. Patients with history of trauma, pathology of mandible, congenital disorders or syndrome patients.
2. Low quality images, e.g., ones that contained scattering or insufficient accuracy of bony borders.

The measurements were distance between the lingual outer cortex to outer surface of the IAC along lingual side; distance between buccal outer cortex to outer surface of the IAC along buccal side; and distance between the peri apexes to the superior surface of IAC [Table/Fig-1].

Presence or absence of anterior loop of mental nerve, distance from medial margin of mental foramen to proximal edge of anterior loop, presence or absence of AMF and mean distance of AMF from mental foramen were also studied.

Statistical Analysis

All the above parameters were calculated in males, females and right and left side and along the second premolar, first molar and second molar of the mandible. For continuous variables range, mean and standard deviation will be calculated and for categorical variables proportion and percentage will be obtained.

Result

A total of 120 CBCT scans from 78 numbers of patients were studied. In these subjects 48 were male and 30 were females, aged 22-80 years, with mean age of 31.6 years and 34 years. The number of right side mandible scans was 64 and left side was 56.

In 10 patients, 8 AMF were detected, so its prevalence was 4.18%. Four of these subjects were male with mean age of 15.8 years and six were females with mean age of 26.4 years. Bilateral AMF were present in one male case. Mean distance of AMF from mental foramen, gender wise and sidewise is shown in **[Table-1/Figure-2]**. Anterior loop in the mental region was detected in 97% of the scans. Prevalence of anterior loop in females 6 out of 10 scans (60%) was found higher than found in males, 4 out of 10 (40%).

Table 1: Accessory Mental Foramen

Gender	Number of AMF	Mean age	Mean distance between MF and AMF on right side in mm	Mean distance between MF and AMF on left side in mm
Male	4	15.8	3.2±1mm	3.6±0.7
Female	6	26.4	2.8±1mm	2.3±0.5

The mean length from the medial margin of the Mental Foramen to the proximal edge of the anterior loop ranged from 3.12 to 3.28 mm. Anterior loop on the right side was found in 64 out of 120 (53.3%) and on the left side in 56 out of 120 cases (46.6%). The prevalence of anterior loop regarding gender in the left and right side is presented in [Table2/Figure3]

Table 2: Mean (in mm) values of distance from medial margin of mental foramen to proximal edge of anterior loop according to gender and side.

	Right		Left	
	Male	**Female**	**Male**	**Female**
Mean Length from the medial margin of the mental foramen to anterior loop	3.25	3.12	3.32	3.28

The IAC was noted to be closest to the buccal cortical plate in the region of the premolars on both sides with the mean distance of 2.8 mm [Table 3]. The canal courses toward the LCP (Lingual Cortical Plate) and the Inferior Border of Mandible (IBM) as it moves posterior toward the distal root of the second molars. Mean distance from the LCP to the canal at the level of the molars was 2.4 mm **[Table5/Figure-1].**

Table 3: Mean distance (in mm) between buccal outer cortex to outer surface of the IAC along Buccal side

	Male		Female	
	Right	**Left**	**Right**	**Left**
2^{nd} Pre-molar	2.8	2.9	2.7	2.8
1^{st} Molar	5.4	5.3	5.2	5.4
2^{nd} Molar	5.83	6.3	5.5	5.7

Table 4: Mean distance (in mm) between the peri-apex to the superior surface of IAC

	Male		Female	
	Right	**Left**	**Right**	**Left**
2nd Premolar	5.5	5.7	5.45	5.5
1st Molar	5.8	5.78	5.76	5.69
2nd Molar	5.9	5.88	5.6	5.7

Table 5: Mean distance (in mm) between the lingual outer cortex to outer surface of the IAC along lingual side

	Male		Female	
	Right	**Left**	**Right**	**Left**
2^{nd} Premolar	4.5	4.8	4.2	4.4
1^{st} Molar	3.3	3.2	3.2	3.17
2^{nd} Molar	2.88	2.9	2.4	2.6

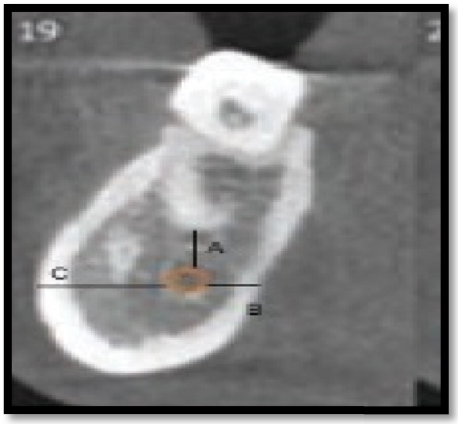

Figure:1 A-Distance Between The Peri Apex To The Superior Surface Of IAN Canal; B-Distance Between Lingual Outer Cortex To Lingual Outer Surface Of IAN Canal; C-Distance Between Buccal Outer Cortex To Outer To Buccal Outer Surface Of IAN Canal.

Table 6: Comparison between the findings of the present study and other similar studies

Studies	Total Subjects	Subjects having accessory mental foramina n (%)
Naitoh M et al., [7	365	37 (10.13%)
Katakami K et al., [12]	150	17 (11.33%)
Kalender A et al., [15]	386	25 (6.5%)
Present	120	15 (6.46%)

Table 7: Difference between the findings of the present study and other similar studies

Studies	Total subjects	Subjects having anterior loopn (%)	Mean distance from mental foramen
Apostolakis D et al., [13]	93	52 (48%)	0.89 mm
Eren H et al., [14]	328	282 (86%)	3.14 mm
Uchida Y et al., [16]	96	87 (84%)	
Edurada H et al., [17]	500	208 (41.6%)	1.1 mm
Present	120	343 (91%)	3.15 mm

Figure 2: CBCT mandible in a different contrast showing the IAC and mental foramen in relation to various anatomical landmarks

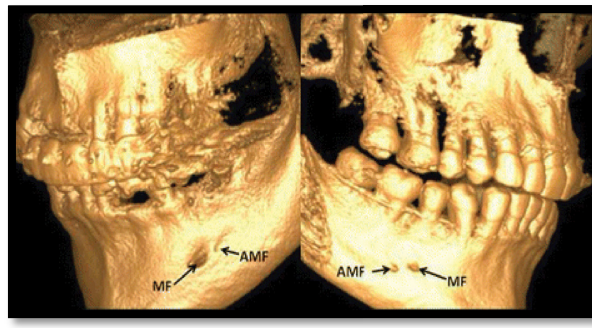

Figure 3-Accessory mental foramina and mental foramina over left and right side of mandibular body region

Discussion

The variations in the course, shape, curve, and direction of the IAN complicates the regional anatomy... The anatomy of the LN is critical for considering the complications of IANB and wisdom tooth extraction. Its course in the retro molar area and oral floor, and its communicating branches with the hypoglossal nerve arewell known [4, 5, 6]. The diameter of the LN has been given as 1.84 mm in a cadaveric study [7] and 2.54mm in an imaging study [8] at the position of the wisdom tooth

Hence, there is an increased risk of inadvertent IAN injury with various surgical interventions in the area. CBCT is the new accurate modality of imaging of the maxillofacial structures without any superimposition or magnification thus, making this study very clinically relevant.

Naitoh M et al., compared the identification of an accessory mental foramen in panoramic radiographs and in reconstruction images (CBCT) [9]. After examining the 365 patients, the authors detected 37 AMF with the aid of CBCT and only 18 accessory mental foramina on panoramic radiographs. Katakami K et al., in a study of 150 patients, observed the presence of 17 AMF by CBCT [10]. On the basis of these findings, the present study agreed with literature as 18 AMF were detected in 15 subjects, so its prevalence was 6.46%.

Apostolakis D et al., showed that, anterior loop could be identified in 48% of the cases with a mean length of 0.89 mm [11]. The present study is not in agreement with their study as anterior loop in the mental region was detected in 53.3% (63) of the scans and the mean length from the medial margin of the mental foramen to the anterior loop proximal edge ranged from 3.12-3.28mm. The difference could be because of more detailed evaluation of anterior loop and measurement. However, the results are in the line of some other studies like Eren H et al., [12]

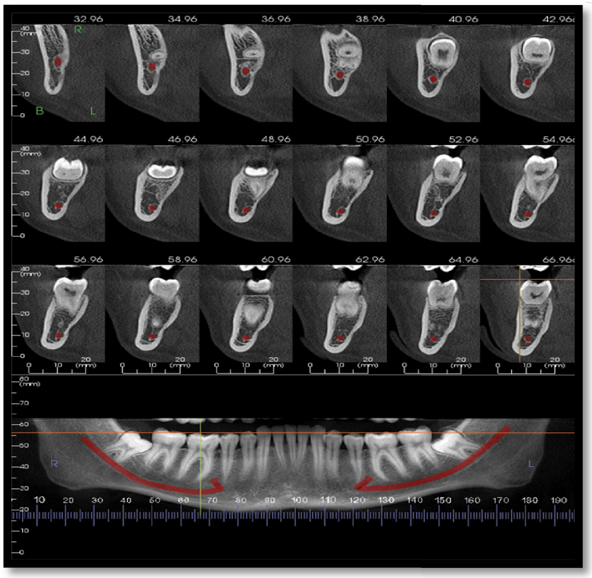

Figure 4: Anterior loop, IAC and IAN in relation to various anatomical landmarks of mandible and their precise measurements over digital scale

The study shows that the lingual cortex is thicker at the first molar level, while the buccal cortex is much thicker at the second molar level. This could be due to consistent remodeling due to the muscles attached in this region. The lohyoid line here is oriented at a higher position in 2nd molar region than 1st molar region, thus explaining the greater thickness of lingual cortex at the first molar level. On the buccal surface, the attachment of the masseter at the 2nd molar region causes the greater thickness there. The canal was closest to the second molar roots in 61.6% of the cases, on average. The difference between the right side and the left side was not remarkable, indicating that the right and left halves are mostly symmetrical. But in the literature the right half value is noted to be slightly higher than the left half values. **[Figure-4]**

Limitations

However, the sample size (number of images) taken for this study was small. Thus, the results may not be the same for general population. Also, results were correlated on the basis of gender and side but they were not correlated with occlusal load and habits of patients, as the patients were not contacted primarily. Both these factors could have affected the alveolar height and mandibular cortical width by activating the periodontal ligament and musculature involved. Systemic conditions of any patient also were not known. Hence, further studies could be done in this direction for more refinements of the results.

Conclusion

CBCT cross-sectional images are more accurate on the appearance, location and course of the canal and their relation to other anatomical structures in the jaw bone including the apex of the tooth which is very useful in preoperative assessment and planning prior to surgeries. CBCT provides an effective tool for pre-surgical evaluation of the neurovascular structures and its variations. This study will be helpful to get rid of iatrogenic injuries which tend to occur during the surgical procedure of this region, as the presence of anatomical variation is frequently neglected. Thus, the results may not be the same for general population. Also results were correlated on the basis of gender and side but they were not correlated with occlusal load and habits of patients, as the patients were not contacted primarily.

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