IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 18, Issue 12 Ser.10 (December. 2019), PP 06-11
www.iosrjournals.org

CBCT Based Anatomical Evaluation of the Anterior Loop of Mental Nerve and Variations in the Position and Course of the Inferior Alveolar Nerve: A Retrospective Study

Dr Priya S Marathe MDS (Oral Medicine and Radiology)
Flat No. 7, Anmol Apartment, Behind Fire Brigade, Shriram Nagar, Padampura, Aurangabad. 431005

Abstract:
Aims:
To detect the presence of alterations in the morphology and course of the inferior alveolar canal and determine the prevalence of anterior loop of inferior alveolar nerve and classify it according to its presence.
Method:
After the approval of ethical committee of the institution, CBCT scans were selected using simple randomized sampling techniquefrom the patients visiting the radiologist at a private dental radiology service over a period of 2 years. Inferior alveolar canal was thoroughly studied and variations in its course and configuration and presence of anterior loop were noted.
Result:
The prevalence of anterior loop was 24.0% with the mean average length of 2.83+1.89 (Mean +SD) which was near to observations by other studies. In our study we found caternary like configuration of IAC in 16.3%, which is said to be safe for the implant placement. In axial view, the sharp turn pattern of the IAC was found in 55% of cases and was considered safe for the implant placement. Specific measurements at second premolar, first, second molar had significant difference suggestive of difference of approximation of canal buccolingually and vertically, at three teeth region.
Conclusion:
There is significant variation in the course of the canal. This data will help the clinician in accurate preoperative assessment and planning of the cases prior to the surgical procedures.
Keywords: *Cone beam computed tomography, Inferior alveolar canal, Anterior loop.*

Date of Submission: 11-12-2019 Date of Acceptance: 26-12-2019

I. Introduction:

For the practice of medicine, precise knowledge of anatomy is the basic requirement. The head and neck are anatomically complex areas of the body[1]. One such critical anatomical structure is Inferior alveolar canal (IAC) in the mandible.

The IAC also poses variations in the course and configuration[2]. One such variation is anterior loop of inferior alveolar nerve. Before exiting the mental foramen, the terminal portion of inferior alveolar nerve (IAN) sometimes runs forward to the anterior border of mental foramen, returns back and exits the foramen. This part of the IAN running forward to the mental foramen is termed as the anterior loop of the inferior alveolar nerve[3]. It is the most important anatomical risk for possible damage during implant placement or surgery.

Traditionally maxillofacial radiological studies were based on two dimensional imaging techniques[4].Very few studies are done to understand the anatomy of the IAC and its variations using CBCT. Taking all these factors into consideration, study was undertaken retrospectively to comply with the radiation protection principle-As Low As Reasonably Achievable (ALARA) using CBCT. Study aimed to understand course of the IAC both in the vertical, buccolingual dimension, its variations and the presence of anterior loop.

AIMS:

1. To detect the presence of alterations in the morphology and course of the inferior alveolar canal.
2. To determine the prevalence of anterior loop of inferior alveolar nerve and classify according to its presence.

II. Materials And Methods:

Scans were selected using simple randomized sampling techniquefrom the patients visiting the radiologist at a private dental radiology service over a period of 2 years and data was retrieved from the computer database. The study was approved by ethical committee of the institution.

Materials:

Materials for this study included,the cone beam computed tomography scans of the mandible of 151 patients (total 300 IAC on each side) of PlanmecaPromax 3D MAX Cone Beam Computed Tomography unit withPlanmecaRomexis Software.

Inclusion criteria involved scans with no periapicalpathology or fracture near the mental foramen region and in the body of mandible.

Patients aged below 20 years and above 80 years of age and patients with foreign nationality were excluded from the study.

The entire statistical analysis is performed using statistical package for social sciences (SPSS, ver 16.0 for MS windows).

A. Anterior loop[2]:

1. The mental foramen was first identified and then the anterior loop was identified. Anterior loop was classified as present, bilaterally, present on the right side only, present on left side only or absent.
2. Anterior loop length determination: The axial slices were reconstructed parallel to the lower border of the mandible and on the appropriate selected axial slice, the most anterior part of mental foramen and most anterior part of inferior alveolar nerve was marked The length of the loop was measured by counting the number of the consecutive contiguous vertical cross sections of 1mm thickness performed between the anterior border of the mental foramen and the anterior border of loop. This number was multiplied by the thickness of the slices.

B. Course of the inferior alveolar canal(IAC):

The course of the inferior alveolar canal in **sagittal view** was classified into three groups according to the classification given by AylaOztuket al[5] as:

Straight Projection: The last part of the mandibular canal is almost at the same level with mental foramen.

Caternary like configuration: Curled as hanging between 2 points.

Progressive descent from posterior to anterior: IAC travels downward then levels off around molar region and ascends to reach the mental foramen at the premolar region.

In **axial view** emerging patterns of the inferior alveolar canal was observed and classified into three groups according to the classification given by AylaOztuk et al[5] namely:

A sharp turn: A canal with sharp exit

Curved existence from foramen: The nerve starting to make a curve one tooth ahead of its existence.

Straight exit: IAC almost follows a straight line axially from buccal to lingual as the canal travels anteriorly.

C. Location of the inferior alveolar canal in mandibular body:

The horizontal dimension was measured as the distance between the outer cortex of inferior alveolar canal to the buccal and lingual cortex. The vertical dimension was measured as the distance between upper border of inferior alveolar canal to the root tips of the teeth and lower border of inferior alveolar canal to lower border of mandible. All the measurements were made by placing five reference points, i.e.at the level of root tip of the second premolar and mesial and distal root tips of the first and second molars. Of the five reference points, scans having at least three reference points were selected.

III. Results:

Anterior loop:

Of total 300 assessments (Right and Left) anterior loops were detected in 72 scans (24.0%). [37 – Right sided, 35 – Left sided and 26 – Bilateral]

The mean (SD) of overall length of anterior loop was 2.83 (1.89) mm with minimum and maximum values 0.40 and 7.00, right side it was 2.01 (1.46) with minimum and maximum values 0.60 and 6.00, left side it was 3.74 (2.15) with minimum and maximum values of 1.09 and 7.00 and bilaterally it was 2.75 (1.69) with minimum and maximum values of 0.40 and 7.00.

Course of canal in sagittal view:

Of 151 right scans studied, 52 (34.4%) had Type I course of inferior alveolar canal, 26 (17.2%) had Type II course of inferior alveolar canal and 73 (48.3%) had Type III course of inferior alveolar canal in the sagittal view.

Of 149 left scans studied, 42 (28.2%) had Type I course of inferior alveolar canal, 23 (15.4%) had Type II course of inferior alveolar canal and 84 (56.4%) had Type III course of inferior alveolar canal in the sagittal view.

Course of canal in axial view:

Of 151 right scans studied, 81 (53.6%) had sharp curved exit, 52 (34.4%) had soft curved exit and 18 (11.9%) had straight path course of inferior alveolar canal in the axial view.

Of 149 left scans studied, 84 (56.4%) had sharp curved exit, 46 (30.9%) had soft curved exit and 19 (12.8%) had straight path course of inferior alveolar canal in the axial view.

Horizontal and vertical measurements:

Measurements illustrated in table no. 1 & 2.

The distribution of mean position of the canal (horizontal and vertical dimensions) of various teeth studied at various locations did not differ significantly between Right and Left sides (P-value>0.05 for all).

IV. Discussion:

Anterior loop:

Various studies have undergone where authors used various methods such as anatomical, radiographic and combined to measure the length of anterior loop of inferior alveolar nerve.Uchida et al.(2007)[3] performed a study to compare the accuracy of CBCT to that of direct measurements made on cadavers. They recorded a mean length of 2.2mm. Nascimento et al (2016)[6]evaluated CBCT scans of 250 patients (500 IAC) in their study. They reported overall prevalence of 41.6%. Prevalence of presence of anterior loop on right side was 21.5%, on left side it was 24.4% and bilaterally it was 54.1%.

Our results were fairly close to the earlier studies done by CBCT. The mean length 2.83 mm was in agreement to Uchida[3] (2.2 mm). The mean length suggests minimum safety margin to be kept in the mental foramen area during implant placement.

Also the prevalence rates of anterior loop presence on right side (24.5%), left side (23.5%) and those present bilaterally (24%) in our study were close to Nascimentoet al[6].

The discrepancies between different prevalence rates can be attributed to type of sample (cadaver, panoramic radiographs or CBCT scans), sample size, samples of different age group, sex and race and method of examination.

Course of the inferior alveolar canal:

Course of the inferior alveolar canal in the sagittal view:

In the literature, three studies by Worthington's et al (2004)[7],Liu et al(2009)[8], Oztuk A(2012)[5] et al have described the different canal patterns , however Worthington et al's[7] report did not inform about the distribution of the each topography.

In sagittal view we found slight difference between the other studies. In our study, the most common canal pattern in sagittal view found was progressive descent from the posterior to the anterior followed by straight projection. This finding was not in agreement with, study by Oztuk A et al[5], in which caternary like configuration (51.1%) was more common, followed by progressive descent from posterior to the anterior (36.7%).Probable difference in this may be related to the difference in ethnicity, where Oztuk A[5] studied dry human mandibles of varying ethnicity.

The course of the IAC in sagittal view is important as it determines the space available for the implant placement, ideal being the caternary projection followed by progressive descent from posterior to anterior with the moderate risk and straight projection with the high risk.We found 16.3% of caternaryprojection , this pattern provides more space for implant placement, especially in the first molar region compared with the premolar region and is considered more safe for the implant placement[9]. Progressive descent from posterior to anterior pattern was found in majority of the samples (52.3%). In this pattern also mental foramen is found to be at a higher level than the canal and said to have moderate risk for the implant placement. 31.3% IAC in our study had straight projection. This type of canal provides least space and considered to have high risk in implant placement[9].

The caternary projection, pattern is safe for implant placement with the maximum available space for implant.

Course of the inferior alveolar canal in the axial view:

There are very less studies which have described the IAC in the buccoligual direction.Our finding was in near agreement with the Oztuk A[5] study, where they had majority of sharp turn pattern (53.1%). When the vertical height of the alveolar crest is reduced due to bone resorption, it becomes important to know the buccolingual location of the mandibular canal. The awareness of the emerging patterns is important while

planning the treatment where canals such as curved soft exit or straight exit may pose risk to the implant placement.
The sharp turn pattern in the axial view is the safe pattern for the implant placement.

Position of the canal:
Measurements:
Many studies have been undertaken to locate and measure the mandibular canal which include anatomical studies by, Anderson et al (1990)[10],Kilic et al (2010)[11] and Radiographic studies such as Bavitz et al. (1993)[12], Levine et al(2007)[13].
Distance between outer cortex of IAC to buccal cortex:
The mean values for the measurement of the distance between the outer cortex of the IAC and the buccal cortex were, 2.94+1.05, 3.38+1.11, 3.90+1.21,4.47+1.55, 4.79+1.43 at second premolar, mesial and distal roots of first and second molar teeth respectively.The measurement revealed the greatest distance between the inferior alveolar canal and the buccal bone is at the distal root of second molar, followed by the distal and mesial root of first molar and the second premolar respectively.
Distance between outer cortex of the IAC and lingual cortex:
The mean values of the measurement of the distance between the outer cortex of the inferior alveolar canal and the lingual cortex of the mandible were 3.48+1.46, 3.11+1.25, 2.71+1.01, 2.33+0.79, 2.12+0.72 at second premolar, mesial and distal roots of first and second molar teeth respectively in millimetres. According to the measurement values shortest distance between the inferior alveolar canal and the lingual bone is at the distal root of second molar, followed by the mesial root of second molar, distal and mesial root of first molar and the second premolar respectively.
Distance between outer cortex of the IAC and root tips of the reference teeth:
The mean values for the measurement of the distance between the outer cortex of the IAC and the root tips of all the reference teeth were, 4.58+0.59, 4.18+0.58, 3.68+0.52, 3.25+0.49, 2.84+0.50 at second premolar, mesial and distal roots of first and second molar teeth respectively.The measurement revealed the greatest distance between the inferior alveolar canal and the root tips of the reference teeth is at the second premolar followed by the mesial and distal root of first molar and mesial and distal roots of second molar respectively.
Distance between outer cortex of the IAC and inferior border of mandible:
The mean values for the measurement of the distance between the outer cortex of the IAC and the inferior border of mandible were, 10.31+1.42, 9.98+1.62, 9.78+1.65, 9.61+1.73, 9.59+1.81 at second premolar, mesial and distal roots of first and second molar teeth respectively.The measurement revealed the greatest distance between the inferior alveolar canal and the inferior border of mandible is at the second premolar followed by the mesial and distal root of first molar and mesial and distal roots of second molar respectively.
Our study showed decrease in distance of IAC from inferior border of mandible at second molar level which was in agreement with study by U Nair et al[14]. The differences in measurements may be attributed to type of sample, age, sex and race of subjects.

On considering the vertical dimensions, canal is closest to the roots of teeth in molar region. The canal position is highest in premolar region and lowest in second molar region from inferior border of mandible. This finding can be a guide in case of absence of teeth where inferior border of mandible can be considered as a reference point.

To summarize, the prevalence of anterior loop was 24.0% with the mean average length of 2.83+1.89. Also we found caternary like configuration in 16.3% in sagittal view & in axial view, the sharp turn pattern was found in 55% which are considered safe for the implant placement.

The linear measurements suggest that, there is no significant difference between the right and the left sides owing to similarities between the sides. Specific measurements at second premolar, first, second molar had significant difference suggestive of difference of approximation of canal buccolingually and vertically, at three teeth region.

V. Conclusion:

The numerical data provided the range of location of the IAC buccolingually and superoinferiorlyand there was significant difference. This data will help the clinician in accurate preoperative assessment and planning of the cases prior to the surgical procedures. The following conclusions can be drawn:

- There is significant variation in the course of the canal.
- Significant prevalence of anterior loop is present which sometimes continues as incisive canal in the anterior mandible. Hence the mesial distance from the mental foramen where endosseous implants can be placed safely should be determined pre operatively in each individual case.
- The buccolingual measurements suggests lingual placement of canal with respect to molar teeth.

- The vertical measurements suggests upward course of canal in molar region with distal root of second molar being closest to the canal.

References:

[1]. DrakeRL,VoglW,MichaelAWM.Grays anatomy for students.1st ed.Newyork:Elsevier;2006.p.1,747.
[2]. Apostolakis D, Brown J. The anterior loop of the inferior alveolar nerve: prevalence, measurement of its length and a recommendation for interforaminal implant installation based on cone beam CT imaging. Clin Oral Implants Res. 2012; 23:1022-1030.
[3]. Uchida Y, Yamashita Y, Goto M, Hanihara T. Measurement of anterior loop length for the mandibular canal and diameter of the mandibular incisive canal to avoid nerve damage when Installing endoseous implants in the interforaminal region. J Oral Maxillofac Surg. 2007;65:1772–1779.
[4]. White SC, Heslop EW, Hollender LG et al. Parameters of radiologic care: An official report of the American Academy of Oral and Maxillofacial Radiology. Oral Surg Oral Med Oral Pathol Oral RadiolEndod 2001;91:498-511.
[5]. Oztuk A, Anitha P, Alexander R. Position and course of the mandibular canal in skulls. Oral surg Oral med Oral pathol Oral RadiolEndod 2011Feb;20:1-6.
[6]. NascimentoEduarda HL , AnjosPontual ML, AnjosPontual A, da Cruz Perez DE, Figueiroa JN, Gomes Frazão MA, de Moraes Ramos-Perez FM. Assessment of the anterior loop of the mandibular canal: A study using cone-beam computed tomography. Imaging Science in Dentistry. 2016; 46: 69-75.
[7]. Worthington P. Injury to the inferior alveolar nerve during implant placement: a formula for protection of the patient and clinician. Int J Oral Maxillofac Implants;19:731-734.
[8]. Liu T, Xia B, Gu Z. Inferior alveolar canal course: a radiographic study. Clin. Oral Impl Res 2009;20:1212–1218.
[9]. Lopez AB, Diago MP. Failure of locoregionalanesthesia in dental practice. review of the literature. Oral Patol Oral Cir Bucal 2006;11:510-513.
[10]. Anderson LC, Kosinski TF, Mentag PJ. A review of the intraosseous course of the nerves of the mandible. J Oral Implant 1991;17:394–403.
[11]. Kilic C, Kamburoglu K, Ozen T, Balcioglu HA, Kurt B, Kutoglu T, Ozan H. The position of the mandibular canal and histologic feature of the inferior alveolar nerve. Clin. Anat 2010; 23:34–42.
[12]. Bavitz JB, Harn SD, Hansen CA, Lang M. An anatomical study of mental neurovascular bundle-implant relationships. Int J Oral Maxillofac Implants. 1993;8: 563–567.
[13]. Levine MH, Goddard AL, Dodson TB. Inferior Alveolar Nerve Canal Position: A Clinical and Radiographic Study. J Oral MaxillofacSurg 2007;65:470-474.
[14]. U. Nair, Yazdi MH, Nayar GM, Parry H, Katkar RA, Nair MK. Configuration of the inferior alveolar canal as detected by cone beam computed tomography. J of Cons Dent. Nov-Dec 2013.Vol 16.Issue 6.

Table No. 1The measurement values of the position of the canal at second pre-molar, first and second molar teeth region in millimetres (Horizontal dimensions).

	Tooth	Location	Side	n	Mean	SD	Min - Max	T-Value	P-value
Buccal cortex	2nd Pre-Molar	Root Tip	Right	134	2.93	1.09	1.60 – 6.16	-0.219	0.827^{NS}
			Left	128	2.96	1.02	1.55 – 6.10		
			All	262	2.94	1.05	1.55 – 6.16		
	1st Molar	Mesial Root	Right	128	3.34	1.14	1.94 – 7.60	-0.498	0.619^{NS}
			Left	130	3.41	1.09	1.24 – 6.90		
			All	258	3.38	1.11	1.24 – 7.60		
	1st Molar	Distal Root	Right	128	3.88	1.26	1.90 – 8.60	-0.185	0.854^{NS}
			Left	130	3.92	1.16	1.92 – 7.42		
			All	258	3.90	1.21	1.90 – 8.60		
	2ndMolar	Mesial Root	Right	129	4.50	1.61	2.08 – 9.60	0.313	0.754^{NS}
			Left	126	4.44	1.49	2.12 – 9.60		
			All	255	4.47	1.55	2.08 – 9.60		
	2nd Molar	Distal Root	Right	129	4.81	1.44	3.00 – 10.81	0.135	0.893^{NS}
			Left	126	4.78	1.42	2.34 – 11.20		
			All	255	4.79	1.43	2.34 – 11.20		
Lingual cortex	2nd Pre-Molar	Root Tip	Right	134	3.43	1.45	1.50 – 8.81	-0.571	0.568^{NS}
			Left	128	3.53	1.47	1.60 – 9.20		
			All	262	3.48	1.46	1.50 – 9.20		
	1st Molar	Mesial Root	Right	128	3.15	1.26	1.64 – 9.23	0.575	0.566^{NS}
			Left	130	3.06	1.24	1.23 – 9.21		
			All	258	3.11	1.25	1.23 – 9.23		
	1st Molar	Distal Root	Right	128	2.72	1.03	1.20 – 5.87	0.276	0.783^{NS}
			Left	130	2.69	0.99	1.01 – 6.00		
			All	258	2.71	1.01	1.01 – 6.00		
	2ndMolar	Mesial Root	Right	129	2.35	0.84	1.00 – 5.27	0.300	0.764^{NS}
			Left	126	2.32	0.74	1.20 – 5.21		
			All	255	2.33	0.79	1.00 – 5.27		
	2nd Molar	Distal Root	Right	129	2.13	0.74	1.00 – 4.60	0.320	0.749^{NS}
			Left	126	2.10	0.71	1.00 – 4.76		
			All	255	2.12	0.72	1.00 – 4.76		

Table no. 2:The measurement values of the position of the canal at second pre-molar, first and second molar teeth region in millimetres (Vertical dimensions).

	Tooth	Location	Side	n	Mean	SD	Min - Max	T-Value	P-value
Superior border of IAC to root tip	2nd Pre-Molar	Root Tip	Right	134	4.54	0.61	1.60 – 6.21	-1.186	0.237^{NS}
			Left	128	4.63	0.58	3.60 – 6.80		
			All	262	4.58	0.59	1.60 – 6.80		
	1st Molar	Mesial Root	Right	128	4.15	0.54	2.83 – 6.00	-0.696	0.487^{NS}
			Left	130	4.20	0.61	2.40 – 6.19		
			All	258	4.18	0.58	2.40 – 6.19		
	1st Molar	Distal Root	Right	128	3.69	0.51	2.83 – 5.76	0.363	0.717^{NS}
			Left	130	3.67	0.53	2.40 – 5.14		
			All	258	3.68	0.52	2.40 – 5.76		
	2nd Molar	Mesial Root	Right	129	3.26	0.49	2.15 – 4.82	0.455	0.650^{NS}
			Left	126	3.23	0.48	2.00 – 5.14		
			All	255	3.25	0.49	2.00 – 5.14		
	2nd Molar	Distal Root	Right	129	2.87	0.48	1.65 – 4.10	0.873	0.383^{NS}
			Left	126	2.81	0.52	1.22 – 4.79		
			All	255	2.84	0.50	1.22 – 4.79		
Inferior border of IAC to inferior border of mandible	2nd Pre-Molar	Root Tip	Right	134	10.27	1.47	5.60 – 13.69	-0.481	0.631^{NS}
			Left	128	10.36	1.37	5.83 – 13.00		
			All	262	10.31	1.42	5.60 – 13.69		
	1st Molar	Mesial Root	Right	128	10.00	1.67	4.13 – 13.08	0.201	0.841^{NS}
			Left	130	9.96	1.58	5.10 – 12.53		
			All	258	9.98	1.62	4.13 – 13.08		
	1st Molar	Distal Root	Right	128	9.86	1.64	5.12 – 12.85	0.835	0.404^{NS}
			Left	130	9.69	1.66	5.12 – 12.86		
			All	258	9.78	1.65	5.12 – 12.86		
	2ndMolar	Mesial Root	Right	129	9.62	1.71	4.20 – 12.49	0.033	0.973^{NS}
			Left	126	9.61	1.76	4.00 – 12.46		
			All	255	9.61	1.73	4.00 – 12.49		
	2nd Molar	Distal Root	Right	129	9.54	1.85	4.18 – 13.30	-0.471	0.638^{NS}
			Left	126	9.65	1.78	4.01 – 12.85		
			All	255	9.59	1.81	4.01 – 13.30		

Dr Priya S Marathe MDS. "CBCT Based Anatomical Evaluation of the Anterior Loop of Mental Nerve and Variations in the Position and Course of the Inferior Alveolar Nerve: A Retrospective Study." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 18, no. 12, 2019, pp 06-11.