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Evaluation of Mental Foramen and Frequency of Anterior Looping Using Cone Beam Computed Tomograghy (CBCT): A Retrospective Study

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KEYWORDS

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ABSTRACT:

Aim: To evaluate position,size,shape of mental foramen and frequency of anterior looping.

Objectives: To evaluate various observation of Mental Foramen,to evaluate the age group and sex on the location,size,shape of the Mental Foramen and frequency of anterior Loop using CBCT.

Material And Methods: 160 CBCT scan,divided into Males and Females between age groups 20 to 60yrs

Results: Revealed Mental Foramen commonly located at Position 4, The average MF height was 2.2 mm(ranges from 1.0- 4.2mm) and male have higher values then female,distance A observed 6.59mm,Distance B observed 13.29mm,Distance C12.37 mmcommonly seen shape of mental foramen is round.and frequency of anterior looping ranges from 7.3-13% of cases.

Conclusion: Position of mental foramen predominantly apical to the long axis of the second premolar Average mental foramen size and distance C are higher in men with frequency of anterior looping 7.3-13%.

INTRODUCTION

Mandible is the strongest and largest bone of face.The mandibular nerve (V3) originates from the trigeminal nerve enters the mandibular foramen, which is located at the medial aspect of the ramus and horizontally forward in the body, along with the inferior alveolar artery and vein. The inferior alveolar nerve (IAN) proceeds downward and forward through the mandibular canal, from the lingual to the buccal aspect of the mandible.In the mental canal, the nerve proceeds upward and emerges from the mental foramen located mostly next to the second premolar apex, along with blood vessels[1]. The mental nerve exiting the mental foramen supplies skin of the mental area, a lower lip, mucous membrane, and gingiva[2]

Mental foramen[MF] is situated in anterolateral aspect of body of mandible. It is usually located between the lower premolars[3]

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The morphology of the mandible undergoes variations from birth onwards and till old age. In children it is situated below deciduous 1st Molar,in adults between 1st and 2nd premolars and in old age due to resorption and loss of teeth, mental foramen moves upwards closer to alveolar ridge[4]

The shape of Mental foramen is usually round,oval and irregular[5].**Mbajiorgu et al.** found the shape of the mental foramen round in 43.7% and oval in 56.3% of the mandibles[6]

Size of mental foramen is calculated by measuring horizontal and vertical distance[7].**Oguz and bozkir** in 2002 stated that horizontal dimension of MF was 2.93 on right side and 3.14 mm on left side and vertical dimension was 2.38 and 2.64mm on right and left siderespectively[8]

In literature various anatomical structure are seen in mandible one of them is mandibular canal[MC]. The MC is located close to the lingual surface of the bone reaches the mesial surface of the mandibular first molar, from where it becomes more buccally and its termination in the mental foramen.Relation between mandibular canal and mental foramen have been categories into 3 pattern i.e Linear, perpendicular and anterior looping. The portion of inferior alveolar nerve present straight to the mental foramen, prior to exiting the canal is referred to as the straight or linear pattern of the mandibular canal.The portion of inferior alveolar nerve present forming right angle to the mental foramen, prior to exiting the canal is referred to as the perpendicular pattern of the mandibular canal and The portion of inferior alveolar nerve present anteriorly to the mental foramen, prior to exiting the canal is referred to as the anterior loop (AL) of the mandibular canal[9]

Morphometric evaluations of the MF have shown interest,in various specialties like endodontics, implantology, and surgery etc because correct localization of the MF is important for procedures such as periapical surgery, incision, flap thickness, and administration of local anesthesia Also locating the MF is critical for surgical procedures such as removal of blocks for bone grafting, placement of plates for fixation of fractures, mentoplasty, orthognathic surgeries and dental implant[10]

To visualize mental foramen and mandibular canal various radiographical techniques were used. Due to various drawbacks of 2Dimension technique CBCT a 3Dimension visualization is used as it limits the image elongation and provide good resolution of area of interest free from excess magnification[11]

The aim of the study determine the position, size, distance, shape of MF and frequency of anterior loop(AL) using CBCT. Objectives is to evaluate various observation of Mental Foramen by Cone Beam Computed Tomography,to evaluate the age group and sex on the location,size,shape of the Mental Foramen and frequency of anterior Loop using CBCT

MATERIAL AND METHOD

This retrospective,observational,comparative study was approved by our institution's Research Ethics Committee. A total 350 CBCT examinations were available,from which 160 were selected for evaluation after application of the following exclusion criteria: (1) Teeth i.e 1st 2nd Premolars and 1st Molar missing around the Mental Foramen area.(2)Any Periapical pathology in the area of interest.(3)Patient with poor bone support around the Premolars, 1st Molar and Mental Foramen.(4)Patient with systemic diseases(arthritis,osteoporosis)(5)Patient with habit of bruxism. Of these,54 were female and 32 were male. Patient ranged from 21-60yrs.The scans were obtained from CS 8100 3D Select scanner under fixed parameters (60-90kv, 2-15mA, exposure time 07-15 seconds). Gray scale 16384-14 bits, Maximum field of view (FOV) was 8 x 5"

Statistical Analysis done using IBM SPSS Software version 26 Fischer Exact Test(to assess the association between Categorical Variable) and One Way- ANOVA(is used to determine the effect of means between dependent and independent variables)

For standardization of tomographic evaluations, acquiredimages were analyzed by two radiologistsobtained at twodifferent time points. For both sexes and all age groups, all images were evaluated according to the following parameters:MF position, MFsize,shape Distance A, Distance B, and Distance C and frequency of anterior looping.

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CBCT scanned images selected for the study divided into male and female groups and sub-groups with 4 different age groups 21-30yrs,31-40 yrs,41-50 yrs and 51-60yrsTo evaluate the horizontal position of the MF, six locationswere analyzed: Position 1 (anterior to the long axis of thefirst lower premolar (LPM)), Position 2 (in line with the longaxis of the first LPM), Position 3 (between the long axes of the first and second LPMs), Position 4 (in line with the long axisof the second LPM), Position 5 (between the long axes of thesecond LPM and the first molar), and Position 6 (in line withthe long axis of the mesial root of the first lower molar).(Figure1)

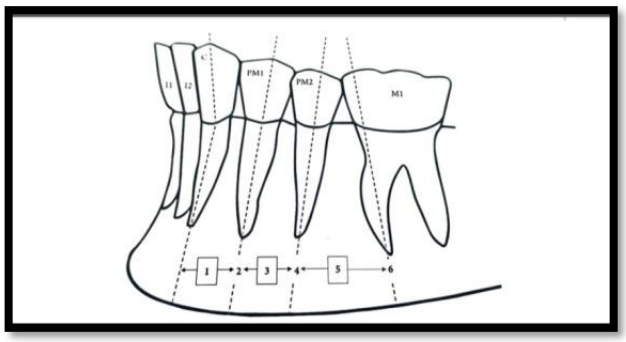

Figure 1

Size of mental foramen is measured in sagittal view selected from the multiplanarreconstructions to better visualize the MF.Height of Mental Foramen is calculated by measuring vertical measurement between cortical border of Mental Foramen&Length of mental Foramen is calculated by measuring horizontal measurement between the cortical border of Mental Foramen(Figure 2)

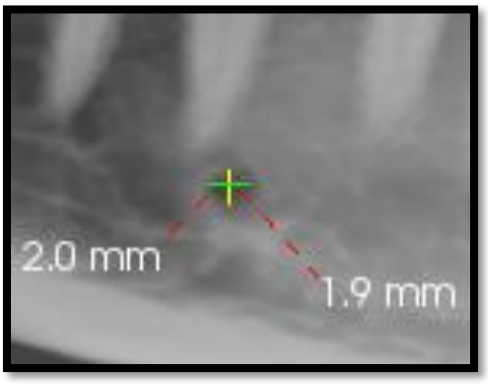

Figure 2

Distance was analyzed in the coronal view to identify the area corresponding to the opening of the MF.The distance from the upper limit of the MF to the apex of the first LPM was designated “Distance A”(figure 3) The distance from the upper cortical border of the MF to the alveolar crest was designated “Distance B.”(Figure 4). The distance from the border of the MF to the base of the mandible was designated “Distance C.”(Figure 5)

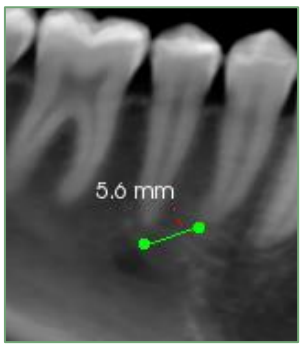

Figure 3

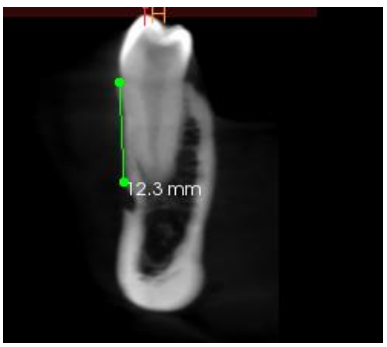

Figure 4

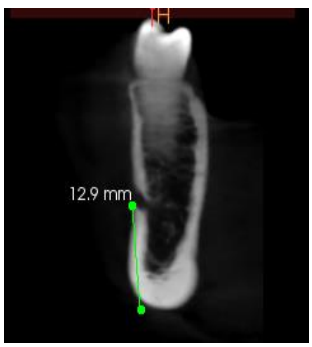

Figure 5

Shape of Mental Foramen is assessed by viewing its symmetry as oval and round .The prevalence of anterior looping was assessed by classifying inferior alveolar canal into three patterns as linear,perpendicular and anterio looping(figure 6,7,8)

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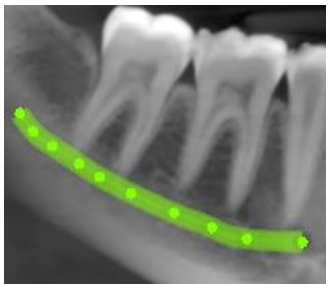
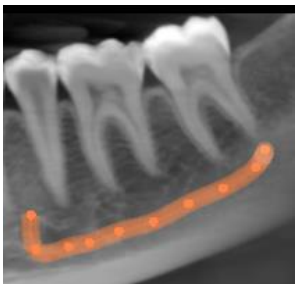
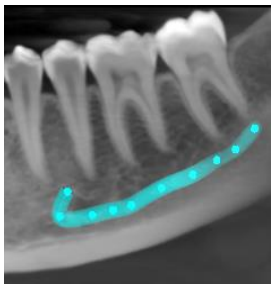

Figure 6 **Figure7** **Figure 8**

RESULTS

The frequency distribution of measurements in the total sample according to sex and age groups is shown in Table 1

Table 1:sample frequency distribution by sex and age

Age Group	Sex		Total N(%)
	Female n(%)	Male n(%)	
21-30 yrs	23(62.2%)	14(37.8%)	37
31-40 yrs	13(61.9%)	8(38.1%)	21
41-50 yrs	12(66.7%)	6(33.3%)	18
51-60 yrs	6(60%)	4(40%)	10
total	54	32	86

The distribution of MF location according to sex and age group of right side is shown in Table 2. There were no significant difference between sexes(p=0.138) and age group(p=(P=0.996)

With regards to the location of the MF,39 MF(47.5%) were located In line with the long axis of the 2nd LPM (Position 4),31MF(37.8%) were located Between long axis of lower 1st and 2nd premolar (Position 3),11 MFs(18.4%)were located between the long axes of the 2nd LPM and mesial root of 1st molar (Position 5),only 1 MF (1.2%) was located in line with the long axis of the first LFM(Position 2) and no MF observed located anterior to long axis of 1st PM and along Long axis of mesial root of lower 1st molar(i.e Position 1 and Position 6 respectively)

Position	Sex		Age Group			
	Female	Male	21-30y	31-40y	41-50y	51-60y
1	0	0	0	0	0	0
2	1(100%)	0	1	0	0	0
3	20(64.5%)	11(35.5%)	13	8	7	3
4	22(56.4%)	17(43.6%)	15	10	9	5
5	10(90.9%)	1(9.1%)	6	2	2	1
6	0	0	0	0	0	0

There is no significance difference in MF location between the sexes(P= 0.297) and age groups(P= 0.897) of left side as shown in table 3

Position	Sex		Age Group			
	Female	Male	21-30y	31-40y	41-50y	51-60y
1	0	0	0	0	0	0
2	1(50%)	1(50%)	1	1	0	0

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3	20(58.8%)	14(41.2%)	13	9	7	5
4	21(56.8%)	16(43.2%)	16	8	9	4
5	5(100%)	0(%)	4	0	1	0
6	0	0	0	0	0	0

The average MF height of right side was 2.2 mm(ranges from 1.0- 4.2mm) shown in table 6.there is a significant difference in average MF heights between the sexes(p=0.005),and the average values were higher in male patients than in female patients(2.4mm in men while 2.06mm in female) however ,there was no significant difference between the age groups (P=0.248) of right side as shown in table 4

Table 4 Height of MF Right side

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
21-30 yrs	35	2.048571	.6805583	.1150354	1.814791	2.282351	1.0000	3.9000	
31-40 yrs	21	2.300000	.5468089	.1193235	2.051096	2.548904	1.0000	3.0000	P=0.248
41-50 yrs	18	2.300000	.5871166	.1383847	2.008034	2.591966	1.0000	3.2000	
51-60 yrs	9	2.444444	.7666667	.2555556	1.855132	3.033757	2.0000	4.2000	
Female	54	2.066667	.6448636	.0877548	1.890653	2.242681	1.0000	4.2000	
Male	29	2.475862	.5610291	.1041805	2.262458	2.689266	1.8000	3.9000	P=0.005

The average MF height of left sidewas 2.28 mm(ranges from 1.0- 4.0mm).there is a significant difference in average MF heights between the sexes(p=0.013),and the average values were higher in male patients than in female patients(2.4mm in men while 2.1mm in female) however ,there was no significant difference between the age groups (P=0.336) of right side.as shown in table 5

Table 5 height of MF of left side

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
21-30 yrs	34	2.252941	.5281387	.0905750	2.068665	2.437217	1.0000	3.5000	P=0.336
31-40 yrs	17	2.476471	.8089572	.1962009	2.060543	2.892398	1.0000	4.0000	
41-50 yrs	17	2.117647	.4639980	.1125360	1.879081	2.356213	1.0000	3.0000	
51-60 yrs	9	2.333333	.4123106	.1374369	2.016403	2.650263	2.0000	3.0000	
Female	46	2.147826	.4810817	.0709316	2.004962	2.290690	1.0000	3.3000	P=0.013
Male	31	2.480645	.6625302	.1189939	2.237627	2.723663	1.0000	4.0000	

The average MF width of right sidewas 2.2mm(ranges from 1.0- 4.6mm) shown in table 8.there is no significant difference in average MF width between the sexes(P=0.201),and between the age groups (p = 0.47)as shown in table 6

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Table 6 width of MF OF right side

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
21-30	35	2.117143	.6740945	.1139428	1.885583	2.348702	1.0000	4.0000	
31-40	21	2.385714	.5303638	.1157349	2.144296	2.627133	2.0000	3.9000	P= 0.470
41-50	18	2.172222	.6506156	.1533516	1.848679	2.495766	1.0000	3.3000	
51-60	9	2.355556	.9632122	.3210707	1.615165	3.095946	1.4000	4.6000	
Female	54	2.153704	.7306531	.0994293	1.954274	2.353134	1.0000	4.6000	P=0.201
Male	29	2.351724	.5282185	.0980877	2.150801	2.552648	2.0000	3.5000	

The average MF width of left side was 2.3mm(ranges from 1.0- 5.0mm) shown in table 9.there is significant difference in average MF width between the sexes (P=0.042)male have higher values then female ,and no significant difference between the age groups (P= 0.438)as shown in table 7

Table 7 width of MF OF left side

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
21-30	34	2.202941	.5066140	.0868836	2.026175	2.379707	1.0000	4.0000	
31-40	17	2.482353	1.0684307	.2591325	1.933017	3.031689	1.0000	5.0000	P= 0.438
41-50	17	2.247059	.4109709	.0996751	2.035757	2.458361	2.0000	3.0000	
51-60	9	2.477778	.5953524	.1984508	2.020149	2.935406	2.0000	3.5000	
Female	46	2.180435	.4768506	.0703078	2.038828	2.322042	1.0000	4.0000	
Male	31	2.493548	.8453542	.1518301	2.183470	2.803627	1.0000	5.0000	P=0.042

Distance A observed was 6.59mm (ranges from 1.00mm- 14.0mm)in both the sexes and age groups.no significant difference observed between the sexes(p=0.355) or between the age groups(p=0.654), Distance B was 13.29mm(range:8.8mm-19mm) no significant differences in the measurement were found between the sexes(P=0.104)or between the age groups(P=0.652) and distance C observed 12.37mm. a significant differences in this distance was found between the sexes(men 12.1mm and female 12.8mm)but not between the age groups as shown in table 8 of right side

Table 8 Distances measured of right side

		N	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
	21-30 yrs	35	6.200000	2.9540600	5.185245	7.214755	1.0000	12.0000	
Distance A	31-40 yrs	20	6.760000	2.5377985	5.572274	7.947726	.0000	10.8000	P= 0.654
	41-50 yrs	18	6.711111	3.4533682	4.993792	8.428431	1.0000	14.0000	
	51-60 yrs	9	7.500000	1.9039433	6.036500	8.963500	5.0000	11.0000	
	Female	53	6.809434	2.9082948	6.007809	7.611059	1.0000	14.0000	P=0.355
	Male	29	6.193103	2.7869506	5.133004	7.253203	.0000	11.0000	
Distance B	21-30	35	13.17714	2.3727727	12.362067	13.992219	8.8000	19.0000	
	31-40	20	12.99500	1.7869336	12.158689	13.831311	10.0000	17.0000	P=0.652
	41-50	18	13.52777	1.5384505	12.762724	14.292831	11.0000	16.0000	
	51-60	9	13.95555	2.4835011	12.046568	15.864544	11.0000	19.0000	

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	Female	53	13.01886	2.1651129	12.422089	13.615647	8.8000	19.0000	P=0.104
	Male	29	13.80000	1.8289341	13.104311	14.495689	10.0000	19.0000	
	21-30	35	12.35142	1.7722321	11.742646	12.960212	8.0000	16.2000	
Distance C	31-40	20	12.81500	1.2252927	12.241545	13.388455	10.0000	14.0000	
	41-50	18	12.21111	1.2727409	11.578192	12.844030	10.0000	14.0000	P=0.430
	51-60	9	11.85555	1.8460167	10.436581	13.274530	8.0000	14.0000	
	Male	53	12.12641	1.4471658	11.727527	12.525303	8.0000	14.0000	
	Female	29	12.84137	1.6736439	12.204759	13.477999	8.0000	16.2000	P=0.046

Distance A observed was 6.25 mm of left side(ranges from 1.00mm- 14.0mm)in both the sexes and age groups .no significant difference observed between the sexes(P=0.533) or age groups(p=0.710).distance b observed 13.05mm(range:8.6mm-19.1mmNo significant differences in the measurement were found between the sexes(P=0.104)or between the age groups(P=0.652) and Distance C observed(12.5mm) of left side.No significant differences in this distance was found between the sexes and between age groups were found shown in Table 9

Table 9 Distances measured of left side

		N	**Mean**	**Std. Deviation**	**95% Confidence Interval for Mean**		**Minimum**	**Maximum**	
					Lower Bound	**Upper Bound**			
	21-30 yrs	34	5.870588	2.9443865	4.843243	6.897933	1.0000	12.0000	
DISTANCE A	31-40 yrs	18	6.494444	2.3382930	5.331639	7.657250	.0000	9.1000	P=0.710
	41-50 yrs	17	6.400000	3.4416566	4.630463	8.169537	1.0000	14.0000	
	51-60 yrs	9	6.988889	2.0386542	5.421841	8.555937	4.0000	11.0000	
	Female	47	6.095745	2.8318804	5.264273	6.927216	1.0000	14.0000	P=0.533
	Male	31	6.506452	2.8344236	5.466777	7.546127	.0000	11.5000	
	21-30	34	12.93529	2.1973651	12.168597	13.701991	8.6000	19.1000	
DISTANCE B	31-40	18	13.28333	1.4721932	12.551229	14.015438	10.0000	17.0000	P= 0.856
	41-50	17	12.87647	1.8095336	11.946094	13.806847	10.0000	16.0000	
	51-60	9	13.42222	2.6470634	11.387509	15.456935	11.0000	19.0000	
	Male	47	12.67872	1.8676812	12.130352	13.227095	8.6000	19.0000	P= 0.038
	Female	31	13.63548	2.0836744	12.871186	14.399782	10.0000	19.1000	
	21-30	34	12.624	1.7804	12.002	13.245	8.1	16.0	
DISTANCE C	31-40	18	13.211	1.2073	12.611	13.811	11.0	16.0	P=0.093
	41-50	17	12.259	1.1527	11.666	12.852	10.0	14.0	
	51-60	9	11.700	1.8358	10.289	13.111	8.0	14.0	
	Male	47	12.360	1.5272	11.911	12.808	9.0	16.0	P=0.144
	Female	31	12.897	1.6418	12.295	13.499	8.0	16.0	

Maximum shape observed were round in shape. With regards to pattern of MC 39 linear pattern,38 perpendicular pattern and 6 Anterior loop pattern were observed of right side and 42 linear pattern, 25

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perpendicular pattern,10 Anterior loop pattern were observed according to age groups and gender according to age groups and gender of left side shown in table 10

Table 10 frequency of anterior looping of right and left side

Age group	R/L OF Right			P value	Relation of left			P value
	Linear	Perpendicular	Anterior Looping		Linear	Perpendicular	Anterior looping	
21-30	14	18	3		17	13	4	
31-40	7	12	2	0.154	10	6	1	0.771
41-50	10	7	1		9	4	4	
51-60	8	1	0		6	2	1	
Total	39	38	6		42	25	10	
Male	15	12	2		17	9	5	
female	24	26	4	0.876	25	16	5	0.764

DISCUSSION

Correction location of Mental Foramen is paramount importance for the placement of anaesthesia either in the surgical and invasive procedures so as to prevent from post operative complications[12].

In present study 76MFs are located in line with the long axis of lower 2nd Premolar and 65MF are located between the long axis of 1st and 2nd lower Premolar.**Mahalawy 2017**, in his study revealed that the most common position of MF was below the apex of 2nd premolar[10].this may be due to dietary habits of different regions which may ultimately, effect the development of mandible.In present study size of mental foramen is larger in male(Height-2.48MM and Width-2.3MM)while in female(Height-2.0mm & Width-2.1mm) since the significant results are observed. This could be due to hereditary factors, polymorphisms in the genes that influence bone metabolism, physical activity, muscle strength [13]

The means distance A observed in present study 6.59mm which is similar to the study conducted by **von Arx et al.** who found an average distance from the MF to the nearest root of 6 mm[14].**Kalender et al.** , which found an average distance from the MF to the nearest tooth of 5.8 mm[15]

In present study mean distance B observed 13.29mm.**OLIVERA et al** the average distance from the MF to the alveolar crest was 12.6 mm, and the range was **5.7 to 19.6 mm**The valuesfound in these studies were similar to those observed in our study, but the variability in measurements suggests that this distance cannot be consistent because of the loss of alveolar bone[16].

The mean Distance C observed in present study is 12.37 mm.the reasons might be due to hormones such as **androgens and estrogen**contribute to the development of a morphologic difference of craniofacial skeleton between gender.**Enlow in (1982) stated** that the speed of bone growth in adult women is lower than that in men[17]

Shape of the mental foramen in present study is usually round in shape this could be due to bone remodeling activity like apposition, inactivity and resorption in 3 dimensions.Frequency of anterior looping in present study ranges from 7.3% to 13%.Identification of anterior looping is paramount importance to prevent from neurosensory damage and prevention of post-operative complications[18]

LIMITATIONS & FUTURE SCOPES

Small sample size,More population group should be included to know ethnic variation of mental foramen among different group of population ,Actual localization of MF through surgical exploration should also have been included in the study .Future research should expand upon this study by evaluating and comparing differences among anatomical landmarks of the mandible in populations of different ethnic and racial origins

CONCLUSIONS

Position of mental foramen predominantly apical to the long axis of the second premolar Average mental

foramen size and distance C are higher in men.Frequency of anterior looping is 7.2%- 13%.After analysinginformation,it was found that CBCT is more accurate and trustworthy diagnostic tool for determining anterior looping,making it beneficial for pre-operative surgical planning.

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