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Evaluation of relationship between mandibular molars and the inferior alveolar canal in young and aged population- A Cone Beam Computed Tomography study

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ABSTRACT
Introduction:
Several inadvertent errors during a dental treatment can lead to iatrogenic injuries to the inferior alveolar nerve canal, causing serious complications like varying degrees of symptoms such as pain, hyperesthesia or even anaesthesia. In the mandibular region, the molar apices are the closest to the nerve and hence more prone to injury. In order to interpret these problems, clinicians rely on various methods of radiographic examination. Hence, the study focused on evaluating the relationship between inferior alveolar canal and mandibular molars in young and aged population using Cone Beam Computed Tomography.
Materials and Methods:
A total of 120 mandibular permanent molar CBCT scans were acquired and the subjects were divided on the basis of age, as young and old. The CBCT machine used was Carestream CS 9300 Premium Dental Cone Beam Imaging System and the software incorporated analysed the images.
Results and Discussions:
Distance from the mesial root apex to the IAN was shorter than that to the distal root apex. Also, among the younger individuals, the largest distance between the molar root apices and the inferior alveolar canal which was observed was (5.85+2.16) mm and the lowest overall distance observed was (1.06+0.99) mm. The distances of the mandibular roots and IAN to the root apices of the mandibular first, second as well as the third molars were shorter in females than in males.
Conclusions:
The older age group showed a greater distance from the molar root apices to the canal and the females had shorter distances, attributing to an increased chance of post-operative pain in females.

Keywords: Inferior Alveolar nerve canal, Cone Beam Computed Tomography, Pre-surgical assessment, preoperative, root canal treatment, endodontic healing, procedural errors.

I. INTRODUCTION

Different procedures in dentistry may lead to inferior alveolar nerve (IAN) injury, a rare but serious treatment complication (1). These injuries to the Inferior alveolar nerve canal are mostly iatrogenic. Major causes for these injuries could be the clinical procedures such as root canal treatment, tooth extraction, implant placement and other surgical procedures in the area of the first and second molars and also to the branches of the trigeminal nerve within the inferior alveolar canal. In 40% of the cases, injury is due to dental implants (2), followed by 1–10% due to endodontic procedures . This is why radiographic examination, especially pre-operative, is an important complementary procedure for clinical diagnosis in endodontics (3). It enables clinicians to know what to expect, beforehand, to at least some extent, and be prepared to handle the situation on hand. A lot of times, radiographic examination also helps us to evaluate if there are any inadvertent errors or status of complexity of the case even during the ongoing procedure.

Among different types of radiographic examination available to a clinician, we have a variety of choices comprising of two-dimensional and three-dimensional imaging techniques. But the two-dimensional imaging, though cost-effective and sometimes easy to use or portable, the accuracy of imaging does not give us the complete picture in case of a complex case. In such kind of situations, three-dimensional imaging proves as a boon for clinicians giving them the correct idea to be

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prepared for the case to be encountered, and also, to manage the mishaps at hand.

Among the three-dimensional imaging, of late, Cone Beam Computed tomography (CBCT) is one of the most utilized modalities in the current times due to its precision, and field of view characteristics. Previous studies indicate that CBCT helps dentists and specialists with all these above-mentioned difficulties faced by a clinician and overcomes the difficulties of a two-dimensional imaging, while giving the same, or better detailing. Various evidences state that the use of CBCT comes into necessity to assist in many significant dental procedures as it makes even most difficult cases possible, predictable, and almost easy (4). When a procedure demands precise localization, CBCT provides non-distorted, unmagnified, reliable images that contribute to accurate treatment methods.

Advantages in visualizing an individual tooth or dentition in relation to surrounding skeletal tissues and to create three-dimensional images of the area to be examined (5). If compared with traditional radiographic methods, which reproduce the three-dimensional anatomy as a two-dimensional image, CBCT is a three-dimensional imaging method that offers the possibility to view an individual tooth or teeth in any view, rather than predetermined 'default' views. Therefore, CBCT can be a powerful tool in endodontic diagnosis, treatment planning and follow-up (6).

II. METHODS:

Selection and description of participants: A total of one hundred and twenty mandibular permanent molar CBCT scan images were acquired from the database archives for the study from the Department of Oral Medicine and Diagnostic Radiology. The scans that were taken, were either to guide the diagnostic process or as a part of patient's treatment plan. The subjects were divided on the basis of age, as young (20-44 years) and old (45-65 years).

Group 1: Young group (n = 60)
Males- n=30
Females- n=30
Group 2: Old age group(n=60)
Males- n=30
Females n=30
Inclusion criteria:
CBCT images of mandibular molar region of patients in the age range of 20-44 years and 45-65 years

Exclusion criteria:
Immature teeth with open apices, Resorption, Signs of root fracture, Periapical lesion, Images with artifacts

The course of the inferior alveolar nerve and the canal borders were traced from the mental foramen travelling posteriorly till the ramus of mandible corresponding to the region below the mandibular third molars. The course of the IAN was traced using the nerve tool incorporated in the software and then the images were analysed under the oblique slice for calculating the distance from root apices to the superior border of inferior alveolar canal.

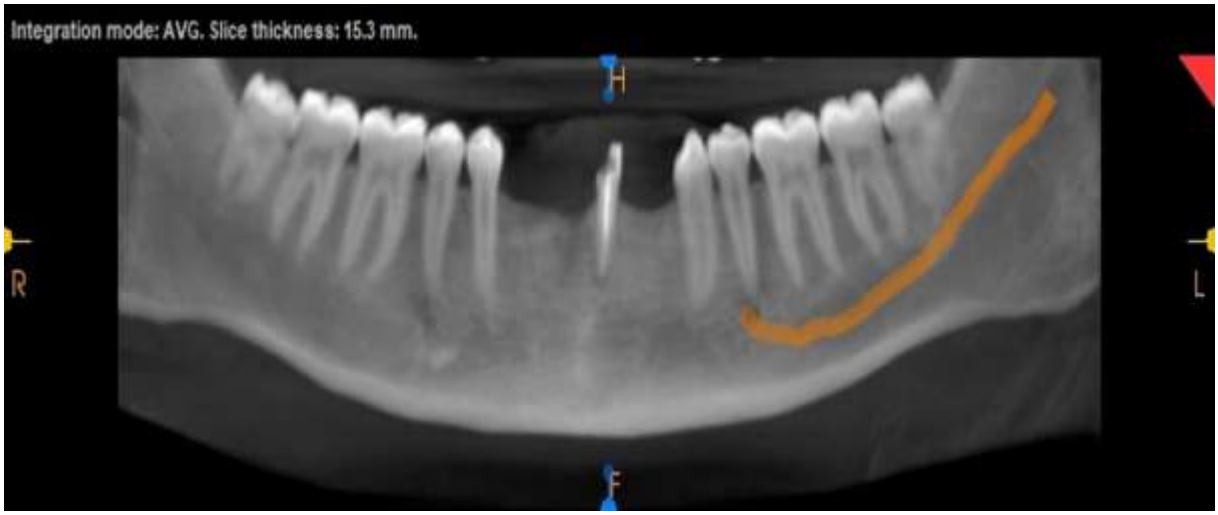

Fig 1: Inferior Alveolar canal traced

International Journal Dental and Medical Sciences Research
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The nerve tool was used to trace the course of the IANB exiting from the mental foramen till the ramus and the root apices sections were analysed from the cervical, middle and apical third and the orientation and the location of the inferior alveolar canal was observed.
Technical Information: The CBCT machine used in this study was Carestream CS 9300 and the scanning parameters was kept constant for all patients.

Scanning parameters were set at 75kV, 6mA, 11 seconds of exposure. The software used to analyse the images will be the CS9300 Dental Cone Beam Imaging System (Carestream Dental, a Division of Carestream Health, Inc., Rochester, New York) incorporated with the same machine.

Sample size and distribution:
Sample size was calculated based on inclusion and exclusion criteria and sample size of 120 teeth was determined.

Sample Size Estimation

$$n = 2\frac{S^2(Z1 + Z2)^2}{(M1 - M2)^2}$$

M1	Mean test intervention	5.82
M2	Mean control intervention	3.82
S1	Standard deviation of M1	3.26
S2	Standard deviation of M2	2.22
S	Pooled SD	2.78
AH	One sided=1, Two sided =2	2
1-α	Set level of confidence. Usual values 0.95; 0.99	0.99
1-β	Set level of power of test. Usual values 0.8, 0.9	0.9
Z1	Z value associated with alpha **	2.57
Z2	Z value associated with beta	1.28
n1	Minimum sample size	58

The sample size for the study is estimated using the above formula. Substituting the values, sample size is estimated to be 58 which is rounded off to 60
Since there are 2 groups (old and young), total sample Size is 60*2=120 which is subdivided into males and females (30 in each subgroup).

Statistics:

SPSS (Statistical Package for Social Sciences) version 20. (IBM SPASS statistics [IBM corp. released 2011] was used to perform the statistical analysis. Data was entered in the excel spread sheet. Descriptive statistics of the explanatory and outcome variables were calculated by mean, standard deviation for quantitative variables. Inferential statistics like independent sample t test was applied to compare the statistical difference of vertical distances from the inferior alveolar canal to the root apices between the groups (young vs old, females Vs males). Paired sample t test was applied to compare the statistical difference of vertical distances from the inferior alveolar canal to the root apices within the groups (Right Vs left). Pearson's correlation was applied to correlate the age with the vertical distances from the inferior alveolar canal to the root apices. The level of significance is set at 5%.

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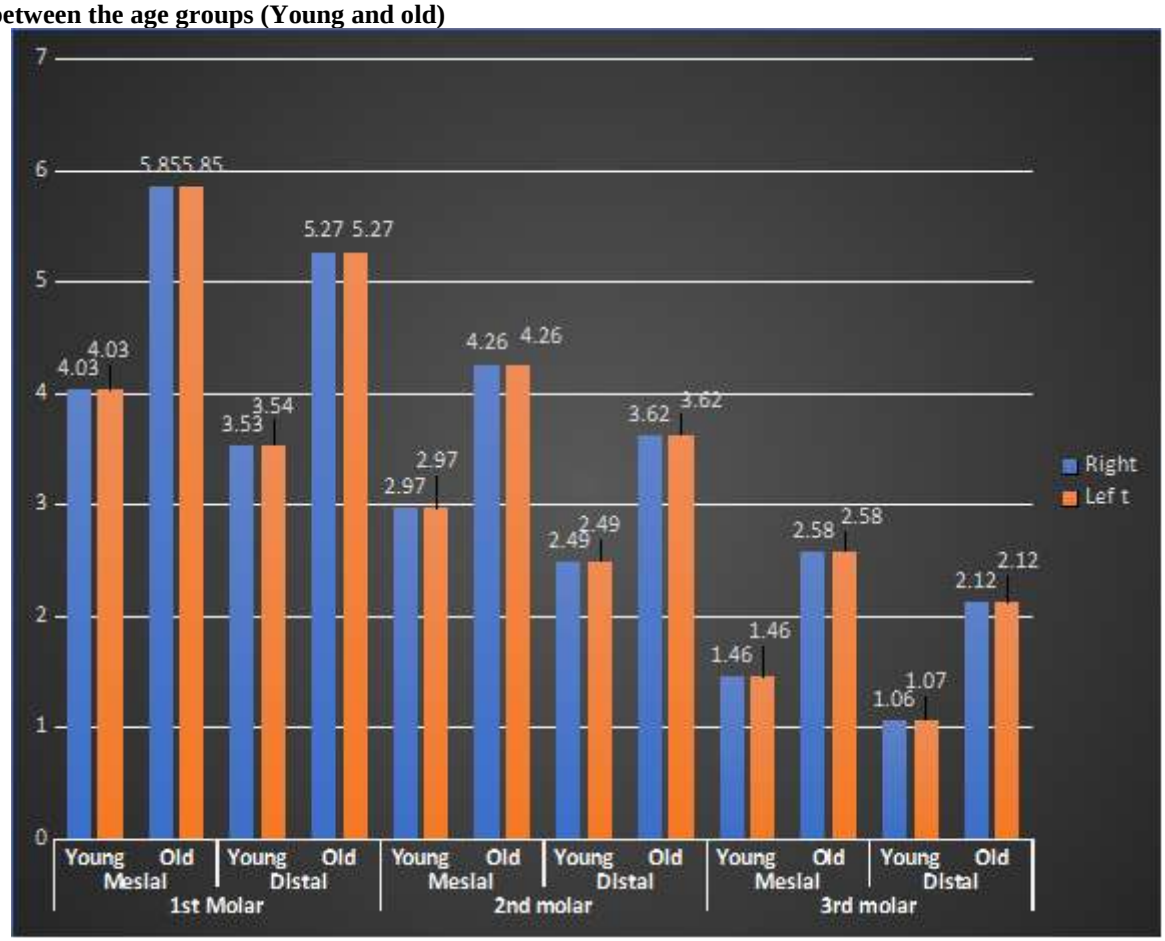
III. RESULTS:

Bar Graph 1: Comparison of the Vertical Distances from the Inferior Alveolar Canal to the Root Apices between the age groups (Young and old)



As depicted in Bar Chart 1, the overall largest distance between the molar root apices and the inferior alveolar canal which was observed among all the groups, was (5.85+2.16) mm and the lowest overall distance observed was (1.06+0.99) mm. In the younger age group, the longest distance among all the comparisons was observed to be (4.03+1.60) mm and the least distance was the same as the overall group (1.06+0.99) mm. In the case of the older age group taken individually, the longest distance observed was same as the overall group, (5.85+2.16) mm and the shortest distance observed was (2.12+1.55) mm. In all the cases, the distances measured in the older age group is significantly greater than the distances measured in the younger age group.

When comparing between the three molars on each side (right or left), in all the cases it can be observed that the distances measured from the root apices to the inferior alveolar canal in the first molar is always greater than that of the third molar. This result is observed in the inter-group (between the age groups) comparison as well.

When we take the bilateral comparison into consideration between the age groups is checked for all the three molars, in all the cases, as depicted in the bar graph clearly, it was observed to be either same or slightly different, which was observed to not be statistically significant.

International Journal Dental and Medical Sciences Research
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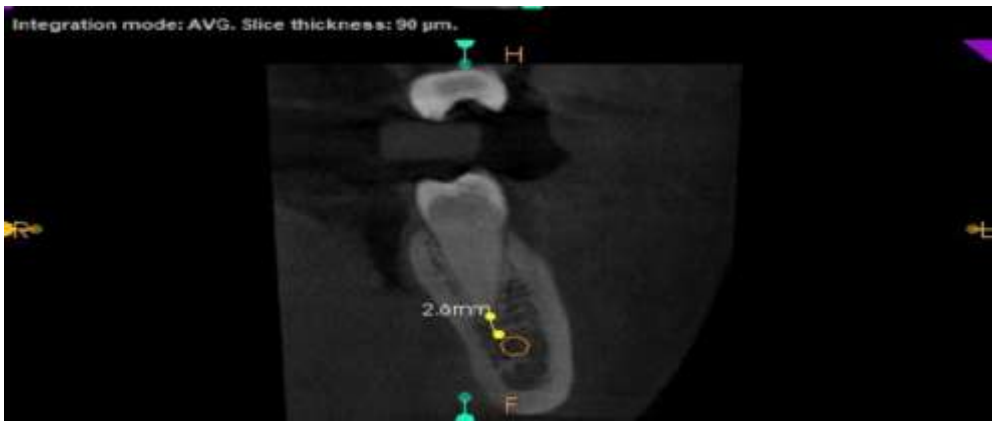
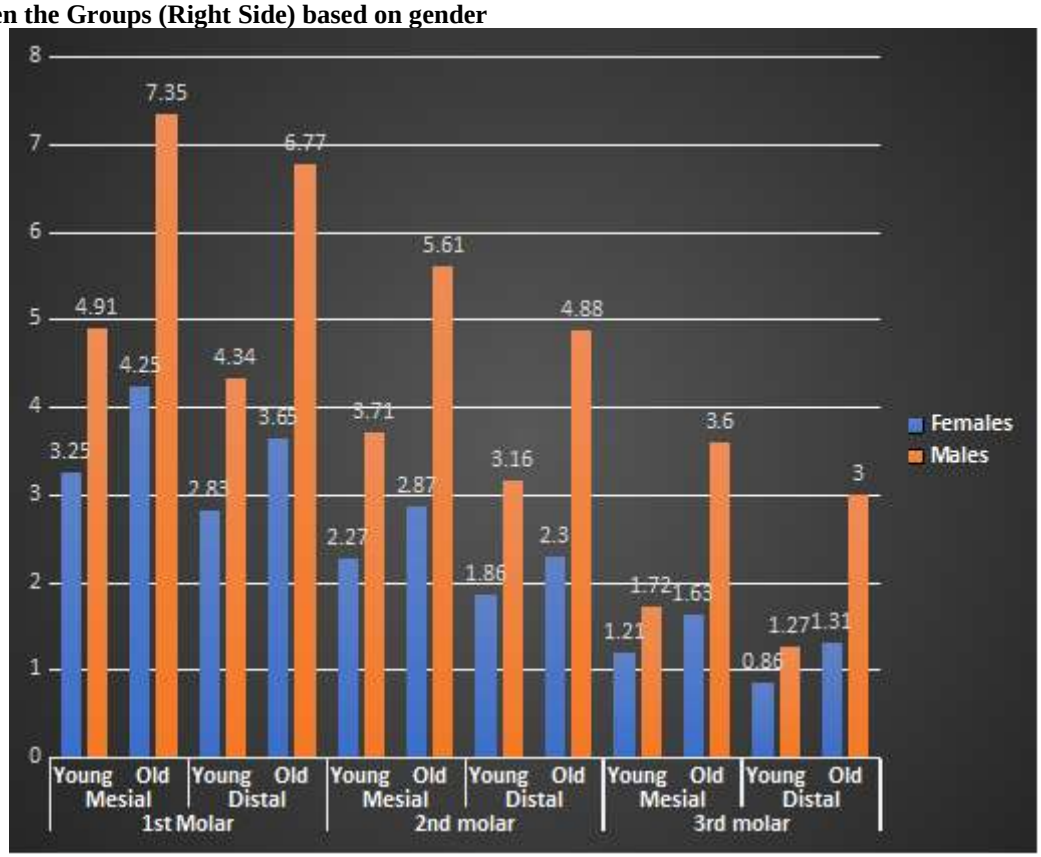


Fig 2: First mandibular molar-distal root measured to the inferior alveolar canal

Bar Graph 2: Comparison of the Vertical Distances from the Inferior Alveolar Canal to the Root Apices between the Groups (Right Side) based on gender



Bar graph, depicted in Fig 2, depicts the vertical distances assessed on the basis on gender comparison as well as comparison on the basis of age variations.

When the comparison between the genders is assessed, the overall highest value of the distances measured from the molar root apices to the inferior alveolar canal in case of males is observed to be (7.35+1.76) mm whereas in females, the highest value noted was (4.25+1.19) mm. The overall shortest distance that was observed in case of males was (1.27+0.93) mm, and in case of females was (0.86+1.02) mm.

When only the younger age group is considered, among the gender sub-groups, the distances observed in case of the measurements from the root apices to the canal, is significantly much greater (highest distance in younger males-(4.91+1.29) mm) than that of the distances measured in case of the female sub-group (highest distance observed in younger females (3.25+1.45) mm).

International Journal Dental and Medical Sciences Research
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Similarly, when considering the older group as well, the males have a much greater distance (7.35+1.76) mm observed from the root apices to the IANC compared to the older female sub-groups (4.25+1.19) mm.

Overall, among the main age groups, the vertical distances observed in the older group is much greater in all the cases compared to the younger group which is depicted by the bar graph displaying a significant difference between the sub-groups, i.e, the males and females, as well as the main groups between the young and the elderly group.

Table 1: Pearson's Correlation between the Age and Vertical Distances from the Inferior Alveolar Canal to the Root Apices

	Tooth	Surfaces	Old			Young			Overall		
			r value	p value	N	r value	p value	N	r value	p value	N
Right	1st molar	Mesial	0.07	0.57	58	-0.06	0.60	58	0.41	0.000 *	116
		Distal	0.11	0.37	58	-0.08	0.54	58	0.40	0.000 *	116
	2nd molar	Mesial	0.07	0.59	59	-0.11	0.39	60	0.30	0.001 *	119
		Distal	0.02	0.87	59	-0.11	0.36	60	0.29	0.001 *	119
	3rd molar	Mesial	-0.15	0.26	54	-0.08	0.95	57	0.30	0.001 *	111
		Distal	-0.14	0.30	54	0.02	0.82	57	0.32	0.000 *	111
Left	1st molar	Mesial	0.07	0.57	58	-0.06	0.61	58	0.41	0.000 *	116
		Distal	0.11	0.37	58	-0.07	0.57	58	0.40	0.000 *	116
	2nd molar	Mesial	0.07	0.59	59	-0.10	0.41	60	0.30	0.001 *	119
		Distal	0.02	0.87	59	-0.11	0.37	60	0.29	0.001 *	119
	3rd molar	Mesial	-0.15	0.26	54	-0.04	0.97	57	0.30	0.001 *	111
		Distal	-0.14	0.30	54	0.03	0.78	57	0.32	0.001 *	111

When checking for the correlation between the age and the vertical distances measured groups, among the younger and older subjects individually, no significant results for obtained in the individual groups. This inference shows that there is no difference observed between the subjects (intra-group in each of the groups), when correlated based on the increasing age or decreasing age among the major group of older or younger individuals. Whereas, if we carry out a correlation between the age groups, then we can see the significant difference in all the three molars on both the left and the right side.

Whereas when correlating the female and male sub-groups along with the genders, the individual groups of each sub-group, within themselves also show a significant p value, depictive of significant differences

IV. DISCUSSION:

The major comparison assessed in the present study was between the younger and the older age groups. According to a previous study, Simonton et al. had reported that the distance from the IAN to the mesial root apex was shorter than that to the distal root apex, which also corresponds with the results of the present study when age-related differences are taken into account (7).

Also, it was found out that in the population taken in the study, among the younger individuals, the largest distance between the molar root apices and the inferior alveolar canal which

was observed was (5.85+2.16) mm and the lowest overall distance observed was (1.06+0.99) mm and in the case of the older age group, the longest mean distance observed was (5.85+2.16) mm and the shortest mean distance observed was (2.12+1.55) mm.

Another observation made was that in all the cases, the distances measured in the older age group is significantly greater than the distances measured in the younger age group. According to the orthodontic cephalometric studies by Love, Foley and Mamandras in which they studied facial skeletal growth during late adolescence in males and females and reported that AFH increased over the observation period. Between the ages of 18 and 50 years, AFH increases about 22% more in males than in females (8). This could be attributed to the extreme difference in the distances observed in elderly males compared to the females or the younger males. This may be an important aspect when considering for implant surgical site for planning.

The sub-groups analysed in the study were the genders. When the comparison between them were assessed in the study, the overall highest value of the distances measured from the molar root apices to the inferior alveolar canal in case of males was observed to be (7.35+1.76) mm whereas in females, the highest value noted was (4.25+1.19) mm. The overall shortest distance that was observed in case of males was (1.27+0.93) mm, and in case of females was (0.86+1.02) mm. The inference that can be drawn from the above is that the vertical distances observed in the younger individuals was significantly shorter in both the males as well as the females compared to the older aged groups in both the genders. This result was consistent with most of the previous studies, except in a study by Adiguzel et al, where the author found shorter distances in a Turkish population contradicting the results obtained (9).

Additionally, in accordance with the study by Simonton et al, the present study showed that the distances of the mandibular roots and IAN to the root apices of the mandibular first, second as well as the third molars were shorter in females than in males. This observation can be correlated clinically for being a possible cause for the increased post-operative pain or sensitivity observed in case of female patients compared to the male patients (10). Also, in both, between the genders, as well as the age groups, the bilateral differences in the vertical distances measured bilaterally were seen to be not significant and hence did not exhibit much difference on either side.

As it is a well-documented previous result, the third molars in most of the cases studied were in closest proximity to the IANC, and in two of the cases, the canal was observed to be running touching the root apices linguo-mesially. This was one of the variations observed and this can be beneficial especially when planning for the third molar extraction, and most commonly in open extraction cases.

The second part of the study evaluated the bucco-lingual course of the IAN in the canal with respect to the mandibular molars. The Anterior loop (AL), the posterior descending loop and the exit from mental foramen are the three elements that form the most important aspect of the bucco-lingual course of the IAN.

An additional finding about the mental foramen and the buccolingual course was found out. The MF is commonly found between first and second premolars (11). Some studies on the Saudi population found out that the MF is most commonly located below the second premolar (12) depicting the location of exit of the IAN from the buccal aspect of second premolar. This study also found that in the buccolingual dimension, in many cases, the IAC was near or in contact with the lingual cortex.

Another important finding of this study is the relationship between the location of mental foramen and the buccolingual position of the IAC. At all regions (second premolar, first molar, and second molar), the more distally the mental foramen was located, the more buccally the IAC progressed in the mandibular body. In the previous study by Pyun et al, this held true only about the second premolar region (13). In the current study, the minimum values for the buccolingual ratio of the canal at all regions were found in Type 1 (in which the mental foramen was located below the second premolar). In this type of mental foramen, the second premolar and the first molar region seem to be subjected to high risk of damage to the inferior alveolar nerve during implant placements or endodontic surgeries. This showed that the IAC progresses from the lingual to the buccal side clearly, from the third molar to the first molar and further the second premolar region.

V. CONCLUSION:

Within the limitations of this study, the distances measured from the mandibular molar root apices to the superior border of inferior alveolar canal in the older age group the distances measured were significantly greater than the distances measured in the younger age group. Distances between root apices and the canal with respect to the mandibular first, second as well as the third molars were shorter in females than in males, attributing to an increased chance of post-operative pain in females.

The inferior alveolar nerve traverses from the lingual to the buccal side, starting near the third molar, then towards to the first molar and further the second premolar region. In most of the cases, the nerve travels from the lingual aspect with respect to the third and the second molars but travels buccally in the region between the first molar and the second premolar to exit finally from the mental foramen.

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