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Original Research Article

A study to evaluate the proximity of anterior of border of incisive canal to maxillary central incsors roots in skeletal class I and skeletal class II malocclusion using CBCT

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Abstract

Introduction: Determination of the three-dimensional (3D) position of the maxillary incisors is an integral part of orthodontic diagnosis and treatment planning. The contact of maxillary central incisor root with the incisive canal after maximum retraction was associated with apparent root resorption raising potent complications.

Aims & Objectives: To evaluate the relative position of incisive canal with regard to maxillary central incisors roots using CBCT in skeletal class I and skeletal class II malocclusion. To compare the proximity of anterior border of incisive canal to maxillary central incisors roots in Pre-treatment stage between skeletal class I and skeletal class II malocclusion using CBCT. To compare the proximity of anterior border of incisive canal to maxillary central incisors roots before strap up and at pre-finishing stage in skeletal class I and skeletal class II malocclusion using CBCT.

Materials and Methods: Total of 30 patients were divided into two groups: Group A: 15 skeletal class-I patients, Group B: 15 skeletal class-II patients. Both pre and post treatment CBCT images of both the groups were taken to evaluate the anteroposterior distance from incisive canal to maxillary central incisors roots.

Results: All the study parameters showed a slight decrease from the pre- treatment to post-treatment time points and the changes in Rm-canal (P value 0.05) and CI root (P value 0.005) mean values with treatment were statistically significant.

Conclusion: Anteroposterior distance between maxillary central incisor roots and incisive canal in both skeletal class I and class II groups does not show any significant differences.

Keywords: Incisive canal, Incisor retraction, CBCT, Root resorption, EAR

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1. Introduction

The determination of the position of the maxillary incisors is a key issue in orthodontic diagnosis and treatment planning. In patients with bimaxillary or bialveolar protrusion, premolar extraction followed by maximum retraction of the anterior teeth is required for esthetic improvement and functional occlusion. In general, the ideal position of the maxillary incisor is determined based on various soft and hard tissue criteria, and orthodontic tooth movement within the biologic limitations is desirable for a successful treatment outcome with long-term stability.[1]

The upper central incisors play an important role in the appearance, phonetics, and function of individuals. Various anatomical structures restrict orthodontic tooth movement, including the periodontal apparatus, tongue, lips, cheeks, muscles, and cortical plates. Consideration of the related limiting structures can reduce the risk of iatrogenic damage to tooth roots and alveolar bone while moving teeth Orthodontically.[2]

Determination of the three-dimensional (3D) position of the maxillary incisors is an integral part of orthodontic diagnosis and treatment planning, and various biomechanical

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treatment modalities are employed to achieve the ideal incisor position.

The "envelope of discrepancy," which graphically shows the extent of changes possible with orthodontic tooth movement alone, with orthopedic or functional appliance therapy for growth modification, and with orthognathic surgery in combination with orthodontic treatment.3 Accordingly, it is traditionally thought that the amount of changes possible for the maxillary incisors with orthodontic treatment alone are approximately 7, 2, 4, and 2 mm for retraction, protraction, extrusion, and intrusion, respectively.[4]

The palatal cortical plate was commonly regarded as the main constraint for retracting the upper centrals. Recent craniofacial anatomical studies found that the incisive canal (IC) was encircled by a thick layer of cortical bone and was closer to the upper central incisors (U1) between the U1 roots than the palatal cortical plate.[5]

The incisive canal is an anatomic structure located on the median plane of the palatine process of the maxilla, posterior to the roots of the central incisor, surrounded by thick cortical bone. It transmits nasopalatine vessels and nerves, branches of the maxillary division of the trigeminal nerve, and the maxillary artery.[6-76] Although the incisive canal has not been proposed as an anatomic structure that may limit tooth movement, it has gained attention because of the possibilities of surgical invasion and associated complications such as non-osseointegration or sensory dysfunction owing to its proximity to the maxillary incisor region.[8]

External apical root resorption is one of the most common deleterious effects of orthodontic therapy and has been a challenge to orthodontists for a long time. Radiographic estimation revealed incidence of root resorption in a range from 48% to 66%. About 20% of cases showed at least one upper incisor with resorption greater than 2 mm after the first year of therapy.[9]

Although the overall anatomy of the incisive canal is well defined, its precise location in relation to the maxillary incisors is not well documented in the orthodontic literature. This may be because of the difficulties in detecting incisive canal morphology using conventional orthodontic radiographs. However, with recent advancements in 3D imaging, the approximation of the maxillary incisor roots to the incisive canal can be frequently detected after anterior retraction following orthodontic treatment. The contact of maxillary central incisor root with the incisive canal after maximum retraction was associated with apparent root resorption raising potent complications.[11,36]

The present study is to evaluate the relative position of incisive canal with regard to maxillary central incisors roots using CBCT in skeletal class I and skeletal class II malocclusion. To compare the proximity of anterior border of incisive canal to maxillary central incisors roots in Pre treatment stage between skeletal class I and skeletal class II malocclusion using CBCT. To compare the proximity of anterior border of incisive canal to maxillary central incisors roots before strap up and at pre-finishing stage in skeletal class I and skeletal class II malocclusion using CBCT.

2. Materials and Methods

2.1. Source of data

Patients who visited to the Department of orthodontics and Dentofacial orthopedics for the purpose of orthodontic treatment at Meghna institute of dental sciences, Mallaram, Nizamabad, Telangana. The patients were informed about the study and their consent was taken.

2.2. Inclusion criteria

Patients with skeletal class I bases
Patients with skeletal class II bases
Patients with or without extraction of teeth
Patients with minimum over jet of 3-6 mm

2.3. Exclusion criteria

Patients who underwent orthognathic surgery
Patients with developmental anomalies
Patients with Dentofacial deformities
Patient with severe facial asymmetries
Patients with periodontitis
Patients with systemic diseases

2.4. Materials

Total of 30 patients were taken in to the study and were divided into two groups:

1. Group A: consists of 15 skeletal class-I patients
2. Group B: consists of 15 skeletal class-II patients

Both pre and post treatment CBCT images of both the groups were taken to evaluate the anterioposterior distance from incisive canal to maxillary central incisors roots. NNT viewer with a field of view of 13x16 cm and an image resolution of 0.25-mm voxel size software was used for evaluation.

2.5 Sample size

This study comprises of 60 CBCT images (30 pre treatment and 30 post treatment) of Group - A and Group - B respectively.

2.6. Methodology

For all the patients, orthodontic treatment has been carried out with or without extraction and MBT 0.022 bracket system was used.

Initially Cephalometric evaluation was done to know the skeletal pattern of patient.

After the evaluation and before bonding a pre-treatment CBCT maxillary image was taken for both the Group - A and Group - B patients.

After one year of the start of the treatment or at pre-finishing stage another post treatment CBCT maxillary image was taken for both the Group - A and Group - B patients.

CBCT (NNT viewer) maxillary images of skeletal class I and class II were taken before treatment (T0) and one year after treatment or at pre- finishing stage (T1) using CBCT machine. CBCT data sets were acquired by using NNT viewer software.

In the software the CBCT maxillary image was set to multiplanar mode and fine, clear image slice was selected for evaluating the anterioposterior distance from incisive canal to maxillary central incisors roots.

3. Results

Data were analyzed using IBM SPSS version 20 software (IBM SPSS, IBM Corp., Armonk, NY, USA). Descriptive statistics, independent samples t tests, and paired t tests were done to analyze the study data. Bar charts with positive error bars were used for data presentation. With IBM SPSS Software (Version 2021)

The study was done to evaluate the proximity of anterior border of incisive canal to maxillary central incisors roots in skeletal class I and skeletal class II patients before and after orthodontic treatment by taking a pre and post treatment CBCT respectively, and were evaluated using CBCT NNT viewer software.

Table 1Table 1 presents the descriptive statistics for the pre-treatment study parameters in both the study groups. No significant differences were found between Class I and Class II in the pre-treatment study parameters (Table 2). Table 3 shows the intra-group comparison of study parameters among class I study subjects between the pre-treatment and post-treatment time points.

While the Rm-cat and CI root mean values decreased from the pre- treatment (2.94±0.82 and 3.51±0.8, respectively) to post-treatment time points (2.76±0.67 and 3.3±0.8, respectively), the mean values of Rm-canal demonstrated a slight increase (from 3.56±0.74 to 3.64±0.85) with treatment; however, none of these differences were statistically significant.

Table 4Table 4 shows the intra-group comparison of study parameters among class II study subjects between the pre-treatment and post-treatment time points. All the study parameters showed a slight decrease from the pre- treatment to post-treatment time points and the changes in Rm-canal and CI root mean values with treatment were statistically significant.

Table 5Table 5 presents the inter-group comparison of the difference in study parameters between pre-treatment and post-treatment time points. No significant differences were noted between Class I and Class II groups with regard to difference in any of the study parameters between time points.

Table 1: Descriptive statistics for the pre-treatment study parameters in both the study groups

Parameter	Class	N	Mean	Std. Deviation	Std. Error Mean	95% CI lower	95%CI upper
Rm- cat	Class I	15	2.946667	.8296873	.2142243	2.48	3.406
	Class II	15	2.553333	.4501851	.1162373	2.3	2.8
Rm-canal	Class I	15	3.566667	.7451430	.1923951	3.15	3.97
	Class II	15	3.560000	.5302291	.1369046	3.26	3.85
CI root	Class I	15	3.513333	.8025554	.2072189	3.06	3.95
	Class II	15	3.606667	.7601378	.1962667	3.18	4.02

Table 2: Comparison of the pre-treatment study parameters in both the study groups

Parameter	Class	N	Mean	Std. Deviation	Std. Error Mean	t value	P value
Rm- cat	Class I	15	2.946667	.8296873	.2142243	1.614	0.118
	Class II	15	2.553333	.4501851	.1162373		
Rm-canal	Class I	15	3.566667	.7451430	.1923951	0.028	0.978
	Class II	15	3.560000	.5302291	.1369046		
CI root	Class I	15	3.513333	.8025554	.2072189	-0.327	0.746
	Class II	15	3.606667	.7601378	.1962667		

Independent samples t test; p≤0.05 considered statistically significant

Table 3: Intra-group comparison of study parameters among class I study subjects between the pre-treatment and post-treatment time points.

Parameter	**Time point**	**n**	**Mean**	**Std. Dev**	**Std. Err**	**t value**	**P value**
Rm-cat	Pre- treatment	15	2.946667	.8296873	.2142243	0.978	0.345
	Post- treatment	15	2.760000	.6727343	.1736992		
Rm-canal	Pre- treatment	15	3.566667	.7451430	.1923951	-0.297	0.771
	Post- treatment	15	3.640000	.8550689	.2207778		
CI root	Pre- treatment	15	3.513333	.8025554	.2072189	1.043	0.314
	Post- treatment	15	3.300	.8098	.2091		

Paired t test; p≤0.05 considered statistically significant

Table 4: Intra-group comparison of study parameters among class II study subjects between the pre-treatment and post-treatment time points.

Parameter	**Time point**	**n**	**Mean**	**Std. Dev**	**Std. Err**	**t value**	**P-value**
Rm-cat	Pre- treatment	15	2.553333	.4501851	.1162373	0.401	0.694
	Post- treatment	15	2.506667	.4847189	.1251539		
Rm-canal	Pre- treatment	15	3.560000	.5302291	.1369046	2.058	0.05*
	Post- treatment	15	3.320000	.5608667	.1448152		
CI root	Pre- treatment	15	3.606667	.7601378	.1962667	3.297	0.005*
	Post- treatment	15	2.987	.6875	.1775		

Paired t test; p≤0.05 considered statistically significant

Table 5: Inter-group comparison of the difference in study parameters between pre-treatment and post-treatment time points.

Parameter	**Class**	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**	**t value**	**P value**
	1	15	.18666	.7395623	.1909542	0.626	0.536
RM-cat (Pre-			7				
post)	2	15	.04666	.4501851	.1162373		
			7				
			-			-1.147	0.261
RM-canal (Pre-post)	1	15	.07333 3	.9565314	.2469754		
	2	15	.24000	.4516636	.1166190		
			0				
	1	15	.21333	.7918032	.2044427	-1.464	0.154
CI root (Pre-			3				
post)	2	15	.62000	.7282072	.1880223		
			0				

Independent samples t test; p≤0.05 considered statistically significant

Figure 1Figure 5 represents the Comparison of the pre-treatment study parameters in both the study groups in which the Rm-Cat mean value of skeletal class I group is slightly high compared to that of skeletal class II group.

There was no significant difference noted between Rm-Canal mean value of skeletal class I group compared to skeletal class II group.

Figure 2Figure 6 represents Intra-group comparison of study parameters among Class I study subjects between the pre- and post-treatment time points in which study parameters among class I study subjects between the pre and post showing the Rm-cat and CI root mean values decreased from the pre- to post-treatment time points, the mean values of Rm-canal demonstrated a slight increase with treatment.

Figure 7 represents Intra-group comparison of study parameters among Class II study subjects between the pre- and post-treatment time points in which all the study parameters showed a slight decrease from the pre to post and the changes in Rm-canal (P value 0.05) and CI root (P value 0.005) mean values with treatment were statistically significant.

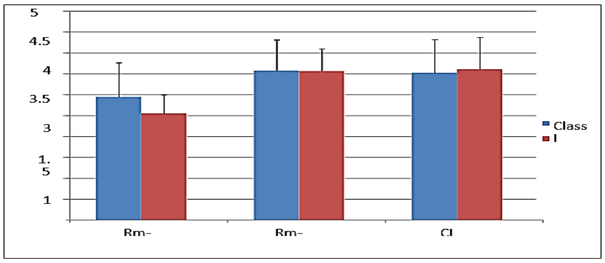

Figure 1: Comparison of the pre-treatment study parameters in both the study groups

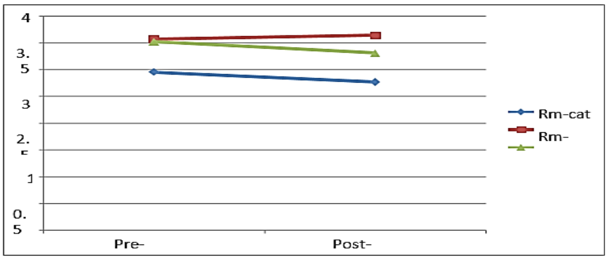

Figure 2: Intra-group comparison of study parameters among Class I study subjects between the pre-treatment and post-treatment time points

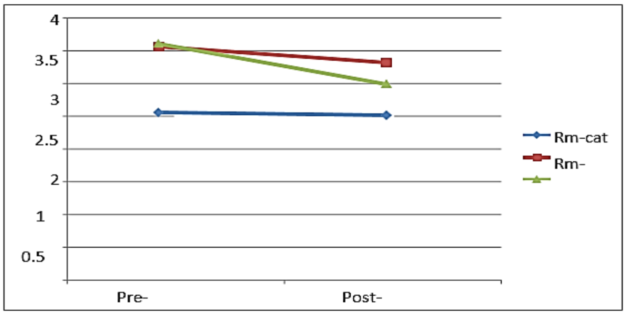

Figure 3: Intra-group comparison of study parameters among Class II study subjects between the pre-treatment and post-treatment time point.

Represents Inter-group comparison of the difference in study parameters between pre-treatment and post-treatment time points in which No significant differences were noted between Class I and Class II groups with regard to difference in any of the study parameters between time points.

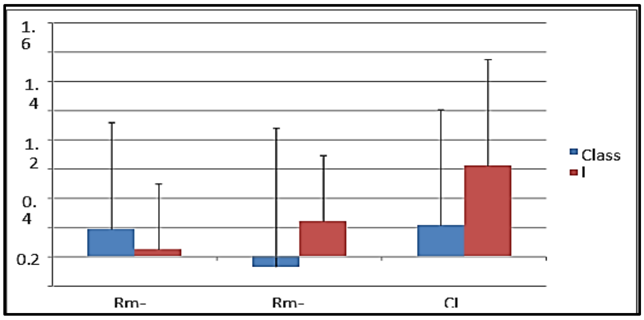

Figure 4: Inter-group comparison of the difference in study parameters between pre-treatment and post-treatment time point

3. Discussion

The extent of orthodontic tooth movement is constrained by the periodontal attachment apparatus; adjacent anatomical structures, such as the alveolar bone, tongue, and lips; and the biomechanical limits of anchorage during orthodontic mechanotherapy. Ackerman and Proffit[3] introduced the concept of the "envelope of discrepancy," which graphically shows the extent of changes possible with orthodontic tooth movement alone, with orthopedic or functional appliance therapy for growth modification, and with orthognathic surgery in combination with orthodontic treatment. Accordingly, it is traditionally thought that the amount of changes possible for the maxillary incisors with orthodontic treatment alone are approximately 7, 2, 4, and 2 mm for retraction, protraction, extrusion, and intrusion, respectively.

Interestingly, the range of tooth movement during retraction of the maxillary incisors far exceeds the range of movement possible in other directions and/or for other teeth. The anatomical limit of maxillary incisor retraction is reportedly the palatal cortical plate. However, another anatomical structure, the incisive canal, runs more closely to the maxillary incisor roots between the central incisor roots in the median plane than does the palatal cortical plate.[1]

Because of its proximity to the maxillary incisors, the possibility of surgical invasion of the incisive canal during dental procedures has been reported, and this can result in non osseo integration of dental implants or sensory dysfunction. The contact of maxillary central incisor root with the incisive canal after maximum retraction was associated with apparent root resorption raising potent complications.[1]

Contact of tooth roots with the cortical plate has been addressed as a contributor to root resorption result in delayed tooth movement, and may also cause perforation and dehiscence of the cortical plate.25-2725,26,27 Considering the morphologic dimensions of the central incisor roots and the incisive canal, the posterior-median aspect of the apical third of the roots rather than the root apex is most likely to approximate with the canal following maxillary anterior retraction and root movement.[1]

Chung et al.[1] found contact of the U1 root with the IC cortical plate and subsequent root resorption was observed after en-masse retraction of the U1. Pan and Chen found that the root length decreased significantly more in the U1-IC contact group (2.63+_0.93 mm) compared to the non-contact group (1.14+_0.83 mm). Despite the anatomy of the IC being well known, its approximate location relative to the U1 is not well reported in the orthodontic literature.

Cho et al.[24] estimated the proximity of the U1 and IC and found greater than 60% of cases had an IC width greater than the U1 inter-root distance. Interestingly, a recent clinical study reported that 53% of cases that underwent more than 4 mm of incisor retraction revealed IC invasion by the incisor roots after maximum incisor retraction.

Hence, an evaluation of the relationship between the upper central incisors and the incisive canal is a valuable measure to estimate the risk of expected root resorption. This consideration is particularly important in maximum retraction cases that involve Class I or II maxillary or bimaxillary dentoalveolar protrusion.[2]

Class I or II maxillary or bimaxillary protrusion cases planned to have maximum maxillary incisor retraction should be evaluated carefully, considering the U1-IC relationship, especially for those in the high angle facial group and for females, who showed a bit shorter distance between the U1 and IC, and a wider IC width .The IC could be considered as one of the anatomic/ biologic limiting parameters for orthodontic tooth movement that was not comprehensively investigated in the orthodontic literature and could be among the risk factors that induce root resorption.[30]

Although the sagittal distance between the incisor roots and the incisive canal is yet to be determined, 3D evaluations during orthodontic diagnosis and close monitoring of the incisor roots throughout treatment would be advantageous in preventing potential complications, especially in patients requiring maximum retraction. Therefore, when planning orthodontic treatment, it is critical to confirm the exact location of maxillary incisors and the incisive canal and determine the morphology of the alveolar bone.

Considering the importance of incisive canal and its proximity to maxillary central incisors ,the aim of the present study was to evaluate the relative position of incisive canal with regard to maxillary central incisors roots using CBCT in skeletal class I and skeletal class II malocclusion and compare the proximity of anterior border of incisive canal to maxillary central incisors roots in Pre-treatment stage between skeletal class I and skeletal class II malocclusion using CBCT and also to compare the proximity of anterior border of incisive canal to maxillary central incisors roots at pre- treatment and pre-finishing stage in skeletal class I and skeletal class II malocclusion using CBCT.

Rm indicates the most medial point of the maxillary central incisor roots; Rp, the most posterior point of the maxillary central incisor roots; Cl, the most lateral point of the incisive canal; Rm-Rm, interroot distance; Rp-Rp, posterior interroot distance; Cl-Cl, canal width.Ca indicates the most anterior point of the incisive canal; Cat, the tangent line through Ca; Rm-Cat, the distance from Rm to Cat; Rm-Canal, the distance from Rm to the anterior border of the incisive canal; Cl-Root, the distance from Cl to the posterior border of the maxillary central incisor root.

The study revealed that there are no significant changes in the dimensions of incisive canal and its proximity to maxillary central incisors between Skeletal class I and class II groups and there could be no skeletal pattern influence in the position of incisive canal.

The intra group comparison of study parameters among class I study subjects between the pre-treatment and post-treatment time points showing the Rm-cat and CI root mean values decreased from the pre-treatment (2.94±0.82 and 3.51±0.8, respectively) to post-treatment time points (2.76±0.67 and 3.3±0.8, respectively), the mean values of Rm-canal demonstrated a slight increase (from 3.56±0.74 to 3.64±0.85) with orthodontic treatment. The increase in mean values of Rm-Canal is attributed to approximation of roots of maxillary central incisors to the anterior border of incisive canal and maximum retraction in class I or bimaxillary protrusion cases.

The intra-group comparison of study parameters among class II study subjects between the pre-treatment and post-treatment time points, showed a slight decrease and the changes in Rm-canal(P value 0.05) and CI root(P value 0.005) mean values with treatment were statistically significant. A slight decrease and the changes in Rm-canal (P value 0.05) and CI root(P value 0.005) mean values in post treatment time points is suggestive of decrease in distance between roots of maxillary central incisors to the anterior border of incisive canal as maximum retraction is carried out in class II division 1 malocclusion with increased overjet.

Dr. Ane ten hoeve8 has studied the effect of antero-posterior incisor repositioning on the palatal cortex using laminagrams and cephalograms and author concluded that there is a significant notch on the lingual root surface. The palatal cortex attempts to follow the notched configuration and the area of the notch probably represents the contact point of the root and the cortical plate prior to torquing. A characteristic type of root resorption, extending from the apex of the root, along the lingual root surface, sometimes accompanied by notching and scalloping. Similar to the present study in which as the proximity of anterior border of incisive border of incisive canal to maxillary central incisors decreases the risk of root resorption increases.

James Kaley et al.[9] has studied the factors related to root resorption in edgewise practice showed severe resorption of both maxillary incisors. Similar to the present study as the root resorption increases with increasing lenth of active treatment, the proximity of incisive canal to maxillary central incisors roots also decreases resulting contact of maxillary central incisor roots with the incisive canal and severe resorption is more likely in patients with long treatment times.[27]

Chooryung J. Chung et al.[6] has conducted a study on approximation and contact of the maxillary central incisor roots with the incisive canal after maximum retraction with temporary anchorage devices. The maxillary central incisors are most frequently involved in orthodontically induced inflammatory root resorption. Similar to the present study the average width of the incisive canal in the axial plane at the level of the apical third of the root is reportedly about 3 to 5 mm, with a large variation ranging from. to 6.7 mm.

The average interroot distance between the maxillary central incisors is about 3 to 4 mm ,similarly in the present study ,the mean Rm-Cat score in class I group was 2.94, and in class II group was 2.55 and the mean Rm- Canal score in class I group was 3.56,and in class II group was 3.56 and the mean CI-Root score in class I group was 3.5, in class II group was 3.6 suggesting that the root touching or approximation with the incisive canal, especially in the mesiopalatal surface, can be speculated in certain cases after maximum amounts of distal root movement. Variations in the morphology of the incisive canal have been frequently reported with 3D imaging, including deviation to 1 side, widening or cystic changes, furcations, and so on morphology, root proximity to the cortical bone, alveolar bone density, and type of malocclusion, and with orthodontic treatment-related risk factors such as treatment duration, magnitude of force, and amount of apical root movement.[1]

Akira Horiuchi et al.[5] has studied the correlation between cortical plate proximity and apical root resorption and reported that, the root contact with the labial or palatal cortical plate at root apex level during orthodontic tooth movement was to be related to root resorption, and dentofacial morphology was suggested to predispose certain persons to root contact with the cortical plate. They constructed a best-fit straight line for the maxillary palatal cortical plate and set a line for the labial cortical plate from. A point to Prosthion point in order to obtain measurements of proximity of root apices with the cortical plates of the maxillary alveolus and investigated the correlation between apical root resorption and the measured variables.

Similar to the present study, root approximating to palatal cortical plate followed by excessive incisors retraction and by extrusion of incisor was revealed to be factors influencing amount of apical root resorption as the distance between the anterior border of incisive canal to maxillary central incisor roots decreases as the amount of retraction increases in cases with class I bimaxillary or class II division 1 malocclusion. Narrowing of alveolar bone width also influences apical root resorption.[5]

Eun-Ae Cho et al.[4] has studied morphologic features and the relative position of the incisive canal with regard to the maxillary incisor roots using computed tomography (CT). Rm-Cat was 5.2 +_1.16, 5.1+_1.09, and 4.9+_1.30 mm at L1, L2, and L3, respectively. The measurements of Rm- Canal and Cl-Root were 5.9+_1.07 and 5.5+_1.32 mm at L1 and 5.7+_1.14 and 5.6+_1.19 mm at L2. Rm-Canal and Cl-Root were not measurable at L3 because the root apex was farther away from the median plane than was the most lateral border of the incisive canal in all subjects.

Similar to the present study Rm-Cat, Rm-Canal, and Cl-Root measurements did not show significant differences according to the vertical levels. The author concluded that, the anterioposterior distance between the maxillary central incisor roots and the incisive canal was approximately 5–6mm. More than 60% of subjects had an incisive canal width greater than the interroot distance.[4]

IC with larger volume and area showed more invasions compared with those with smaller volume and area (P < .01). The amount of root resorption was significantly higher with IC invasion than without invasion (2.39 mm vs 0.82 mm, P < .0001). IC remodeling following maximum retraction was seen in 24% of the subjects. IC remodeling group demonstrated less apical root resorption than the non-remodeling group (0.98 mm vs 3.27 mm, P <.0001). The author concluded that, IC with larger volume and surface area before treatment was more likely to show canal invasion by the incisor roots after maximum retraction. IC invasion resulted in apical root resorption. Similarly in the present study as the dimensions of incisive canal increased, the distance between the anterior border of incisive canal to maxillary central incisor roots decreases resulting in invasion of incisive canal and resorption of maxillary central incisor roots.

Fulya Ozdemir et al.[29] has conducted a study to evaluate the cortical bone thickness of the alveolar process in the maxilla and the mandible on cone-beam computed tomographs of adults with low, normal, and increased facial heights. Similar to the findings in the present study where mean Rm-Cat score in class I group was 2.94, and in class II group was 2.55 and the mean Rm-Canal score in class I group was 3.56,and in class II group was 3.56 and the mean CI-Root score in class I group was 3.5,in class II group was 3.6 ,the average, low, and high angle facial groups revealed different overall U1 to IC sagittal measurements of 4.36+_1.18, 4.78+_1.17, and 3.83+_0.9 mm, respectively. Overall, the low angle facial group showed relatively greater UI to IC sagittal distance, which was in agreement with previous investigations, indicating that the alveolar bone of the low angle facial group subjects was thicker than that in the other facial groups.[12]

Further studies can be conducted by including skeletal class III sample group and compare skeletal class I, class II and class III subjects to evaluate the changes in dimensions of incisive canal and its proximity to maxillary central incisor roots.

4. Conclusion

The findings of the study concluded that:

The antero-posterior diameter between maxillary central incisor roots and incisive canal in both skeletal class I and skeletal class II groups does not show any significant differences.

Evaluation of the proximity of the incisive canal to the maxillary incisors, in addition to its dimensional characteristics, may be helpful when a considerable amount of maxillary retraction is planned.

All the study parameters in Skeletal class II group showed a slight decrease from the pre-treatment to post treatment time points and the changes in Rm -Canal and CI-Root mean values with treatment were statistically significant.

To manage post-orthodontic treatment complications such as root resorption and compression of nerve bundles residing in incisive canal, the anatomy of incisive canal and its proximity to central incisor roots should be carefully examined in each patient and diagnosis should be formulated using 3D information.

When maximum retraction of the maxillary incisors is planned, customized 3D evaluation of the dimension and location of the incisive canal would be advantageous in preventing potential complications.

5. Source of Funding

None.

6. Conflict of Interest

None.

References

1. Chung CJ, Choi YJ, Kim KH. Approximation and contact of the maxillary central incisor roots with the incisive canal after maximum retraction with temporary anchorage devices: report of 2 patients. *Am J Orthod Dentofacial Orthod*. 2015;148(3):493-502.
2. Al-Rokhami RK, Sakran KA, Alhammadi MS. Proximity of upper central incisors to incisive canal among subjects with maxillary dentoalveolar protrusion in various facial growth patterns. *Angle Orthod.* 2022;92(4):529-36.
3. James l. William R. Proffit. Soft tissue limitations in orthodontics: treatment planning guidelines. *Angle Orthod*. 1997;67(5):327-36.
4. Cho EA, Kim SJ, Choi YJ, Kim KH, Chung CJ. Morphologic evaluation of the incisive canal and its proximity to the maxillary central incisors using computed tomography images. *Angle Orthod*. 2016;86(4):571-6.
5. Akira horiuchi, Hotokezaka AH. Correlation between cortical plate proximity and apical root resorption. *Am J Orthod Dentofacial Orthop*. 1998;114:311-8.
6. N mraiwa1, Jacobs R, Cleynenbreugel JV. The nasopalatine canal revisited using 2d and 3d ct imaging. Dentomaxillofac Radiol. 2004;33:396–402
7. liang X, Jacobs R. Macro- and micro-anatomical, histological and computed tomography scans characterization of the nasopalatine canal. *J Clin Periodontal*. 2009;36(7):598–603.
8. Richard A, Boyden KD. Location of incisive canal in relation to central incisor implants. *Imp Dent* 1998:7(3):221-5.
9. Levander E, Malmgren O. Evaluation of the risk of root resorption during orthodontic treatment: a study of upper incisors. *Eur J Orthod*. 1988:10(1):30-8.
10. S. Hakbilen, g. Magat. Evaluation of anatomical and morphological characteristics of the nasopalatine canal in a turkish population by cone beam computed tomography. *Folia Morphol*. 2018;77(3):527–35.
11. Radlanski RJ. Emmerich H. Renz. Prenatal morphogenesis of the human incisive canal. *Anat Embryo*. 2004:208(4):265–71.
12. Asaumi R, Kawai T, Sato I. Three-dimensional observations of the incisive canal and the surrounding bone using cone-beam computed tomography. *Oral Radiol*. 2010;26(1):20–8.
13. Hyo-won AHN, Moon SC. Morphometric evaluation of changes in the alveolar bone and roots of the maxillary anterior teeth before and after enmasse retraction using cone-beam computed tomography. *Angle Orthod*. 2013;83(2):212–21.
14. Panda M, Shankar T, Raut A. Cone beam computerized tomography evaluation of incisive canal and anterior maxillary bone thickness for placement of immediate implants. *J Indian Prosthod Soc*. 2018;18(4):356-63.
15. Thakur AR, Burde K, Guttal K. Anatomy and morphology of the nasopalatine canal using cone-beam computed tomography. *Imag Sci Dent*. 2013;43(4):273-81.
16. Guliz N.Yagmur DG. Hasan Y. Is there a gender difference in anatomic features of incisive canal and maxillary environmental bone? *Clin Oral Impl* Res. 2012;24(9):1-4.
17. Matsumura T, Ishida Y. Quantitative analysis of the relationship between maxillary incisors and the incisive canal by cone-beam computed tomography in an adult japanese population. *Progress Orthod.* 2017;18(1):24.
18. Baidar Gull MA. Evaluation of morphologic features and proximity of incisive canal to the maxillary central incisors using cone beam computed tomography. *J Dent Med Sci*. 2018;17(1):9:46-50
19. Cho ea, kim sj, choi yj, kim kh, chung cj. Morphologic evaluation of the incisive canal and its proximity to the maxillary central incisors using computed tomography images. *Angle orthod*. 2016; 86(4):571–6.
20. Wainwright WM. Faciolingual tooth movement: its influence on the root and cortical plate. *Am J Orthod*. 1973;64:278–302.
21. Kaley J, Phillips C. Factors related to root resorption in edgewise practice. *Angle Orthod.* 1991; 61(2):125–32.
22. Chung CJ, Nguyen T, lee JH, Kim KH. Incisive canal remodeling following maximum anterior retraction reduces apical root resorption. *Orthod Craniofac Res.* 2021;24(1):59–65.
23. Yu JH, Nguyen T, Kim Y, Hwang S, Kim K, Chung CJ. Morphologic changes of the incisive canal and its proximity to maxillary incisor roots after anterior tooth movement. *Am J Orthod Dentofac Orthod. Ajodo*. 2020.161(3):396-403.
24. Ozdemir F, Tozlu M, Germec-cakan D. Cortical bone thickness of the alveolar process measured with cone-beam computed tomography in patients with different facial types. *Am J Orthod Dentofacial Orthop*. 2013;143(2):190–6.
25. Arnett GW, Bergman RT. Facial keys to orthodontic diagnosis and treatment planning. Part i. *AM J Orthod*.1993;103(4):299–312.
26. Sarver DM. The importance of incisor positioning in the esthetic smile: the smile arc. *Am J Orthod*. 2001;120(2):98–111
27. Vardimon AD, Oren E, Ben-bassat Y. Cortical bone remodeling/tooth movement ratio during maxillary incisor retraction with tip versus torque movements. Am J Orthod Dentofac Orthod. 1998;114(5):520–9.
28. Jacob S, Zelano B, Gungor A, Abbott D, Naclerio R, Mcclintock MK. Location and gross morphology of the nasopalatine duct in human adults. Arch Otolaryngol *Head Neck Surg*. 2000; 126(60:741–8.
29. Thakur AR, Burde K, Guttal K, Naikmasur VG. Anatomy and morphology of the nasopalatine canal using cone-beam computed tomography. *Imaging Sci Dent*. 2013;43(4):273–81.
30. Segal GR, Schiff Man PH, Tuncay OC. Meta-analysis of the treatment-related factors of external apical root resorption. Orthod Craniofac Res. 2004;7(2):71–8.
31. Pan y, chen s. Contact of the incisive canal and upper central incisors causing root resorption after retraction with orthodontic mini-implants: A CBCT study. *Angle Orthod*. 2019; 89(2):200-5.
32. Nakada t, motoyoshi m, horinuki e, shimizu n. Cone-beam computed tomography evaluation of the association of cortical plate proximity and apical root resorption after orthodontic treatment. *J Oral Sci.* 2016;58(2):231–6.

33. Ahn HW, Moon Sc, Baek SH. Morphometric evaluation of changes in the alveolar bone and roots of the maxillary anterior teeth before and after en masse retraction using cone-beam computed tomography. *Angle Orthod*. 2013;83(2):212-21.
34. Thongudomporn U, Charoemratrote C, jearapongpakorn S. Changes of anterior maxillary alveolar bone thickness following incisor proclination and extrusion. *Angle Orthod*. 2015;85(4):549–54
35. Weltman B, Vig KW, Fields HW, Shanker S, Kaizar E. Root resorption associated with orthodontic tooth movement: a systematic review. *Am J Orthod Dentofacial Orthop*. 2010;137(4):462–76.
36. Weltman B, Vig KW, Fields HW, Shanker S, Kaizar Ee. Root resorption associated with orthodontic tooth movement: a systematic review. *Am J Orthod Dentofacial Orthop*. 2010;137(4):462–76.

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