Original Article

Comparison of Root - Crown Lengths and Occlusal Contacts in Patients with Class-III Skeletal Relationship, Anterior Open-bite and High Mandibular Plane Angle

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ABSTRACT

Aim: To determine the co-relationships of the root crown length and occlusal contacts in patients with Class-III skeletal relationship, anterior open-bite, and high mandibular plane angle. **Materials and Methods:** Study group consisted of 10 untreated Class-III patients with reverse over jet of minimum-2 or more and an anterior open-bite. Control group consisted of untreated patients with average 0-4 mm of over jet and overbite. Dental casts, orthopantomograms, and lateral cephalograms were recorded for measuring the root and crown lengths, occlusal contacts, and mandibular plane angle readings and were analyzed. **Results:** The root length and the root-crown ratios were reduced from incisors toward the pre-molars in the study group. Occlusal hypofunction was seen associated with the study group. Short dental roots were observed specifically with the anteriors. **Conclusion:** Patients with Class-III skeletal relationship, high mandibular plane angle, and an anterior open-bite have a tendency toward developing short dental roots that can be associated with occlusal hypofunction that is associated with the condition.

Key words: Anomaly, malocclusion, mandibular plane angle, open bite

INTRODUCTION

The orthodontists world over have recognized that appropriate diagnosis yields the best results. Malocclusions are of different types, broadly skeletal or dental malocclusions. In this study, we have compared the patients with Class-III malocclusion with patients with ideal occlusion or Class-I occlusion. Notably, Class-III patients with anterior open-bite were checked for their occlusal contacts, root-crown lengths, and root-crown ratios.

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Recent geriatric studies on dental occlusion state that the incidence of open-bite malocclusion was low even in patients with no missing teeth.[1] The correlation between the loss of occlusal contacts and poor root-crown ratio and chances of early exfoliation of permanent teeth was therefore checked for in this study. Authors have stated that proper occlusal contacts help as precursors for adequate radicular and periodontal development.[2,3] This indicates that inversely, loss or little occlusal contacts and occlusal loading can cause poor periodontal development and altered root-crown ratios. In untreated anterior open-bite cases, the anteriors do not occlude, and there is total anterior occlusal hypofunction. That indicates a risk of a short length of roots due to the developmental anomaly of the anteriors.[4-6]

Frequent occurrence of morphological features with Class-III malocclusion is long faces and high mandibular

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plane angle. This trait is attributed to the weak orofacial musculature associated with Class-III malocclusion. High mandibular plane angle is usually seen due to unrestricted growth of the mandible in relation to the maxilla. Other causes of the same can be a forward positioned mandible or backwardly positioned maxilla or a combination of the same. As the mandible rotates in a clockwise or forward manner the face height of the lower third starts increasing due to the chin moving downwards. Weak occlusal force is exerted by patients with open bite or long face.[6,7] Low occlusal stimuli may be associated and a cause for open-bite and long face syndromes.[8-11]

Various authors have also stated that the open bite cases are at a risk of root-resorption as various extrusive mechanics are required to correct this type of malocclusion. The dental roots of maxillary central incisors in patients with anterior open-bite have been reported to be short as compared to normal root lengths post-orthodontic correction.[12] Short dental roots will invariably alter the root to crown ratio. This alteration needs to be considered while planning force application for the teeth in question to avoid unwanted tooth movements.[13] If this condition pre-exists, prognosis of the teeth and morphology will be affected if more massive forces will use by altering the tooth. Clinically short dental roots influence the anchorage value and mobility of teeth. Short dental roots have also been reported to be associated with Down's syndrome, Turners' syndrome and cleft patients.[9-11]

The purpose of this study was to investigate the co-relationship between factors affecting this type of malocclusion. The aim was to determine the root-crown ratio and dental root length of teeth in patients with open bite and seek any relationships with occlusal contact and the mandibular plane angle.

MATERIAL AND METHODS

Subjects

Patients walking into the Department of Orthodontics of Rangoonwala Dental College, Pune for orthodontic correction were diagnosed using orthopantomograms (OPGs), lateral cephalograms, and dental casts. Consecutive patients who met the inclusive criteria were selected as open-bite group and control group.

Patient selection criteria: Patients visiting for orthodontic correction were randomly selected into two groups (10 patients each).

i. Control group - Untreated patients with average (0-4 mm) overjet and overbite
ii. Study group - Untreated Class-III patients with reverse overjet (−2-10 mm) and open-bite.

Inclusion Criteria

- Open-bite group - Patients with Class-III malocclusion, high mandibular plane angle, anterior open-bite and reverse overjet (−2-10 mm)
- Control group - Patients with average overjet and overbite (0-4 mm).

Exclusion Criteria

1. Loss of 1 or more permanent teeth
2. History of orthodontic treatment
3. Worn out teeth
4. Patients <15 years of age as the root formations of most of the teeth including the third molars is usually not completed until age 14
5. Patients with craniofacial syndromes like cleft lip and palate.

10 patients were selected in the open-bite group and the control group, respectively.

Cephalometrics

We used lateral cephalograms and OPGs for routine diagnostic tools that were also helpful in the detection of dentofacial anomalies. This helped in the selection of patients fitting the criteria for research. The radiographic landmarks were traced with the help of X-ray viewers with the lead acetate paper and felt tip pen. These readings were then recorded with the aid of the protractor and a digital vernier caliper.

Lateral cephalograms were used for tracing routine landmarks, and angular and linear measurements were recorded [Figures 1 and 2]. Mandibular plane inclination to Frankfort horizontal plane was recorded. Furthermore, overjet and overbite were recorded using lateral cephalogram and confirm the measurement by comparing them with dental casts. Skeletal relationships were recorded with the help of sella-nasion-point, and sella-nasion-point inclination of the mandibular plane was compared to Frankfort horizontal plane. Mandibular plane was considered passing through gonion and menton. Angular inclination to the FH plane was also recorded in relation to the upper incisor and lower incisor long-axis. This was done to check for inclination of teeth.

Dental Casts

Dental casts were made with the alginate impressions and later casts were occluded. In each and every patient wax-bite registration was done to confirm reproducibility of the occlusion. Occlusal contacts were checked in all patients by occluding the dental casts and then placing articulating paper in between teeth of upper and lower arches [Figures 3 and 4].

Even single point contact was considered as a positively contacting tooth.

Dental wear was assessed by assessing tooth wear as teeth with extensive tooth were excluded from all study purposes, Worn out teeth have occlusal disharmony, and these can give false results. Hence extensively worn out teeth were excluded from this study.

For proper occlusal contacts of the registered patient for this study, the blue articulating paper was used in conjugation with wax-bite.

OPGs

OPGs were used for assessing the root and crown lengths. Outline tracings of all of the teeth on OPG and cementoenamel junction were recorded for all patients. These tracings were then used for measuring the root-crown lengths using Lind's method.

For the measurement of the root-crown ratio in a tooth following points were marked (Figure 5).

Point i - Midpoint of incised edges or buccal cusp tips.

Point a - Root apex point or highest point on the root apex.

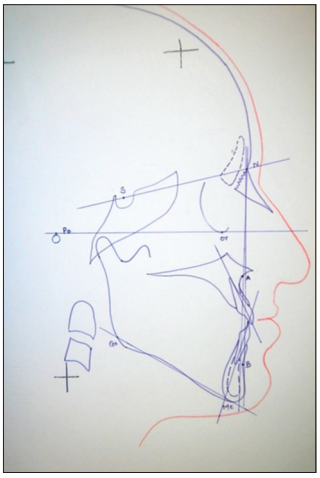


Figure 1: Ceplaometric tracing of the control group

Figure 3: Articulating paper for checking occlusal contacts

Figure 2: Cephalometric tracing of the study group

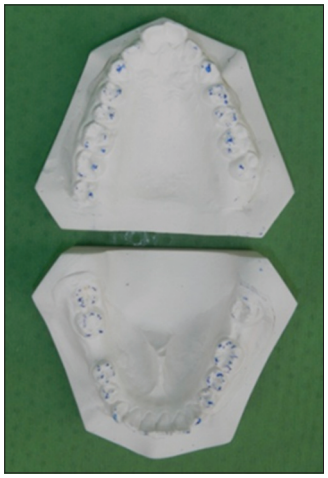


Figure 4: Dental casts after articulation

Point m - The midpoint (m) of the cement enamel junction.

Three parallel lines perpendicular to the long axis of the tooth were marked passing through the points i, a, m. Hence, line a, line i and line m were constructed as tangents to the points perpendicular to the long-axis of the tooth. Apex point in teeth with two buccal roots, the longer root was marked as the root apex point. In incisors and molars, two points on the mesial and distal incisal edges or buccal cusps were marked as the incisal edge points. In canines and pre-molars, one point was marked as the incisal edge point.

Root and crown length was measured by:

- Crown height - Along the perpendicular line from line i to line m
- Root length - Along the perpendicular line from line a to line m.

Root to crown ratio was calculated by dividing root length by crown length. This ratio is imperative in anticipating the type and direction of force required and type movement that can be achieved.

Criteria for Excluding Individual Teeth

1. Outlines or reference points were not clearly visible, i.e., major overlapping, diffuse images. Overlapping of cervical points
2. Extensive caries, restorations and endodontic treatment are already completed. Tooth wear index score >1.

Statistical Analysis

Difference among all variables was analyzed. Significance was determined with the numeric variables using unpaired *t*-test for normally distributed variables or Mann–Whitney *U*-test for non-normally distributed variables.

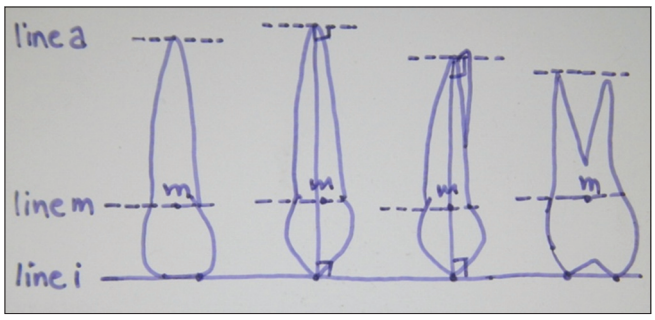


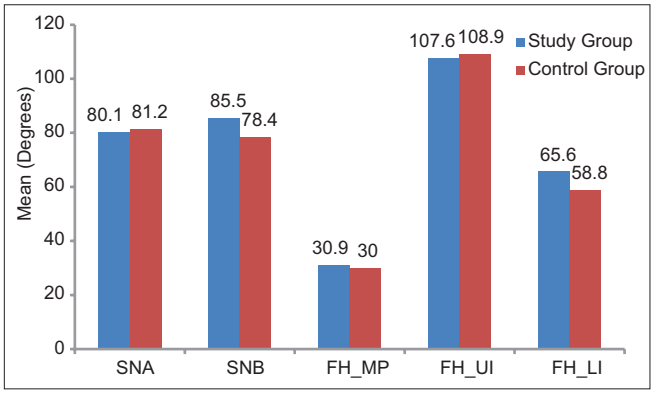
Figure 5: Methods used for measuring root-crown lengths by constructing lines i, a, m

RESULTS

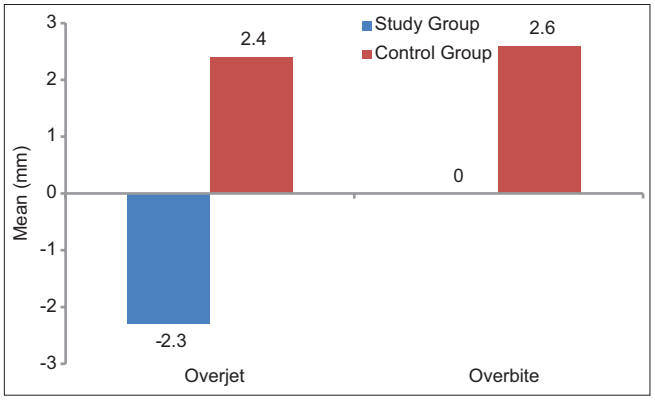
1. Comparison of angular measurements:
a. The average SNA, FH_MP, FH_UI and FH_LI did not differ significantly between two groups ($P > 0.05$ for all).
b. The average SNB is significantly higher in study group compared to the control group ($P > 0.05$) [Graph 1a].
2. Comparison of linear measurements:
a. The average overjet and overbite measurements are significantly higher in the control group compared with the study group ($P < 0.001$ for both) [Graph 1b and Table 1].

Comments

1. Comparison of root length (maxilla) measurements
a. The average root length of 1st pre-molar, 1st and 2nd molar teeth did not differ significantly between two groups ($P > 0.05$ for all)
b. The average root length of central incisor, lateral incisor, canine and 2nd pre-molar teeth is



Graph 1a: The comparison of angular measurements between two study groups



Graph 1b: The comparison of linear measurements between two study groups

significantly higher in the control group compared with the study group ($P < 0.05$ for all) [Graph 2a].

2. Comparison of root length (mandible) measurements:

a. The average root length of central incisor, lateral incisor, canine, 2nd pre-molar, 1st molar and 2nd molar teeth did not differ significantly between two groups ($P > 0.05$ for all)

b. The average root length of and 1st pre-molar is significantly higher in the control group compared with the study group ($P < 0.001$ for all) [Graph 2b and Table 2].

Comments

1. Comparison of crown length (maxilla) measurements

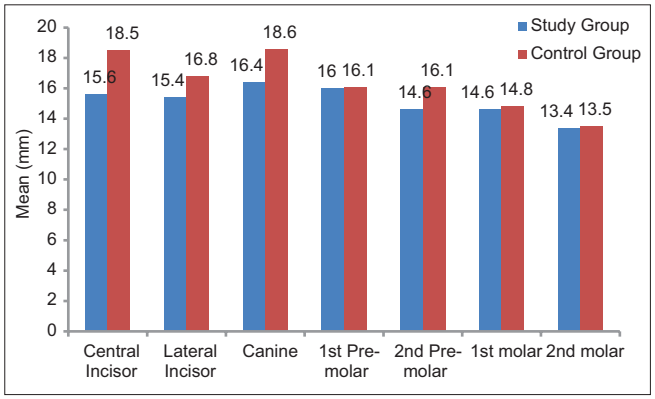
a. The average crown length of lateral incisor, 1st pre-molar, 2nd pre-molar, 1st and 2nd molar teeth did not differ significantly between two groups ($P > 0.05$ for all)

b. The average crown length of central incisor and canine teeth is significantly higher in control group compared to the study group ($P < 0.01$ for all) [Graph 3a].

Table 1: The comparison of angular and linear measurements between two study groups

Measurements	Study group (*n*=10)	Control group (*n*=10)	*P* value
Angular (degree)			
SNA	80.1±3.1	81.2±1.0	0.393
SNB	85.5±4.6	78.4±1.6	0.001
FH_MP	30.9±4.9	30.0±3.7	0.631
FH_UI	107.6±15.2	108.9±18.3	0.393
FH_LI	65.6±11.2	58.8±7.8	0.218
Linear (mm)			
Overjet	−2.3±1.6	2.4±1.1	0.001
Overbite	0.0±0.0	2.6±1.1	0.001

Values are mean±standard deviation. *P* value by Mann–Whitney *U*-test, a non-parametric test for comparing two independent groups. *P*<0.05 is considered to be statistically significant



Graph 2a: The comparison of root length measurements (maxilla) between two study groups

2. Comparison of crown length (mandible) measurements

a. The average crown length of central incisor, canine, 1st pre-molar, 2nd pre-molar, 1st and 2nd molar teeth did not differ significantly between two groups ($P > 0.05$ for all)

b. The average crown length of lateral incisor is significantly higher in control group compared to the study group ($P < 0.05$) [Graph 3b and Table 3].

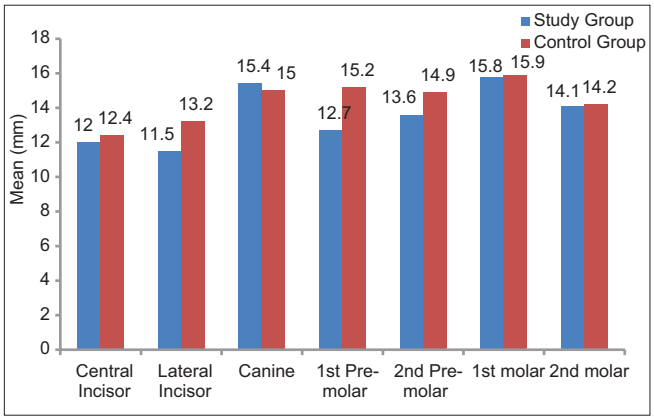
Root-crown ratio along with the root length was decreased among the central and lateral incisors of the open-bite group [Table 4].

Overall the occlusal contacts of the open-bite group are much lower in maxillary and mandibular arches [Table 5].

Table 2: The comparison of root length measurements between two study groups

Root length (mm)	Study group (*n*=10)	Control group (*n*=10)	*P* value
Maxilla			
Central incisor	15.6±1.9	18.5±0.5	0.001
Lateral incisor	15.4±0.8	16.8±1.2	0.023
Canine	16.4±0.5	18.6±1.5	0.005
1st pre-molar	16.0±0.0	16.1±0.3	0.739
2nd pre-molar	14.6±0.5	16.1±1.1	0.001
1st molar	14.6±0.5	14.8±0.4	0.481
2nd molar	13.4±0.5	13.5±0.7	0.912
Mandible			
Central incisor	12.0±1.9	12.4±1.6	0.529
Lateral incisor	11.5±2.3	13.2±1.9	0.089
Canine	15.4±1.4	15.0±1.1	0.739
1st pre-molar	12.7±1.8	15.2±0.4	0.001
2nd pre-molar	13.6±1.8	14.9±1.7	0.105
1st molar	15.8±1.3	15.9±1.4	0.796
2nd molar	14.1±1.2	14.2±0.9	0.579

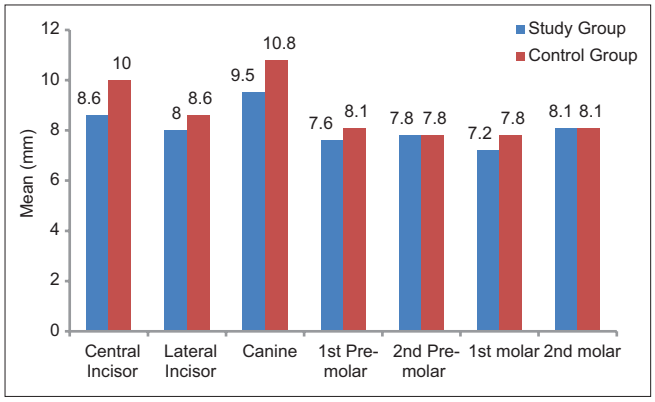
Values are mean±standard deviation. *P* value by Mann–Whitney *U*-test, a non-parametric test for comparing two independent groups. *P*<0.05 is considered to be statistically significant



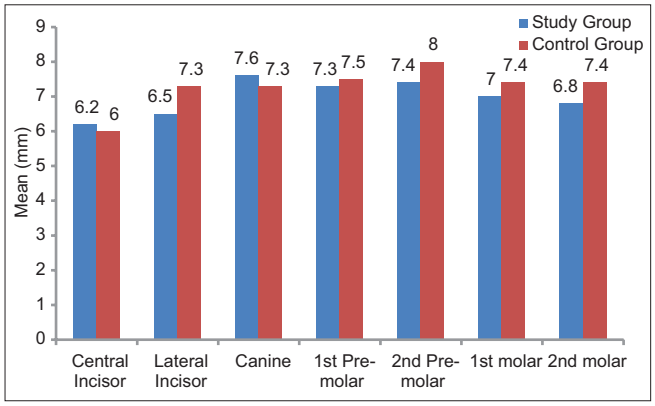
Graph 2b: The comparison of root length measurements (mandible) between two study groups

DISCUSSION

Panoramic radiographs can be used adequately to measure the ratio of dental root and crown lengths.[14-16]



Graph 3a: The comparison of crown length measurements (maxilla) between two study groups



Graph 3b: The comparison of crown length measurements (mandible) between two study groups

Table 3: The comparison of crown length measurements between two study groups

Crown length (mm)	Study group (*n*=10)	Control group (*n*=10)	*P* value
Maxilla			
Central incisor	8.6±0.8	10.0±0.9	0.007
Lateral incisor	8.0±0.8	8.6±0.5	0.123
Canine	9.5±0.7	10.8±0.4	0.001
1st pre-molar	7.6±1.4	8.1±1.2	0.353
2nd pre-molar	7.8±1.2	7.8±1.3	0.971
1st molar	7.2±1.2	7.8±1.3	0.315
2nd molar	8.1±0.3	8.1±0.3	0.999
Mandible			
Central incisor	6.2±0.4	6.0±0.0	0.481
Lateral incisor	6.5±0.9	7.3±0.5	0.023
Canine	7.6±0.8	7.3±0.5	0.579
1st pre-molar	7.3±1.3	7.5±0.5	0.739
2nd pre-molar	7.4±1.7	8.0±1.2	0.529
1st molar	7.0±0.0	7.4±0.5	0.143
2nd molar	6.8±0.8	7.4±0.5	0.105

Values are mean±standard deviation. *P* value by Mann–Whitney *U*-test, a non-parametric test for comparing two independent groups. *P*<0.05 is considered to be statistically significant

Root-crown ratios are adequately measured using linear measurements. Lateral cephalograms' measurements showed that there was a relation between mandibular plane angle being higher among the study group. Hence hypothesized that high mandibular plane angle has a tendency to cause open-bite malocclusion and occlusal hypofunction with high mandibular plane angle.

In this study, we made linear measurements of root and crown that showed short dental roots are associated with some anomalies. Primary cause of short dental roots is either developmental problems or acquired problems like root resorption. Root resorption can be due to heavy loading forces, in excessively proclined teeth due to inefficient distribution of forces along root, trauma from occlusion. Intrinsic root resorption is also found in some cases due to unknown causes. Root resorption alters the root-crown ratio due to the reduction in the root-length. This states that in such cases altered biomechanics will be required for treatment planning. Low force to bring about tooth movement, bracket position more gingival to maintain

Table 4: Comparison of root-crown ratios of upper and lower incisors

Measurements	Mean±SD	
	Control group	Open-bite group
R/C ratio U1	1.94±0.16	1.46±0.13
R/C ratio L1	1.8±0.18	1.65±0.23
Root length U1	18.5±1.55	14.64±3.41
Root length L1	17.33±1.41	15.58±1.06

SD: Standard deviation

Table 5: Comparison of occlusal contacts of maxillary and mandibular teeth

Tooth type	Control group		Open-bite group	
	n/N	Percentage of contacts	n/N	Percentage of contacts
Maxillary				
Central	18/20	90	0/20	0
Lateral	18/20	90	0/20	0
Canine	16/20	80	6/20	30
1st premolar	20/20	100	5/20	50
2nd premolar	18/20	90	12/20	60
1st molar	20/20	100	16/20	80
2nd molar	20/20	100	20/20	100
Mandibular				
Central	16/20	80	0/20	0
Lateral	18/20	90	0/20	0
Canine	16/20	80	2/20	10
1st premolar	20/20	100	8/20	40
2nd premolar	20/20	100	10/20	50
1st molar	20/20	100	20/20	100
2nd molar	20/20	100	20/20	100

N: Total number of teeth of the type of tooth. n: Total number of occluding teeth of the type of tooth.

the normal biomechanical application of forces. Careful application of forces to avoid further root-resorption is necessary. Excessive uncontrolled extrusive forces to correct open-bite are to be avoided.

Normal occlusal loading and function is responsible for the development of alveolar bone and supporting structure associated. It provides required stimulus for adequate root and alveolar bone formation. Occlusal hypofunction causes deficient alveolar and root development, narrowing of the periodontal space, vascular constriction and deformation of mechanoreceptors.[17] According to experimental findings performed on rat molars external apical root resorption was seen in association with hypofunction and atrophic changes were seen in the periodontium. Hence, hypothesized that the stimulus of normal occlusal function is responsible for normal alveolar and root development. Findings of this study indicate that patients with Class-III and open-bite type of malocclusion are at higher risk. If this condition is diagnosed at an early age, interceptive measures may aid in improving the bite at an early and hence enhance periodontal health. We can prevent the sequel to occlusal hypofunction by early interception.

This study also indicates that checking root-crown lengths of all patients with Class-III open-bite type of malocclusion should be carried out routinely for better treatment planning. As altered root-crown ratio requires altered biomechanics for treatment. The high mandibular plane angle is commonly associated with anterior open-bite and Class-III skeletal bases and can negatively affect the patient profile and prognosis of the treatment. Hence, this study conveys that careful diagnosis and intervention of such type of malocclusion is required at an early age. Late intervention requires careful diagnosis and efficient treatment planning.

CONCLUSION

Patients with an open bite malocclusion and Class-III skeletal relationship and high mandibular plane angle have short dental roots from anterior toward pre-molars. Occlusal hypofunction is usually associated with this type of malocclusion and can be either the cause or the effect of the underlying skeletal relationship. The upper and lower incisors in anterior open-bite developed short dental roots and reduced root-crown ratio. Adequate diagnosis and lighter force application should hence consider while planning the treatment of such cases.

REFERENCES

1. Miyazaki H, Motegi E, Yatabe K, Yamaguchi H, Maki Y. A study of occlusion in elderly Japanese over 80 years with at least 20 teeth. Gerodontology 2005;22:206-10.
2. de Freitas MR, Beltrão RT, Janson G, Henriques JF, Cançado RH. Long-term stability of anterior open bite extraction treatment in the permanent dentition. Am J Orthod Dentofacial Orthop 2004;125:78-87.
3. Harris EF, Butler ML. Patterns of incisor root resorption before and after orthodontic correction in cases with anterior open bites. Am J Orthod Dentofacial Orthop 1992;101:112-9.
4. Arntsen T, Kjaer I, Sonnesen L. Lengths of the maxillary central incisor, the nasal bone, and the anterior cranial base in different skeletal malocclusions. Acta Odontol Scand 2009;67:265-70.
5. Sringkarnboriboon S, Matsumoto Y, Soma K. Root resorption related to hypofunctional periodontium in experimental tooth movement. J Dent Res 2003;82:486-90.
6. Miyawaki S, Araki Y, Tanimoto Y, Katayama A, Fujii A, Imai M, *et al*. Occlusal force and condylar motion in patients with anterior open bite. J Dent Res 2005;84:133-7.
7. Kiliaridis S, Mejersjö C, Thilander B. Muscle function and craniofacial morphology: A clinical study in patients with myotonic dystrophy. Eur J Orthod 1989;11:131-8.
8. Prahl-Andersen B, Oerlemans J. Characteristics of permanent teeth in persons with trisomy G. J Dent Res 1976;55:633-8.
9. Al-Jamal GA, Hazza'a AM, Rawashdeh MA. Crown-root ratio of permanent teeth in cleft lip and palate patients. Angle Orthod 2010;80:1122-8.
10. Smith BG, Knight JK. An index for measuring the wear of teeth. Br Dent J 1984;156:435-8.
11. Lind V. Short root anomaly. Scand J Dent Res 1972;80:85-93.
12. Brook AH, Holt RD. The relationship of crown length to root length in permanent maxillary central incisors. Proc Br Paedod Soc 1978;8:17-20.
13. Rejebian GP. A statistical correlation of individual tooth size distortions on the orthopantomographic radiograph. Am J Orthod 1979;75:525-34.
14. Stramotas S, Geenty JP, Petocz P, Darendeliler MA. Accuracy of linear and angular measurements on panoramic radiographs taken at various positions *in vitro*. Eur J Orthod 2002;24:43-52.
15. Enokida M, Kaneko S, Yanagishta M, Soma K. Inference of occlusal stimuli on the remodelling of alveolar bone in a rat hypofunction-recovery model. J Oral Biosci 2005;47:321-34.
16. Mizrahi E. A review of anterior open bite. Br J Orthod 1978;5:21-7.
17. Subtelny JD, Sakuda M. Open bite diagnosis and treatment. Am J Orthod 1964;50:337-58.

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