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Original Article

Prevalence and extent of Alveolar dehiscence and fenestration in Class I hyperdivergent subjects with different buccolingual inclinations of maxillary molar teeth – A CBCT study

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Buccolingual position of teeth could affect the prevalence of alveolar bone defects. Presence of alveolar defects may have a deleterious effect on orthodontic treatment. **Aim:** The aim was to assess the prevalence and extent of dehiscence and fenestration in Class I hyperdivergent subjects and correlate it with buccolingual inclinations(BL) of maxillary first molar teeth. **Methods:** This retrospective study involved 80 CBCTs of class I hyperdivergent subjects divided into two groups - group A (n=33) buccolingual inclination >9º and group B (n=47) buccolingual inclination <9º. Prevalence and extent of alveolar bone dehiscence and fenestrations were measured in CBCTs using OSIRIX Lite software. Descriptive statistics, Mann Whitney U test and Spearman correlation were done for evaluating intergroup differences and correlation with Buccolingual inclination. **Results:** Overall prevalence of dehiscence and fenestration in maxillary first molars was 60.95% and 5% respectively. In the buccal alveolar bone, prevalence of dehiscence was highest in group A (84.6%) for 16 and in the lingual alveolar bone prevalence of dehiscence was highest in group B (71.4%) for 26 . On intergroup comparison, the extent of lingual alveolar bone dehiscence (26) in group B was significantly higher (p value <0.05) than in group A. No significant correlation between the extent of dehiscence and fenestration with buccolingual inclination of molar teeth was noted. **Conclusion:** Molar teeth with BL inclinations of more than 9º had higher prevalence of dehiscence on the buccal side and molar teeth with BL inclinations less than 9 degrees had more dehiscence on the lingual side. But no significant correlation of BL inclination with prevalence and extent of dehiscence and fenestration was noted.

Keywords: Malocclusion, Angle Class I. Maxilla. Molar. Orthodontics.

Introduction

A healthy periodontium is characterized by the presence of interproximal crestal bone positioned not more than 2 mm apical to the cemento-enamel junction [CEJ][1]. Any breach in the continuity of the cortical plate can result in alveolar bone defects like dehiscence or fenestration. Alveolar bone loss extending beyond 2 mm from the CEJ is considered as dehiscence[2,3]. Fenestration was identified as any localized defect in the alveolar bone exposing the root surface[1].

Optimum anterior teeth buccolingual inclination is important for obtaining normal overbite and optimum posterior inclination is important for obtaining maximum intercuspation of teeth while avoiding functional interferences[4]. Buccolingual positioning of the teeth in the alveolus may affect the prevalence of alveolar defects[5]. Factors such as type of malocclusion, facial type may also affect the prevalence of dehiscence and fenestrations[5,6]. Subjects with vertical growth pattern present with narrower cortical bone thickness in the posterior region of maxilla and mandible on the buccal side[7]. They have been reported to be associated with increased prevalence of alveolar dehiscence and fenestrations[8] and this can be attributed to thinner alveolar cortices and narrow alveolar housing[9].

Orthodontic tooth movement involves bone remodeling and can subject the dentition to certain irreversible changes like crestal bone loss hence identification of bony defects prior to starting treatment is very essential[6]. If the available alveolar bone dimensions are reduced or minimal before beginning orthodontic treatment it can subject the teeth and the periodontium to further resorptive processes[9]. Hence it is important to diagnose any alveolar bone defects before beginning orthodontic treatment.

Traditional 2D imaging cannot detect alveolar bony dehiscence and fenestrations accurately. The advent of cone beam computed tomography[CBCT] allows us to anticipate these defects in 3D images[10]. Several studies have assessed the alveolar bone defects using CBCT in cases with cleft lip and palate[11], after rapid maxillary expansion[12,13] in adults with different skeletal patterns[6,8] and different malocclusions[14]. Hence the current study has chosen CBCT as a mode of evaluation for alveolar bone defects.

Studies on the effect of buccolingual inclination of teeth on prevalence of alveolar bone defects have not been done. Hence the aim of the present study is to assess the prevalence and extent of alveolar dehiscence and fenestration in Class I hyperdivergent subjects. Also, to associate the same with different buccolingual inclinations of maxillary first molar teeth.

Materials and methodology

Design and setting of the study

This was a retrospective CBCT study carried out at the Department of Orthodontics, Saveetha Dental College. The study design was approved by the Institutional Review

Board, Saveetha University, Chennai. A total of 250 CBCTs of patients from the department of radiology, saveetha dental college were obtained. These were then further screened for the eligibility criteria given below. Only records of subjects satisfying the eligibility criteria were included in the study.

Inclusion criteria:

1. Class I skeletal occlusion (Wits analysis = -1 to 0mm ; ANB = 2º +/- 2).
2. Hyperdivergent cases with FMA > 30º and Korkhaus palatal index >44%.
3. Permanent dentition without missing molars except for third molars.
4. Good quality pre-treatment records.
5. Subjects with good periodontal health.

Exclusion criteria:

1. Presence of any oral pathologies like cysts/ tumors.
2. Multiple carious lesions, restorations, abrasions or abfractions near the CEJ.
3. Existing periodontal problems.
4. History of orthodontic treatment
5. Systemic diseases affecting bone metabolism and turnover like osteoporosis, osteonecrosis, any hormonal problems.
6. Scans of subjects under medications affecting bone metabolism.

Sample size calculation was performed using G*Power 3.1 software. Power calculation was performed using data obtained from published literature[6]. The analysis revealed a total sample size of 76 to achieve a power of 90% at α=0.10 significance level. The lateral cephalogram of the selected subjects were analyzed using FACAD software[version.3.11] . Among these records of hyperdivergent individuals with high palate index as assessed with Korkhaus palatal ratio of >44% were included in the present study[15,16]. A total of 80 CBCT records were selected based on eligibility criteria and sample size calculation. The included records were further divided into two groups according to the average of buccolingual inclination of first molar teeth; Group A - Buccolingual inclination >9 and < 14° and Group B - Buccolingual inclination of >5° and <9°.

CBCT images in DICOM format were assessed using OSIRIX LITE software by the same investigator [R.M]. Each posterior quadrant was viewed in the multiplanar view (coronal, axial, sagittal panels) with 3 times magnification. The mesiobuccal cusp of the maxillary first molar was used as the landmark for slice orientation. After orientation of the relevant planes, the coronal section was used to identify the landmarks necessary for analysis.

In the coronal section, a horizontal line passing through the mesiobuccal cusp of 16 and 26 was drawn and the palatal depth and width were measured (Figure 1). Buccolingual inclination is the angle between the perpendicular to the horizontal reference line passing through the palate and the long axis of the maxillary first molar in the coronal section (Figure 2). Measurement of Alveolar bony defects (Figure 3).

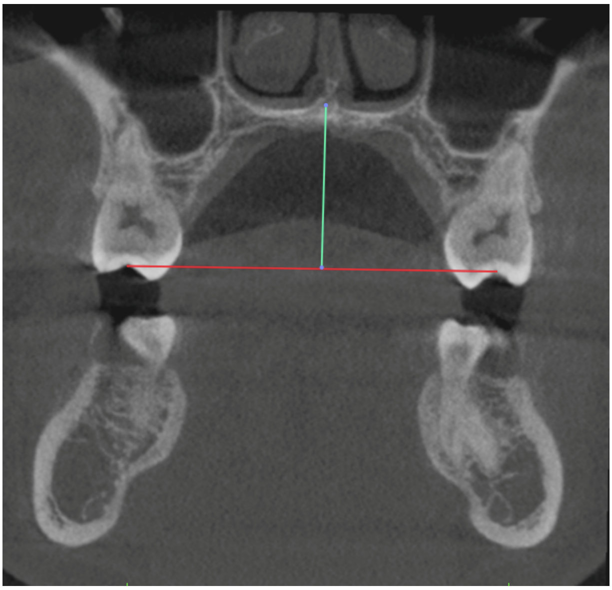

Figure 1. Horizontal line passing through the mesiobuccal cusp of 16 and 26 to drawn the palatal depth and width.

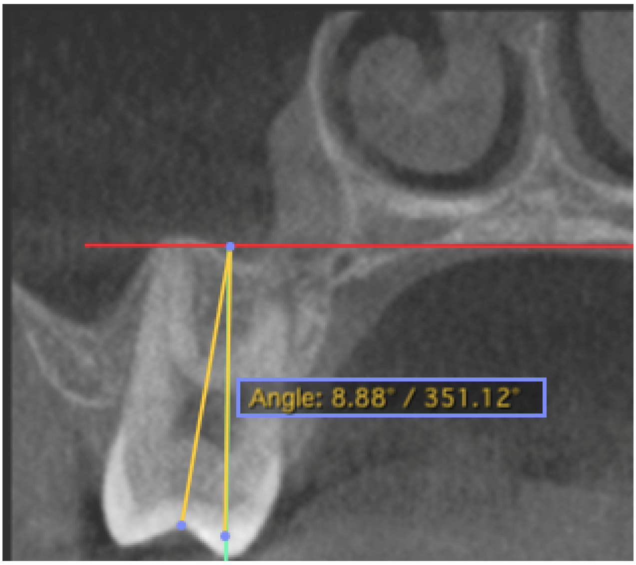

Figure 2. Measurement of buccolingual inclination of maxillary molar

A dehiscence was measured as any alveolar defect that is 2 mm or more in its vertical distance from the CEJ on both lingual and buccal surfaces of maxillary first permanent molar[17]. The prevalence and the extent of dehiscence was noted for both 16,26 in every CBCT. Fenestrations were identified on both buccal and lingual alveolar cortical surfaces of 16 and 26 and also the dimension in mm was measured.

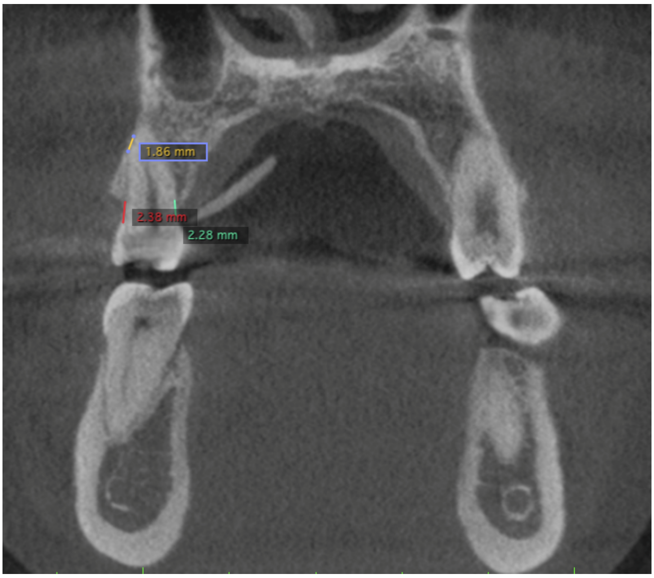

Figure 3. Measurement of alveolar dehiscence and fenestration

160 first molar teeth in 80 scans were examined for prevalence and extent of dehiscence and fenestration. Scans of 33 subjects were included in group A of which 13 were males and 20 were females. Group B included scans of 47 subjects of which 23 were males and 24 were females. Among these, in group A 24 CBCTs were of adult patients and 9 were of adolescents; whereas in group B 28 CBCTs were of adult patients and 19 were of adolescents. [Table.1] All data was tabulated in excel spreadsheet and subjected to statistical analysis. The outcomes assessed were prevalence and extent of dehiscence and fenestrations in the study groups.

Table 1. Demographic representation of study groups

Groups	Gender		Age	
	Male	Female	Adults	Adolescents
Group A	13	20	24	9
Group B	23	24	28	19

Group A= BL >9 degree ; Group B =BL <9 degree

Statistical analyses

All statistical tests were performed using SPSS software version 23.0. Normality of the data was assessed using the Shapiro-Wilk test. Interexaminer and intraexaminer reliability was assessed by kappa statistics. Frequency distribution of both groups in relation to age, gender, surface of involvement was done. Mean and standard deviations of prevalence and extent of dehiscences and fenestrations on buccal/lingual surfaces were computed for both groups. Mann Whitney's U test was done to compare the mean extent of dehiscence and fenestration in both groups. Spearman's correlation was performed to correlate the extent of dehiscence and fenestrations with buccolingual inclinations of maxillary first molars.

Results

Kappa values for interobserver and intraobserver reliability showed good agreement(0.7 to 1.00).

Prevalence of dehiscence and fenestrations in the study groups.

66.3% reported dehiscence in the right first molar (16) and 55.6% in left first molar (26) whereas 5.6% reported fenestration in 16 and 5% in 26.[Table.2] In the buccal surface, prevalence of dehiscence was highest in group A (84.6%) for 16 followed by group B (64.3%) for 26. In the lingual surface prevalence of dehiscence was highest in group B (71.4%) for 26 followed by 16 (70.7%) [Table. 3]. Highest prevalence of fenestration was observed in Group B - buccal of 16(7.3%) followed by buccal surface of 26 (7.1%) and lingual surface 26(7.1%) .

Table 2. Overall percentage distribution of dehiscence and fenestration in maxillary first molars

Tooth. No.	Prevalence of Dehiscence	Prevalence of Fenestration
16	66.3%	5.6%
26	55.6%	5%

Table 3. Prevalence of Dehiscence and Fenestration in both groups for buccal and lingual alveolar surfaces

Groups	Buccal tooth surface		Lingual root surface	
	16	26	16	26
Dehiscence				
Group A	84.6%	52.6%	46.2%	31.6%
Group B	53.7%	64.3%	65.9%	71.4%
Fenestration				
Group A	2.6%	5.3%	0%	0%
Group B	7.3%	7.1%	4.9%	7.1%

Group A= BL >9 degree; Group B =BL <9 degree

Intergroup comparison for extent of dehiscence and fenestration

Table 4 gives the Mann Whitney U test for intergroup difference of mean extent of dehiscence and fenestration on buccal and lingual surfaces of 16 and 26. No significant difference between the groups was noted for mean extent of dehiscence and fenestration (P value>0.05) except for amount of dehiscence in lingual surface of 26 which was reported to be higher in group B (p value < 0.05).

Table 4. Intergroup comparison of mean extent of dehiscence and fenestration (mm) in buccal and lingual alveolar surfaces

Groups	Buccal tooth surface				Lingual root surface			
	16	Sig.	26	Sig.	16	Sig.	26	Sig.
Dehiscence								
Group A	0.87 + 1.03	0.23	0.67 +0.87	0.82	0.66 + 1.06	0.12	0.53 + 0.91	0.03
Group B	0.61 + 0.86		0.67 + 0.74		0.78 + 0.78		0.66 + 0.55	
Fenestration								
Group A	0.03 + 0.21	0.33	0.10 +0.41	0.71	0.72 + 0.33	0.17	0	0.10
Group B	0.13 + 0.48		0.12 + 0.48		0		0.10 + 0.35	

p value<0.05, Mann Whitney U test
Group A= BL >9 degree ; Group B =BL <9 degree

Correlation between severity of alveolar defects with different buccolingual inclination of molars

A negative correlation between the extent of dehiscence and fenestration with buccolingual inclination of first molars was noted but this was not statistically significant except for dehiscence in the lingual surface for the first molars. [Table.5]

Table 5. Spearman's correlation between buccolingual inclination of maxillary molars and extent of dehiscence and fenestration

	Buccal surface	Sig.	Lingual surface	Sig.
Dehiscence	-0.001	0.989	-0.242	0.002
Fenestration	-0.052	0.515	-0.137	0.085

Discussion

The present study was conducted to report on the prevalence and extent of alveolar bone defects such as dehiscence and fenestrations in skeletal class I subjects with varying buccolingual inclinations. The study subjects were grouped based on the buccolingual inclinations of the upper first molar teeth and the prevalence, extent of dehiscence and fenestrations were evaluated.

Prevalence and extent of dehiscence

In the present study the overall prevalence of dehiscence in maxillary first molars was 60.95%. Prevalence of dehiscence in the buccal alveolar bone surrounding the maxillary molars was significantly higher than lingual side (p value<0.05). Many studies have reported similar results with higher prevalence of dehiscence in buccal alveolar bone surface[6,8,18-22]. This may be explained by the narrow morphology of maxilla which may result in resorption of the cortical bone covering the root surfaces[6,14,19]. According to Siriwat and Jarabak[23], the incidence of dehiscence is positively correlated with thin alveolar bone.

It is very important to diagnose these bone defects before attempting transverse expansion of the maxillary arch as these may worsen while attempting arch expansion because the buccolingual inclinations of molar teeth may change during treatment. Highest prevalence for dehiscence was reported in the buccal surface of maxillary molars (84.6%) with buccolingual inclination more than 9º. In lingual surfaces the prevalence of dehiscence was more in teeth with buccolingual inclination less than 9º (70.05%). However no significant correlation was reported between buccolingual inclination of molars and the extent of dehiscence. On intergroup comparison the extent of dehiscence in group B was significantly higher in lingual surfaces of 26 ($p<0.05$). The study by Coskun and Kaya[19] has reported on the prevalence of bone defects between different malocclusions in individual teeth. They have evaluated the buccolingual inclination differences between different malocclusions. The sample was divided into two groups and the prevalence and extent of bone defects was evaluated. They have reported that the prevalence of bone defects is not related to BL inclination which is in consensus with the present study.

Prevalence of Fenestration

The overall prevalence of fenestration was found to be around 5% in maxillary first molars in the present study. Highest prevalence(6.6%) of fenestration was noted in teeth with buccolingual inclination less than 9º in both buccal and lingual alveolar surfaces. No study has reported an association between prevalence of fenestration and buccolingual inclination of teeth.

According to Evangelista et al.[6] class I subjects have a high prevalence of dehiscence and fenestration when compared to Class II malocclusion subjects. The study by Coskun and Kaya[19] has also reported higher prevalence of dehiscence in class I subjects. Enhos et al.[8] reported higher prevalence of dehiscence in hyperdivergent and normodivergent subjects. Hence in the present study we have included skeletal class I subjects with hyperdivergent profiles to study the association of different BL inclinations on the prevalence and extent of dehiscence and fenestrations. Sendyk et al.[24] reported on thickness of alveolar bone and BL inclination in class III and Class I subjects. They reported lesser buccal bone thickness of maxillary molars in class III subjects than in class I subjects[24]. In class III subjects with hyperdivergent profiles the upper molars present with increased BL inclinations to compensate for lingual inclinations of lower molars and in these cases we may observe more dehiscence or reduced alveolar bone thickness.

Alveolar bone defects can be accurately visualized on CTs but in this study we used CBCTs because of easy availability as they are a part of routine radiographic examination for some orthodontic patients. Few studies have investigated the accuracy and also the limitations of CBCT as a detection tool for alveolar bony defects in vivo and in vitro[10,25,26]. CBCT has been reported with high specificity and high negative predictive value for imaging both dehiscence and fenestration but a low positive predictive value, especially for fenestration, has been reported[25,26].

Limitations

The results cannot be extrapolated to other populations or ethnicities since the data distribution is not parametric. The prevalence and extent of these defects in teeth with BL inclinations more than 14 degrees was also not studied.

Within the limitations of this study, the following conclusions could be drawn:

1. Buccal alveolar surfaces presented with higher prevalence of dehiscence.
2. The extent of dehiscence was more in the lingual surface of left maxillary molars with lesser BL inclination.
3. Molar teeth with higher BL inclinations had higher prevalence of dehiscence on the buccal side and molar teeth with lesser BL inclinations had more dehiscence on the lingual side. However, no significant correlation of BL inclination with prevalence and extent of dehiscence and fenestration was noted.

Ethics approval and consent to participate:

Study design was approved by the Institutional scientific review board - Saveetha Dental College and Hospitals [ETHICAL CLEARANCE NUMBER: IHEC/SDC/ORTHO-1903/21/197]

Data availability

Datasets related to this article will be available upon request to the corresponding author.

Author contribution

The study was conducted by RM under the guidance of RKJ. The statistical guidance was under AB. All authors contributed equally for article editing.

Competing interests

No Conflict of Interest.

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