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Research Article

Dehiscences and Fenestrations in Anterior Teeth: How to Assess Severity?

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Abstract

Objective. Determinate the frequency and severity of vestibular dehiscences and fenestrations in anterior teeth in orthodontic–surgical patients with skeletal malocclusion Angle class III evaluated with presurgical Cone-Beam Computed Tomography. **Methods.** Thirty Cone-Beam Computed Tomography of skeletal class III malocclusion patients with presurgical orthodontic treatment were evaluated. The sample was non – probabilistic and consecutive attended cases in the Faculty of Dentistry, UNMSM and the Dentistry Service of Guillermo Almenara Irigoyen National Hospital in Lima, Perú in 2018. Dehiscence may be defined as the apical migration of the alveolar margin bone from 2 mm since the cemento–enamel junction, and fenestration may be defined as the exposure of the root portion but excluding the alveolar margin bone from 0,5mm. **Results.** From all tomographies, 43.3% were from women and 56.7% were from men. Dehiscences were observed in all tomographies, most frequently in the mandible (91.6%) and inferior canines (100%). Fenestrations were observed in 66.7%, most frequently in the maxilla (28.3%) and superior canines (31.7%). The severe level was more frequently in dehiscences (65.8%) and fenestrations (13.9%), affecting the inferior canines (100%) and superior canine (26.7%), respectively in each defect. **Conclusions.** Dehiscences were observed in all tomographies, affecting most frequently mandible canines in severe level and fenestrations were observed in most tomographies, affecting most frequently maxillary canines in severe level.

Keywords: Malocclusion Angle class III; Cone-Beam Computed Tomography; Cuspid. (Source: MeSH NLM)

Introduction

Alveolar bone defects and its relationship with orthodontic treatment has been discussed for a long time [1,2]. In malocclusion Angle class III patient exists a physiological dental compensation with the maxillary incisors with proclination and mandibular incisors with lingual inclination. This, with the reduced bony anatomy surrounding these teeth (mandibular symphysis and vestibular, lingual/palatal plate) may restrict the amount displaced during the treatment, especially if the required inclines are excessive [3].

Kook *et al.* [4] reported a higher vertical alveolar bone loss in mandibular incisors in malocclusion Angle class III patient and a less alveolar bone thickness in the Cement – Enamel Junction (CEJ) than the apical zone, determining a higher prevalence of dehiscences than fenestrations, especially during orthodontic treatment. Also, Sun *et al.* [17] reported more dehiscences than fenestrations. The most affected tooth by dehiscence was de mandibular cuspid and by fenestration was de maxillary cuspid. Determined the cone beam computed tomography accuracy (CBCT) to detect alveolar defects [5,6].

Caballero [1] indicated patients without orthodontic treatment present dehiscences in anterior teeth (mandibular incisives) and fenestrations in posterior teeth (maxillary bicuspid). While

patients with orthodontic treatment could present more amount or severity of dehiscences and fenestrations because orthodontic movements, especially labio-lingual/palatal movement, reducing the alveolar crest and thickness directed at tooth movement. During orthodontic treatment, if the applied force is higher than can support the periodontal tissue, this alveolar defects appears, considerating patient bone and teeth characteristics.

Occasionally, when the realice camouflage treatment have not the expected outcomes, the treatment can change and do the surgery correction, although, this can be more harmful to the patient [7]. During the orthodontic treatment, the cortical thinning because tooth movements is a periodontal risk factor to consider. The labial and lingual cortical plate and mandibular symphysis are considered limits for a dentoalveolar compensation. For this reason, is necessary a deep analysis of the surrounding bone tissues to make adequate decisions [8].

This investigation allows increase the bone defects knowledge like dehiscences and fenestrations, which can generate consequences in the treatment and an adverse prognosis. Is important related the tooth volume with the skeletal volume to know the limits available for treatment, which allow obtaining a tooth position as equidistant as possible from the bone plates.

In this way, the purpose of this study was determinate the frequency and severity of vestibular dehiscences and fenestrations in anterior teeth in orthodontic–surgical patients with skeletal malocclusion Angle class III evaluated with presurgical Cone-Beam Computed Tomography.

Materials and Methods

A cross – sectional, descriptive and retrospective study was conducted. A non-probabilistic was considered, for consecutive cases of 30 patients with pre surgery orthodontic treatment previously diagnosed with skeletal malocclusion Angle class III confirmed by imaging.

The tomographies evaluated were necessary auxiliary examinations in malocclusion Angle class III patients with pre-surgical orthodontic treatment. For the specialized treatment of these patients, the same informed consent format was used, requested by the Dentistry Clinic of the National University of San Marcos and the Dentistry Service of the Guillermo Almenara Irigoyen National Hospital.

In this study, the data already stored in the tomographic records with the corresponding permissions to access these data are used.

Tomographic Analysis

CBCT images were obtained with a Point 3D Combi 500 device (PointNix Corea) with an exposure data of 90kV, 5 mA y 19s, with a slice thickness of 0mm and a voxel size of 0.303mm and 0.4mm and 4 fields of view (FOV) (an axial, sagittal, coronal and 3D) of 19,5cm x 24,4cm with a resolution of 3.94 lp/mm and a scanner time of 20 seconds. The images were evaluated with Real Scan 2.0 software.

12 anterior teeth were evaluated by tomography to measure dehiscences and fenestrations (6 maxillary teeth and 6 mandibular teeth).

Reference points and measures

Reference points and measurements were taken in the sagittal view of the TCCB along the long axis of the tooth [9-11].

The reference of defects measurement (Fig. 1) were obtained from the Sun [10] and Lee [9] studies, considering only the labial plate of the tooth.

These references are:

- **Dehiscences:**

Apical migration of alveolar crest [12].

Point A: Cementoenamel junction (CEJ) in the labial surface.

Point B: Alveolar crest (AC) defined as the most coronal level of alveolar bone on the labial face.

The distance between these two points >2mm called dehiscence (d)

- **Fenestrations:**

Exposed root portion without affecting the bone margin [13].

Point C: The upper limit of the bone loss, on the labial face in the middle and apical third of the tooth, without affecting the alveolar margin.

Point D: The lower limit of the bone loss, on the labial face in the middle and apical third of the tooth, without affecting the alveolar margin.

The distance between these two points >0,5mm called fenestration (f)

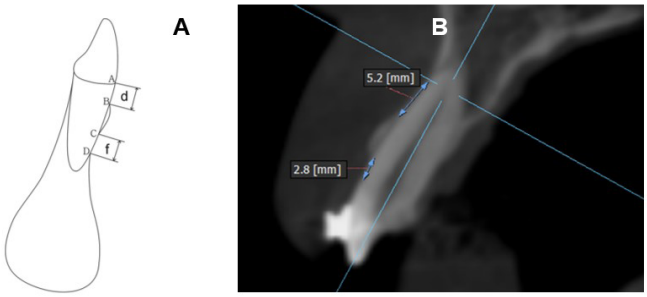

Figure 1: Critical points to measure dehiscences and fenestrations in anterior tooth. **A.** Modification of figure following the Sun *et al.* [10] model. The distance between the point A (cement – enamel junction) and point B (alveolar crest) is considerated dehiscence, and the distance between the pint C (upper limit of the bone loss) and point D (lower limit of the bone loss) is considerated fenestration when it does not affect the alveolar margin. **B.** Points A, B, C and D in sagittal view of CBCT.

Defects severity classification

- **Dehiscences**

To classify dehiscences, the reference was taken according to probing depth by the American Academy of Periodontology (AAP) [14], because in both cases there is a migration to apical since de bone crest to evaluate. Class 1 (absent): <3mm, Class 2 (mild): >3mm to 5mm, Class 3 (moderate): >5mm to 7mm and Class 4 (severe): >7mm.

Sun et al. [10] y Lee et al. [9] reported the dehiscence since 2mm, by that way we consider Mild: >2mm to 5mm, Moderate: >5mm to 7mm and Severe: >7mm. (Chart 1and2).

- **Fenestrations**

To classify fenestrations, the reference was taken according to clinical attachment loss by the American Academy of Periodontology (AAP) [13], because in both cases there is bone loss. Class 1 (absent): 0mm, Class 2 (mild): <2mm, Class 3 (moderate): >2mm to 4mm, and Class 4 (severe): >4mm.

The fenestration was taken since 0,5mm to avoid any tomographic mistake, by that way we consider Mild: >0,5mm to 2mm, Moderate: >2mm to 4mm and Severe: >4mm. (Chart 1 and Chart 2)

Clinical degree of severity		Gingival inflammation, hemorrhage (BOP)	Probing depth (PD)	Clinical attachment loss (CAL)
Class	**Forma**			
Class 1	Gingivitis	+ to +++	1 – 3mm.	-
Class 2	Mild periodontitis	+ to +++	4 – 5mm.	1 – 2mm.
Class 3	Moderate periodontitis	+ to +++	6 – 7mm.	3 – 4mm.
Class 4	Severe periodontitis	+ to +++	>7mm.	>5mm.

Chart 1. Classification of periodontal severity degree according American Academy of Periodontology (AAP) [13].

	Dehiscence	**Fenestration**
Absent	< 2 mm	< 0,5 mm
Mild	>2 to 5 mm	>0,5 to 2 mm
Moderate	>5 to 7 mm	>2 to 4 mm
Severe	>7 mm	>4 mm

Chart 2. Severity degree of dehiscences and fenestrations proposed by this study taking as reference the data of the AAP.

Statistical analyses

Data from a total of 360 anterior teeth were statistically analyzed for the occurrence rates of dehiscence and fenestrations and their severity according to Table 1 for each type of tooth and location (maxilla and mandible). SPSS Statistics 23.0 was used for the statistical processing.

El análisis y procesamiento de datos se realizaron a través del programa estadístico SPSS. The χ^2 test was performed to obtain data statistical significance ($p<0,05$).

Results

Sample description

Were 30 CBCT images from treated patients with pre surgery orthodontic treatment previously diagnosed with skeletal malocclusion Angle class III: 13 women and 17 men, representing 43,3% and 56,7%, respectively.

Frequency of dehiscences and fenestrations

All the sample presented dehiscences. Of the 12 evaluated teeth in each tomography, there were minimum 6 teeth and maximum 12 teeth were affected by dehiscence. (Table 1).

The 66,7% of the sample presented at least one affected tooth by fenestration. There were maximum 9 affected teeth in 10% of sample. (Table 2).

Number of teeth affected by dehiscences	CBCT		
	n	%	Cum. %
12	12	40	40
11	3	10	50
10	6	20	70
9	4	13,3	83,3
8	2	6,7	90
7	1	3,3	93,3
6	2	6,7	100
Total	30	100	100

Table 1. Frequency of dehiscences by tomography.

Number of teeth affected by fenestrations	CBCT		
	n	%	Cum. %
9	3	10	10
7	1	3,3	13,3
6	1	3,3	16,7
5	2	6,7	23,3
4	2	6,7	30
3	4	13,3	43,3
2	4	13,3	56,7
1	3	10	66,7
0	10	33,3	100
Total	30	100	100

Table 2: Frequency of fenestrations by tomography.

Frequency according the arcade

Dehiscences were found in maxilla and mandible teeth of all the sample. Although, mandible teeth had greater frequency (91,7%) (Table 3).

60% of the sample presented fenestrations in maxilla, and 36,7% were in mandible. Also, 28,3% of teeth affected were located in maxilla and 16,7%, in mandible (Table 4).

	Maxillary				Mandible				Total			
	CBCT		Teeth		CBCT		Teeth		CBCT		Teeth	
	n	%	n	%	n	%	n	%	n	%	n	%
With dehiscence	30	100	143	79,4	30	100	165	91,7	30	100	308	85,6
Without dehiscence	0	0	37	20,6	0	0	15	8,3	0	0	52	14,4
Total	30	100	180	100	30	100	180	100	30	100	360	100

(p: 0,001)

Table 3. Frequency of dehiscences according the arch.

	Maxillary				Mandible				Total			
	CBCT		Teeth		CBCT		Teeth		CBCT		Teeth	
	n	%	n	%	n	%	n	%	n	%	n	%
With fenestration	18	60	51	28,3	11	36,7	30	16,7	20	66,7	81	22,5
Without fenestration	12	40	129	71,7	19	63,3	150	83,3	10	33,3	279	77,5
Total	30	100	180	100	30	100	180	100	30	100	360	100

(p: 0,008)

Table 4: Frequency of fenestrations according the arch.

Frequency according type of anterior tooth

All mandibular cuspid evaluated presented dehiscences (100%). The second tooth more affected were mandibular lateral incisor (88,3%) and the less affected tooth were maxillary central incisor (76,7%) and maxillary cuspid (76,7%) (Table 5).

Type of tooth	Dehiscences					
	With		Without		Total	
	n	%	n	%	n	%
Md C	60	100	0	0	60	100
Md LI	53	88,3	7	11,7	60	100
Md CI	52	86,7	8	13,3	60	100
Mx LI	51	85	9	15	60	100
Mx CI	46	76,7	14	23,3	60	100
Mx C	46	76,7	14	23,3	60	100
Total	308	85,6	52	14,4	360	100

(p: 0,003)

Md C: Mandibular cuspid

Md LI: Mandibular lateral incisor

Md CI: Mandibular central incisor

Mx LI: Maxillary lateral incisor

Mx CI: Maxillary central incisor

Mx C: Maxillary cuspid

Table 5: Frequency of dehiscences according the type of anterior teeth.

31.7% of the maxillary canines were affected by fenestrations, followed by the maxillary lateral incisor (30%) and the mandibular central incisor (30%). Although, the mandibular canine was not affected by this defect (Table 6).

Type of tooth	Fenestraciones					
	With		Without		Total	
	n	%	n	%	n	%
Mx C	60	31,7	41	68,3	60	100
Mx LI	18	30	42	70	60	100
Md CI	18	30	42	70	60	100
Mx CI	14	23,3	46	76,7	60	100
Md LI	12	20	48	80	60	100
Md C	0	0	60	100	60	100
Total	81	22,5	279	77,5	360	100

(p: 0,000)

Mx C: Maxillary cuspid

Mx LI: Maxillary lateral incisor

Md CI: Mandibular central incisor

Mx CI: Maxillary central incisor

Md LI: Mandibular lateral incisor

Md C: Mandibular cuspid

Severity of dehiscences

The results showed different severity degrees of dehiscences. In the first place is severe degree with 65.8%, followed by mild degree with 17.5% and the moderate degree with 2.2%. Also, in mild degree, the most affected tooth was maxillary lateral incisor (35%), in moderate degree, was mandibular lateral incisor (6.7%) and in severe degree was all mandibular cuspid (100%). (Table 7).

Type of tooth	Absent		Mild		Moderate		Severe		Total	
	n	%	n	%	n	%	n	%	n	%
Mx CI	14	23,3	17	28,3	2	3,3	27	45	60	100
Mx LI	9	15	21	35	1	1,7	29	48,3	60	100
Mx C	14	23,3	8	13,3	1	1,7	37	61,7	60	100
Md CI	8	13,3	11	18,3	0	0	41	68,3	60	100
Md LI	7	11,7	6	10	4	6,7	43	71,7	60	100
Md C	0	0	0	0	0	0	60	100	60	100
Total	52	14,4	63	17,5	8	2,2	237	65,8	60	100

(p: 0,000)

Table 7: Severity degree of dehiscences according the type of anterior tooth.

Severity of fenestrations

The results showed different severity degrees of fenestrations. In the first place is severe degree with 13,9%, followed by moderate degree with 5% and the mild degree with 3,6%. Also, in mild and moderate degree, the most affected tooth was mandibular central incisor with 11,7% and 10%, respectively, and in severe degree, the most affected tooth was maxillary cuspid (26,7%) (Table 8).

Type of tooth	Absent		Mild		Moderate		Severe		Total	
	n	%	n	%	n	%	n	%	n	%
Mx CI	46	76,7	2	3,3	2	3,3	10	16,7	60	100
Mx LI	42	70	3	5	4	6,7	11	18,3	60	100
Mx C	41	68,3	0	0	3	5	16	26,7	60	100
Md CI	42	70	7	11,7	6	10	5	8,3	60	100
Md LI	48	80	1	1,7	3	5	8	13,3	60	100
Md C	60	100	0	0	0	0	0	0	60	100
Total	279	77,5	13	3,6	18	5	50	13,9	60	100

(p: 0,000)

Table 8: Severity degree of fenestrations according the type of anterior tooth.

Discussion

This study provides to recognize, measure and classify through tomographic evaluation dehiscences and fenestrations in patients with skeletal malocclusion Angle class III. Previous studies [3,8,15] have reported more frequency of dehiscences and fenestrations in anterior teeth than posterior teeth, and more defects in vestibular plate than lingual plate.

CBCT evaluation showed that dehiscences are more frequent than fenestrations in patients with malocclusion Angle class III, even without orthodontic treatment [16]. Sun *et al*. [10] also reported a higher percentage of dehiscences, similar to this study. Kook *et al.* [4] reported less alveolar thickness in the CEJ than it apex of the mandibular incisors, promoting greater dehiscence formation [17].

The patients with skeletal malocclusion Angle class III have bone characteristics which plays an important role in the development of these defects, due to the fact that they have thinner bone plates and anterior teeth tipping [3,8,10]. Kook et al. [4] and Kim et al. [18], reported greater bone resorption in mandibular plates than in maxillary plates of mandibular incisors of these patients, because their mandibular symphysis is thinner than patients with other types of malocclusion. Also, Yagci et al. [3] shows a higher percentage of mandibular dehiscences and higher fenestrations in maxillary. Those results are similar with this study where mandibular dehiscences are more frequent than maxillary ones and maxillary fenestrations are more frequent than mandibular fenestrations.

The mandibular cuspid was the more affected tooth by dehiscence, this was consistent with Rupprecht et al. [19] y Sun et al. [10] studies. And maxillary cuspid was the more affected tooth by fenestration, similar to other studies [2,10,16].

Yan Yang et al. [11], classify dehiscences according to their size (Class I), the presence of other alveolar defects (Class II), or according to the affected dental plates (labial and lingual/palatal). The degree of severity could be determined as subdivisions into Class I and Class II, however, it does not define which ones have a worse prognosis. Pan et al. [16] classify fenestrations into 6 types, according to the root third affected. Types I, II and III depend on the apical, middle or coronal exposure of one third of the root, respectively. Types IV and V refer to mid-apical and mid-coronal exposure, respectively. And type VI refers to the three thirds of the exposed root. The size depends to the root length.

This study proposes a new classification for these defects according to their size with a degree of severity for future studies and the planning of a probable treatment. This classification takes into account the mild, moderate and severe degree, since the absent degree is only a reference. According to this classification, dehiscences were more frequent in the severe degree with all mandibular canines affected. Fenestrations were also more frequent in the severe grade with 26.7% of the maxillary canines affected. This higher frequency is due to the fact that orthodontic movement could aggravate their situation, especially with labio-lingual movement due to maxillary incisor protrusion and mandibular incisor retrusion during compensation of Class III patients, reported by Caballero [1]. For this reason, tooth inclination is important in the treatment of Angle class III skeletal malocclusion, depending on the severity of the malocclusion and trying to place the tooth as equidistant as possible from both cortical plates and reducing periodontal damage [20].

Future studies should compare the presence of these defects before and after orthodontic treatment, depending on the patient's age, type and treatment technique, to evaluate the factors that increase their incidence. This allows a better diagnosis for a better treatment plan, since these defects can complicate treatment and even cause risks during pre-surgical orthodontic treatment [10,21].

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