Crowding teeth and alveolar bone of mandibular central incisors in adults

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Abstract
Objectives: To study the correlation between alveolar bone morphology of mandibular central incisors and crowding of the six anterior mandibular teeth by using little's Irregularity Index in adults.
Materials and Methods: A total of 44 adults' cases (22 females and 22 males), aged 18-38 years. Patients were scanned by CBCT. We evaluated the morphology of alveolar bone around mandibular central incisors, calculated Little's Irregularity Index of the anterior lower dental arch, analyzed data, performed the statistical analysis, and studied the correlation.
Results: The current study showed statistically significant differences according to gender between some sites of alveolar bone surrounding central incisors and found no confirmed correlations between the studied variables.
Conclusion: The potential risks, which may occur as a result of orthodontic treatment for adults, require individual planning of each tooth movement after assessing its condition and position within the dental arch, as well as a continuous evaluation of the surrounding alveolar bone, in order to achieve safe treatment results that ensure the integrity of the periodontal tissues.

Keywords: Alveolar bone, CBCT, Central incisors, Little's Irregularity Index, Crowding teeth

Introduction

Recently, the number of adult patients requesting orthodontic treatment has increased. Therefore, the orthodontist must pay more attention to the periodontal tissues through accurate diagnosis and careful planning for treatment with participation from other specialties [1].

Garib *et al*. attempted to determine the bio-limits of dental movement and found that the orthodontic movements are restricted by the morphology of alveolar bone. They mentioned also that the dehiscence regions may exist prior to orthodontic treatment in adults (especially at alveolar bone sites around mandibular incisors) or maybe cause by buccolingual tooth movement [2]. Hence came the necessity of evaluating alveolar bone from all aspects and trying to define its correlations with other factors to reach a comprehensive view of this important topic.

Gowda *et al*. confirmed the correlation between the alignment of anterior teeth and periodontal biotype and mentioned that the thick biotype is accompanying good alignment [3]. Whilst, Shekar *et al*. reported the interrelationship between the periodontal tissues and the orthodontic movements [1].

Orthodontic treatment of crowding teeth will improve oral hygiene and periodontal tissues; from another side, it will lead to proper conditions to regenerate these tissues [4]. In general, dental crowding is defined as a misalignment of the teeth resulting from a discrepancy between the size of teeth and the required space (for correct aesthetic and functional alignment) within the dental arch [5, 6], and this irregularity is reported as the most prevalent type of malocclusion [7].

Sayin *et al*. classified the crowding teeth degree according to the sum of spaces shortage within the dental arch as follow: mild crowding (0–3 mm), moderate crowding (4–6 mm), and severe crowding (> 6 mm) [8].

Whereas the crowding in the mandibular anterior teeth region was classified according to Little's Irregularity Index (LII). This index depends on the sum calculation of the five displacements of contact points between these teeth, and classification is as follow: perfect alignment (0 mm), minimal irregularity (1-3 mm), moderate irregularity (4-6 mm), severe irregularity (7-9 mm), very severe irregularity (>10 mm) [9].

Materials and Methods

Based on the above, we decided to evaluate buccal and lingual alveolar bone of the mandibular central incisors, and study the crowding of mandibular anterior teeth (canine to canine) by the Little's Irregularity Index to detect if there is any correlation between them.

We collected CBCT cases out of patients' records in the Regional Clinical Dental Polyclinic, Volgograd, Russia.

For confidentiality and privacy of the patients' personal data, we gave random numbers for cases. Then, the selection was made according to the following criteria:

1. **Inclusion criteria:** 1) Age between 18 and 38 years. 2) CBCT cases of Mandible, which are including the anterior teeth fully. 3) Cases before any orthodontic treatment. 4) Cases without spaces, severe rotations, eruption disorders, or missing any anterior teeth. 5) Healthy mandibular anterior teeth.
2. **Exclusion criteria:** 1) Age under 18 and older than 38 years 2) CBCT cases of posterior teeth only. 3) Previous orthodontic treatment. 4) Severely rotated teeth. 5) Spaces between teeth. 6) Disorders of eruption and missing anterior teeth. 7) Short roots of incisors. 8) Periodontitis, bone and gum diseases.

In the end, we selected 44 CBCT cases. Each case represented 2 study subjects (2 mandibular central incisors), and the final distribution of cases was: 44 cases / 88 subjects (22 females - 44 subjects and 22 males - 44 subjects).

All cases were scanned by the Vatech 3D imaging machine (Model: PaX-i 3D, South Korea). "Ez3D plus" software was used to get images reconstruction, and to take the digital measurements on sagittal views. The evaluation of alveolar bone morphology was performed by measuring height and thickness of alveolar crest, alveolar plate thickness and alveolar width at each third of the root (Fig. 1): 1) coronal third, 2) middle third, 3) apical third.

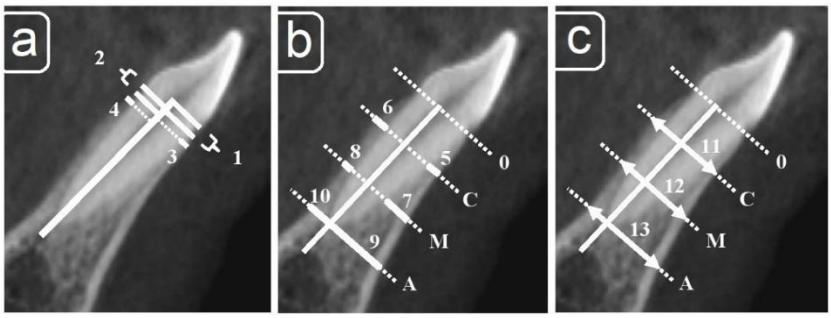

Fig 1a: 1-Buccal alveolar crest height, 2-Lingual alveolar crest height, 3-Buccal alveolar crest thickness at 0.5 mm apically, 4-Lingual alveolar crest thickness at 0.5 mm apically
1b: (5, 7, 9) Buccal alveolar plate thickness at each third of the root length, (6, 8, 10) Lingual alveolar plate thickness at each third of the root length
1c: (11, 12, 13) Alveolar width at each third of the root length
Line (0): level of the root beginning
(C) Level of the Coronal third / 1st third of the root, (M) level of the middle third / 2nd third of the root, (A) level of the apical third /3rd third of the root

We calculated the Irregularity Index for each case after measuring the distances of displacements of contact points between mandibular anterior teeth on the dental models by a digital caliper (Fig. 2).

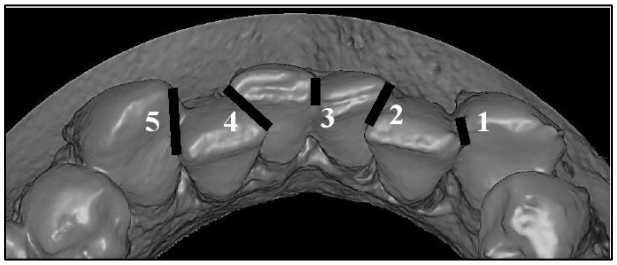

Fig 2: Little's Irregularity Index {Sum (mm) = 1+2+3+4+5}

Finally, we studied cases after dividing them into groups according to studied variables (gender, Little's Index values, and crowding degree).

Results

We used Statistical Package for the Social Sciences (IBM SPSS Statistics, version 26) to perform all data analyses, and summarized the characteristics of the data set by Descriptive Statistics. Then we compared between measurements ($P > 0.05$, assuming a level of significance of 95%) according to gender, Little's Index values, and crowding degree and we reached the following:

1- By comparing the alveolar measurements between males and females, the outcomes showed that there were statistically significant differences (Sig < 0.05) as follow:

- Buccal Plate Thickness at the level of coronal third was thinner in females.
- Buccal Plate Thickness at the level of apical third was thinner in males.
- Lingual Plate Thickness at the level of middle third was thinner in males.
- Alveolar width at the level of coronal third was thinner in females.

2- By comparing the Little's Irregularity Index values and the crowding degree between males and females, no statistically significant differences were found (Sig > 0.05).

From another side, studying correlations (by Spearman/Pearson Analysis) led us to the following:

1. No correlation between Little's Irregularity Index / crowding degree and gender.
2. Very weak positive correlation ($P < 0.05$) between Little's Irregularity Index / crowding degree and age.
3. No correlation between Little's Irregularity Index and alveolar measurements.
4. Very weak positive correlation ($P < 0.01$) between crowding degree and lingual alveolar crest height.
5. Weak positive correlation ($P < 0.01$) between age and lingual alveolar crest height.
6. Very weak positive correlation ($P < 0.05$) between age and both buccal alveolar crest height / buccal plate thickness, at the level of coronal third.
7. Weak positive correlation ($P < 0.01$) between gender and both buccal alveolar crest thickness / buccal plate thickness, at the level of coronal third.
8. Weak negative correlation ($P < 0.01$) between gender and both buccal plate / alveolar width, at the level of apical third.
9. Very weak positive correlation ($P < 0.05$) between gender and alveolar width at the level of coronal third.
10. Very weak negative correlation ($P < 0.05$) between gender and lingual plate thickness at the level of middle third.

Table 1: Descriptive data of measured alveolar bone dimension around central incisors – according to gender

		Buccal Crest Height	Lingual Crest Height	Buccal Crest Thickness	Lingual Crest Thickness	Buccal Plate Thickness at level C	Buccal Plate Thickness at level M	Buccal Plate Thickness at level A	Lingual Plate Thickness at level C	Lingual Plate Thickness at level M	Lingual Plate Thickness at level A	Alveolar Ridge Thickness at level C	Alveolar Ridge Thickness at level M	Alveolar Ridge Thickness at level A
Females	Mean	1.76	2.3	0.58	0.57	0.49	1.37	3.82	0.69	1.31	3.82	6.56	7.18	9.36
	SD	0.57	1.01	0.20	0.14	0.14	0.67	1.11	0.29	0.62	1.11	0.49	0.97	1.97
Males	Mean	1.91	2.49	0.71	0.61	0.7	1.21	3.77	0.7	1.08	3.77	6.91	6.83	8.22
	SD	0.78	0.86	0.17	0.18	0.25	0.64	0.96	0.41	0.48	0.96	0.81	0.87	1.43
Total	Mean	1.84	2.39	0.64	0.59	0.59	1.29	5.00	0.70	1.2	3.8	6.73	7.01	8.79
	SD	0.68	0.94	0.2	0.16	0.23	0.66	1.61	0.35	0.56	1.03	0.68	0.93	1.8

Table 2: Descriptive data of measured alveolar bone dimension around central incisors – according to crowding degree

		Buccal Crest Height	Lingual Crest Height	Buccal Crest Thickness	Lingual Crest Thickness	Buccal Plate Thickness at level C	Buccal Plate Thickness at level M	Buccal Plate Thickness at level A	Lingual Plate Thickness at level C	Lingual Plate Thickness at level M	Lingual Plate Thickness at level A	Alveolar Ridge Thickness at level C	Alveolar Ridge Thickness at level M	Alveolar Ridge Thickness at level A
Minimal	Mean	1.86	1.99	0.63	0.6	0.5	1.25	5.23	0.69	1.21	4.08	6.82	7.27	9.31
	SD	0.61	0.72	0.18	0.17	0.08	0.6	1.55	0.28	0.54	0.92	0.48	0.91	1.51
Moderate	Mean	1.73	2.4	0.67	0.59	0.65	1.39	5.00	0.68	1.19	3.59	6.66	6.89	8.58
	SD	0.54	0.83	0.20	0.13	0.25	0.72	1.63	0.33	0.52	1.00	0.72	0.95	1.82
Severe	Mean	1.96	3.05	0.55	0.48	0.51	1.17	5.28	0.58	1.03	3.69	6.64	6.94	8.97
	SD	0.78	1.45	0.18	0.16	0.14	0.56	1.49	0.26	0.49	0.88	0.7	0.74	1.8
Very Severe	Mean	2.33	2.41	0.73	0.76	0.68	0.95	3.68	1.05	1.58	4.61	7.21	7.15	8.3
	SD	1.39	0.48	0.23	0.17	0.34	0.38	1.64	0.67	0.95	1.46	0.87	1.2	2.53
Total	Mean	1.84	2.39	0.64	0.59	0.59	1.29	5.00	0.7	1.2	3.8	6.73	7.01	8.79
	SD	0.68	0.94	0.2	0.16	0.23	0.66	1.61	0.35	0.56	1.03	0.68	0.93	1.8

Discussion

The present study showed statistical differences according to gender in some measured alveolar sites. As for the Little's Irregularity Index / crowding degree, no differences were found according to gender.

There is no confirmed correlation between Little's Irregularity Index / crowding degree and gender, age, alveolar bone of mandibular central incisors. As well as, there is no confirmed correlation between alveolar bone of mandibular central incisors and gender, age.

According to values of Little's Index, moderate crowding (LII value: 4-6 mm) was the prevalent type of this irregularity with 54.76% of total cases (23.81% of females, and 30.95% of males).

At the level of coronal third, means of buccal and lingual thicknesses of alveolar bone around mandibular central incisors were thin (less than 1 mm) in both females and males. This matter led us to assume that there are critical sagittal movements during orthodontic treatment, as follow:

1. Buccal movements of mandibular central incisors at the level of the coronal buccal third. These movements are more critical in females (mean of thicknesses was less than 0.5 mm).
2. Lingual movements of mandibular central incisors at the level of the coronal lingual third.

Conclusion

Within the limits of this study, we failed to identify any significant correlation between the alveolar bone of mandibular central incisors and anterior crowding. Nevertheless, we recommend further investigation into this matter by studying a larger number of cases.

There is a probable risk at the level of alveolar bone with some sagittal movements of mandibular central incisors. Therefore, we emphasize the necessity for individual planning for the orthodontic movement of each tooth after evaluating the alveolar bone at various levels to determine the risky sites if any. This evaluation should be continuous before, during, and after orthodontic treatment to achieve the best results and maintain the integrity of periodontal tissues.

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