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THE ANALYSIS OF NON-SPECIFIC FACTORS INDUCING THE ALVEOLAR BONE ATROPHY EXACERBATED BY AN OCCLUSAL TRAUMA

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Abstract

Dentoalveolar malocclusion, accompanying the periodontal diseases and exacerbated by the generalized alveolar bone atrophy, is an important challenge for orthodontics. It has been traditionally diagnosed based on two dimension radiology only, thus the complex of factors leading to the generalized alveolar bone atrophy has been dismissed and insufficinetly studied. In our opinion the main factors causing the alveolar bone atrophy are bone density and bone thickness.

Objectives: *to evaluate the density of bone structure and the position of the roots of the lower incisors in it, and it's impact on the development of non-inflammatory generalized alveolar bone atrophy in the presence of chronic occlusal trauma.*

Materials and methods: *To study the effect of bone density and the position of the roots of the incisors, we chose CBCT of 20 patients which devided into two groups: one with generalized alveolar bone atrophy (group No. 1), others with generalized dental abrasion (group No. 2). Thicknesses and densities were measured at three levels of the roots (cervical, middle and apical regions) from the labial and lingual sides. Then we calculated the Student's test, which showed us statistically significant data.*

Results: *in group No. 1, bone density of D4 was detected, atrophy was observed the same as with vestibular and lingual side. In group No. 2, bone density was identified as D1, D2, and atrophy was insignificant. In all cases, the density and thickness of the cortical layer increased from the cervical to the apical region.*

Conclusion: *The bone density and the thickness of its cortical layer are one of the determining factors in the development of non-inflammatory generalized alveolar bone atrophy. With the correct interpretation of these factors, it is possible to predict the development of pathologies by sending treatment to their prevention or remission.*

Key words*: **occlusal trauma, alveolar bone density, alveolar bone thickness, cone-beam computed tomography.***

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INTRODUCTION:

Dentoalveolar malocclusion, accompanying the periodontal diseases and exacerabated by the generalized alveolar bone atrophy, is an important challenge for orthodontics[1,3,10,18]. Defining this pathology with greater precision is crucial for further diagnostics and choosing the right method of malocclusion treatment. However, it has been traditionally diagnosed based on two dimension radiology only, thus the complex of factors leading to the generalized alveolar bone atrophy has been dismissed and insufficinetly studied. The studies into the correlation between various factors remain highly controversial.

Teeth movement is a complex process of simultaneous bone resorption and bone formation being in a subtle equilibrium. In some cases, bone resorption dominates over the process of bone formation, which brings about its intensive atrophy. Moreover, a set of specific and non-specific factors also trigger the process.

The specific factors include inflammatory processes in periodontal tissues; somatic diseases such as: diabetes mellitus, atherosclerotic disease, osteoporosis; smoking; alcohol abuse; usage of glucocorticosteroids, vitamin D and calcium deficiency[12]. The nonspecific factors include the magnitude of bone tissue, its density, the position of the incisors relative to the thickness of the alveolar bone, the presence of occlusal support in the area of the molars, age, sex, and etc [9,10,12,14]. These factors have particular importance in case of crowding or protrusion of lower incisors due to the lesser thickness of bone tissue in this area. Still, the studies establishing a link between the anomalies of the teeth position, the generalized alveolar bone atrophy, and the severity of periodontal disease. This correlation may provide an answer to the long-standing question of the particular reasons that trigger the abrasion of the teeth in some patients and the localized or generalized bone atrophy in the others.

There is some evidence demonstrating that an accelerated bone loss occurs only with an inflammatory agent being present. McNamara Jr. et al. showed this prossess in the presence of a chronic periodontitis in combination with an occlusal trauma. In case of an inflammatory periodontal diseases, both soft tissue and hard tissue loss can occur. Defects of hard tissues include the loss of inter-proximal bone, penetration defects, generalized or a localized horizontal atrophy of bone tissue, one-, two-, three-walled bone defects. The severity of these defects is the determining factor for treatment planning [12].

Other studies indicate the effect of a set of nonspecific factors leading to the bone atrophy. They are: bone density, position of the incisors relative to bone thickness, sex and age, and the occlusive trauma. The bone density is a critical factor determining the severity of the clinical cases.The cortical layer is known to prevail in the area of the incisors in the lower jaw, (Lekholm & Zarb (1985) corresponding to type 1 or type 2 bone density (D-1, D-2) [4]. Studies by Maram MN Al-Masri et al found differences in the type of bone density in the cervical and apical areas of the tooth in cases of malocclusion of II and III Angle classes. In the apex area of the root, the densest bone D1 or D2 is observed. As we move to the cervical region, we can observe a decrease in bone structure density to D4 [10]. The same conclusion was drawn by the results of Nauert et al [16]. Another factor biased to bone thickness and working in correlation with it is the position of the incisors relative to bone thickness. Each of the 4 lower incisors was divided in the sagittal direction into 3 equal parts: the cervical, the middle and the apical, and the thickness of the bone tissue in these regions was calculated from the lingual and vestibular sides. The thickness of bone tissue in the apical part of the tooth was much higher than the thickness of bone tissue in other areas of the tooth. In patients with class II Angle, the thickness of the bone tissue is increased from the vestibular side, and in patients with class III from the lingual side.[10] This trend has also been described in Nahas-Scocate et al study, but only in the area of the upper incisors[15].

The sex and age factor can also influence the development of generalized alveolar bone atrophy, but as shown by the K-Y-Nahm et al studies, these factors do not play a significant role, and have not been statistically confirmed[9].

Another facor that is usually neglected in atrophy studies is the role of occlusion trauma. Thus, data on the prevalence of various factors affecting the intensity of bone tissue atrophy in the frontal part of the mandible are ambiguous, Dr. Stephen K. Harrel and Martha E. Nunn claimed it to be another nonspecific factor [7].

It was proved that in the presence of occlusal trauma, the probability of developing the mobility of teeth significantly increases. Moreover, in patients with occlusal trauma, the depth of sounding of the dentogingival pockets increased in comparison with patients without occlusive disorders. The joint effect of incorrect occlusal contacts with other etiologic causes, for example, with unsatisfactory oral hygiene, was also investigated. Yet, even with an excellent oral hygiene the occlusal trauma itself was demonstrated to initiate the periodontal diseases. This study suggests the advisability of complex treatment of periodontal diseases (correcting the occlusal contacts, creating the adequate occlusal support in the lateral group of teeth, as well as subsequently eleminating the remaining etiological factors) [7].

Taking all those facors into account we put forward that if there is a correct location of the incisors in the thickness of the bone tissue and its density is not lower than D-2, the abnormal abrasion of the teeth will be observed, whereas in the presence of bone density D-3, D-4 with an incorrect location of the teeth in its thickness, there will be the generalized atrophy.

We aimed to evaluate the density of bone structure and the position of the roots of the lower incisors in it, and it's impact on the development of non-inflammatory generalized alveolar bone atrophy in the presence of chronic occlusal trauma.

MATERIALS AND METHODS:

This was a retrospective radiological study for descriptive and analytic purposes and was carried out at the department of pediatric dentistry and orthodontics at Sechenov University. To study the effect of bone density and the position of the roots of the incisors, we selected two groups of patients: one with generalized alveolar bone atrophy (group No. 1), others with generalized dental abrasion (group No. 2). In each group there are 10 patients. In both groups of patients, there is a factor of occlusal trauma in the frontal group of teeth due to the absence of the chewing group of teeth. The criteria for exclusion were age over 50 years, the presence of periodontal diseases, confirmed radiologically, the presence of endodontically treated teeth, the presence of problems with the TMJ, the presence of significant crowding of the teeth, and orthodontic treatment before the study.

All CBCT images were scanned at the same imaging apparatus, i.e. PLANMECA (Finland) with 15 mA, 85 kV, 40-second exposure time and isotropic voxel size of 0,25*0,25* 0,25 mm. Files were saved as digital imaging and communications in medicine (DICOM) format and the images were viewed through Romexis Planmeca software (Finland). Sections in the sagittal direction of lower incisors in these patient groups were centered when the tooth is the largest in the vestibulo-oral direction to demonstrate the lingual and vestibular plate of all incisors.

According to a study by Nahm K-Y et al., the root of each lower incisor was divided into 10 equal parts (levels) in the transverse direction. At each level, data were recorded on the thickness of bone tissue, the distance from the root surface to the cortical plate from the lingual and vestibular sides [14]. The Maram MN-Masri et al study also examined the thickness of bone tissue in the sagittal direction, but here the root of each tooth was divided into three parts: the cervical, middle and apical parts. And just like in the above written technique, the thickness of bone tissue was measured [10]. We decided to choose the option of dividing the root of the tooth into 3 parts, as in the study by Maram MN-Masri et al. The distance from the cement-enamel joint to the apex of the tooth in the sagittal direction was taken as the total length of the root. For situations where the cement-enamel joint from the lingual side did not coincide with the vestibular side, the lower boundary was chosen as a common cement-enamel joint.

In the same position, in each part of the root of the tooth, bone density was measured, expressed in units of Hounsfield. According to the classification of Lekholm & Zarb (1985), there are 4 types of bone tissue. 1 type of bone tissue is represented almost entirely by a homogeneous compact layer and according to the Hounsfield scale corresponds to> 1250 units. Class II is represented by a thick compact layer surrounding a highly developed spongy layer, from 850 to 1250 units. Class III is a thin compact layer surrounding a highly developed spongy layer, from 350 to 850 units. Class IV - a thin compact layer surrounds the spongy layer with a low density of the trabecular network, according to the scale <350 units [2, 4,5]. The data obtained were averaged in each part of the root of the tooth.

The intraoral photographs of these patient groups were also examined. The photos are taken with a Nikon camera, in jpeg format. A standard block of photographs was used: in a direct projection, in lateral projections to the right and left, photographs of the upper and lower dental arches. The photos obtained are presented as a demonstration of a clinical situation in the oral cavity, namely, the absence of a lateral group of teeth, the presence of signs of occlusive trauma: the erosion of hard tissues of the teeth, recessions, spontaneous migration of teeth, and abfractive defects.

RESULTS:

To compare the indices presented in two different patient groups, we used the Student's t-test and calculated by the following formula:

$$t = \frac{M_1 - M_2}{\sqrt{m_1^2 + m_2^2}}$$

,

where M1 is the arithmetic mean of the first compared population (group), M2 is the arithmetic average of the second compared population (group), m1 is the average error of the first arithmetic mean, m2 is the mean error of the second arithmetic mean.

Tables 1, 2 show average values of bone thickness measurements in the region of lower incisors of two groups of patients. The first group consisted of patients with generalized atrophy of bone tissue. The second group included patients who had generalized abrasion of hard tooth tissues.

Table 1

	Root length	bone loss	the thickness of bone tissue in cervical part from the vestibular part	the thickness of bone tissue in middle part from the vestibular part	the thickness of bone tissue in apical part from the vestibular part	the thickness of bone tissue in cervical part from the lingual part	the thickness of bone tissue in middle part from the lingual part	the thickness of bone tissue in apical part from the lingual part
Patient 1								
average	13,74	6,38	0,6875	1,7525	4,2	1,175	1,605	2,9125
Patient 2								
average	13,5375	6,6	0,6575	1,276	4,58	1,2375	1,5725	2,9425
Patient 3								
average	14,005	6,1825	0,9175	1,63	4,705	1,21	1,93	2,7375
Patient 4								
average	12,977	5,58	0,89898	1,033	5	1,3476	1,895	2,879
Patient 5								
average	13,7825	6,38	0,7577	1,457	4,92	1,547	1,76	3
Patient 6								
average	12,7688	5,97	0,5766	1,688	4,56	1,022	1,598	2,972
Patient 7								
average	13,897	6,225	0,693	1,52	5,099	1,878	2	3
Patient 8								
average	12,995	5,5	0,77	1,43	4,6	1,545	1,705	2,599
Patient 9								
average	14,02	6,988	0,808	1,298	4,9	1,425	1,656	2,233
Patient 10								
average	13,548	5,05	0,767	1	4	1,32	1,43	2,367
Group 1								
average		6,08555	0,753378	1,40845	4,6564	1,37071	1,71515	2,76425

Table 2

	Root length	bone loss	the thickness of bone tissue in cervical part from the vestibular part	the thickness of bone tissue in middle part from the vestibular part	the thickness of bone tissue in apical part from the vestibular part	the thickness of bone tissue in cervical part from the lingual part	the thickness of bone tissue in middle part from the lingual part	the thickness of bone tissue in apical part from the lingual part
Patient 1								
average	12,84	1,18	0,97	1,986	4,49	1,965	2,37	3
Patient 2								
average	12,575	1,24	0,98	0,88	4,72	1,807	1,2	3,3
Patient 3								
average	12,98	1,48	0,88	1,79	4,705	1,757	1,25	2,38
Patient 4								
average	13,53	1,28	0,93	1,84	5,57	1,935	1,68	2,02
Patient 5								
average	13,29	1,32	1,03	1	3,98	1,547	1,98	3,39
Patient 6								
average	12,84	1,19	0,92	1,954	4,69	1,46	1,76	3,25
Patient 7								
average	13,48	1,38	0,85	1,02	5,099	1,09	1,72	2
Patient 8								
average	13,92	1,05	0,87	1,72	4,8	1,03	1,16	3,25
Patient 9								
average	12,73	1	0,808	1,83	4,9	1,12	1,2	2,233
Patient 10								
average	13	1,02	0,99	1,7525	5	1,26	1,43	3,18
Group 2								
average		1,214	0,9228	1,57725	4,7954	1,4971	1,575	2,8003

Tables 3.4 show average values of bone density measurements in the region of lower incisors of two groups of patients. Table 3 consists of patients who have generalized atrophy of bone tissue. Table 4 includes patients who have generalized abrasion of hard tooth tissues.

Table 3

	Root length	Bone loss	the thickness of bone tissue in cervical part from the vestibular part	the thickness of bone tissue in middle part from the vestibular part	the thickness of bone tissue in apical part from the vestibular part	the thickness of bone tissue in cervical part from the lingual part	the thickness of bone tissue in middle part from the lingual part	the thickness of bone tissue in apical part from the lingual part
Patient 1								
average	13,74	6,38	350	430	750	328	430	736
Patient 2								
average	13,5375	6,6	325	400	728	346	400	762
Patient 3								
average	14,005	6,1825	376	420	698	375	425	710
Patient 4								
average	12,977	5,58	380	500	745	380	420	753
Patient 5								
average	13,7825	6,38	365	440	705	339	500	729
Patient 6								
average	12,7688	5,97	330	455	712	350	510	703
Patient 7								
average	13,897	6,225	370	470	735	379	418	755
Patient 8								
average	12,995	5,5	389	495	690	361	469	748
Patient 9								
average	14,02	6,988	380	482	729	330	482	733
Patient 10								
average	13,548	5,05	338	415	700	355	475	700
Group 1								
average		6,08555	360,3	450,7	719,2	354,3	452,9	732,9

Table 4

	Root length	Bone loss	the thickness of bone tissue in cervical part from the vestibular part	the thickness of bone tissue in middle part from the vestibular part	the thickness of bone tissue in apical part from the vestibular part	the thickness of bone tissue in cervical part from the lingual part	the thickness of bone tissue in middle part from the lingual part	the thickness of bone tissue in apical part from the lingual part
Patient 1								
average	12,84	1,18	750	926	1239	730	901	1250
Patient 2								
average	12,575	1,24	780	897	1160	760	896	1187
Patient 3								
average	12,98	1,48	773	900	1158	771	920	1120
Patient 4								
average	13,53	1,28	809	920	1165	800	949	1255
Patient 5								
average	13,29	1,32	769	903	1200	784	915	1190
Patient 6								
average	12,84	1,19	792	930	1250	765	908	1321
Patient 7								
average	13,48	1,38	790	929	1198	812	931	1294
Patient 8								
average	13,92	1,05	820	889	1185	793	900	1275
Patient 9								
average	12,73	1	801	898	1290	745	885	1244
Patient 10								
average	13	1,02	789	900	1274	790	910	1198
Group 2								
average		1,214	787,3	909,2	1211,9	775	911,5	1233,4

We calculated Student's t-test for bone density and thickness for each of the three measurement zones (cervical, middle and apical parts). Thus, the following results were obtained:

1. The density of bone tissue in each measurable lower incisor in all patients was a statistically significant criterion for diagnosing and selecting a method of treatment.
2. Data on measurements of bone thickness were less statistically significant than bone density. But the criterion of the thickness of bone tissue in the cervical region showed itself especially clearly. Criterion t- Student was greater than the critical value (= 18), and therefore the differences were statistically significant.

Bone thickness

It was found that group No.1 showed a decrease in bone tissue of approximately 6.5 mm. Atrophy is expressed equally with both the vestibular and the lingual surface of the tooth root. The thickness of the cortical plate increased to the apex of the tooth. Its thickness from the lingual side was slightly larger than with the vestibular. In group 2, the atrophy of bone tissue is negligible, about 1.2 mm. The thickness of the cortical plate is higher than that of the group No.1; nevertheless, in the middle part it is approximately 1 mm. The tendency of bone thickness growth from the cervical to the apical part is also present here.

Density of bone tissue

In Group 1, bone tissue is represented by a thin cortical plate surrounding the spongy layer with a low density of the trabecular network, which corresponds to type D4. However, there is an increase in bone structure density from the cervical to the apical region, from 325 units to 750 units. Group 2 found bone tissue in the form of a thick thick cortical plate that surrounds the highly developed spongy layer. According to classification corresponds to type D1-D2 of bone tissue. And there is also a tendency here to increase the density of bone tissue from the cement-enamel compound to the top of the root.

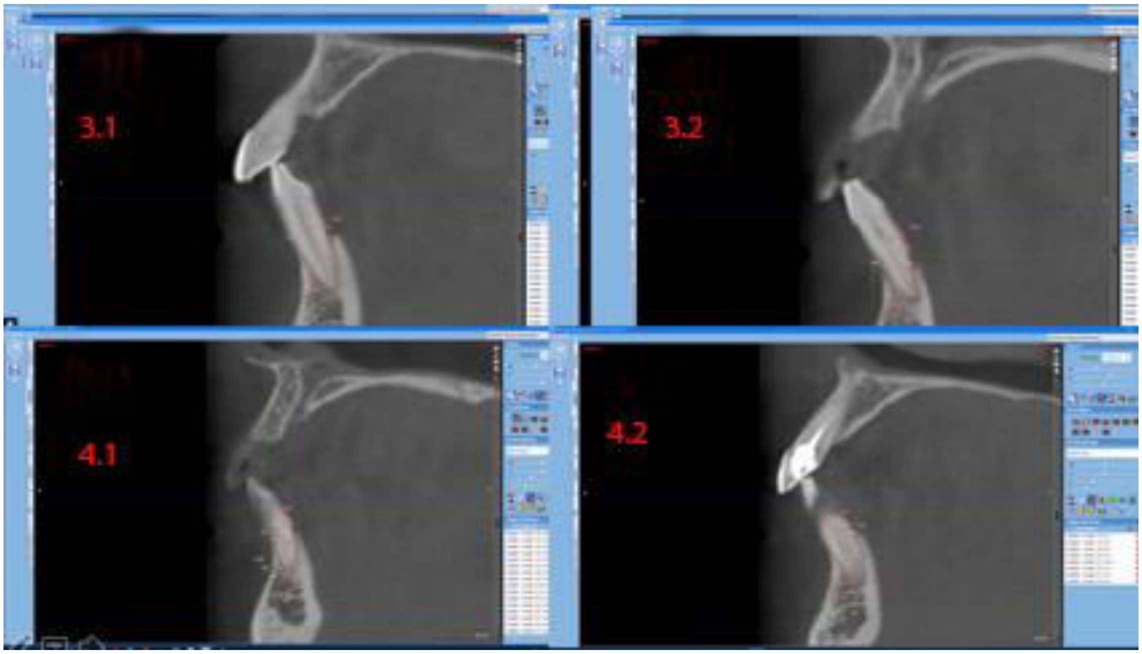

Fig.1 Images of CBCT of the lower incisors of the patient from group # 1. There is atrophy of bone tissue, thinning of bone tissue from the vestibular and lingual sides. The density of bone tissue corresponds to the D4 type of bone tissue according to Lekholm & Zarb classification.

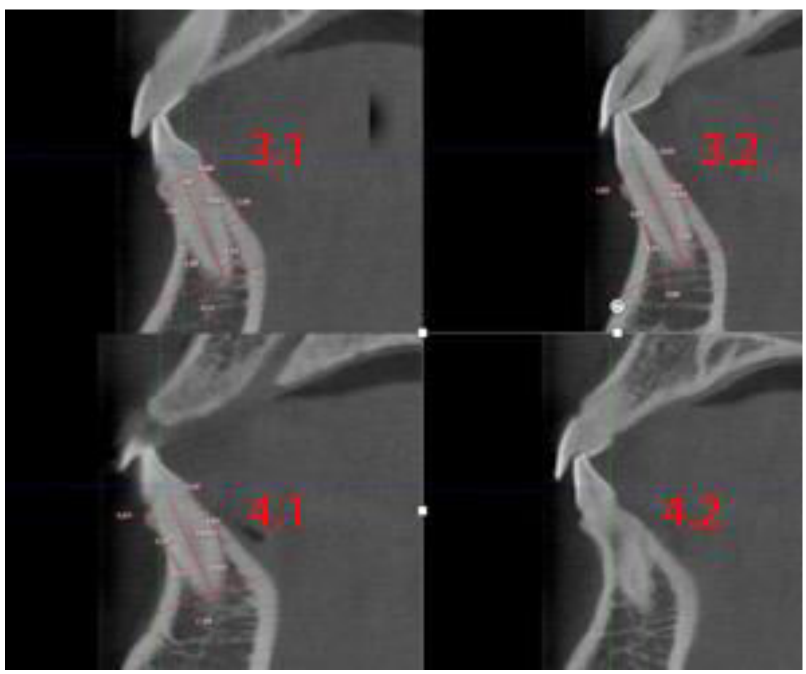

Fig.2 CBCT images of the lower incisors of the patient from group # 2. Atrophy is almost not observed, the cortical plate is thick. The bone density is high, corresponds to type D1 according to Lekholm & Zarb classification.

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The patient from group # 1 and the patient from group # 2 in the frontal group of teeth have occlusion trauma. In this case, the patient from group 2 has generalized abrasion, the presence of multiple wedge-shaped defects. The patient from Group 1 has a decrease in bone tissue, the presence of recesses, and an increase in the clinical crown of the tooth (Figure 3,4).

Fig.3 Intraoral photographs of a patient from group 2 with generalized abrasion of teeth. There is a lack of teeth 2.5, 3.6, 4.6, multiple wedge-shaped defects.

Fig. 4 Intraoral photos of the patient from group # 1. There is generalized atrophy of bone tissue, spontaneous migration of teeth, the presence of recesses of the roots of teeth, the absence of teeth 14,15,23,26, 36,37,46,47.

DISCUSSION:

Although there are already articles that consider the relationship between the position of the lower incisors relative to the bone structure and its density, they all consider only the radiographic aspects of this pathology, not including the clinical methods of examination. Based on the results of these articles, the density of bone tissue affects the speed of movement of teeth both during orthodontic treatment, and outside it. This fact can explain the occurrence of spontaneous migration of teeth with low bone density, as well as a higher rate of tooth movement in children during orthodontic treatment. However, all these studies do not take into account that generalized tooth abrasion may occur in the presence of dense bone tissue type D1-D2 in combination with occlusive trauma in the frontal group of teeth.

According to the CBCT in Patient No. 2, the thickness and bone density values were much higher than those in Patient No. 1. However, the tendency to increase the density of these parameters from the cement-enamel joint to the apex of the tooth was observed in both No. 1 and No. 2 of the patient, the difference was only in the magnification ratio, in the patient with erasability it was higher. The same conclusions were reached by the studies of Nahm et al [14], Nauert et al [16], who considered this correlation in the skeletal I class and using a traditional computer tomogram. Maram MN-Masri et al also considered this correlation, but already among the anomalies of I, II, III classes according to Angle's classification [10].

Our results also led to the conclusion that the thickness of the cortical plate in the region of the lower incisors from the vestibular side is less than with the lingual side, as in the results of Maram MN-Masri et al, but according to their conclusion, this is observed only in patients with I or II class according to Angle's classification, at class III the thickness is the same or from the vestibular side may exceed [10].

We came to the conclusion that the erosion of teeth caused by occlusal trauma is observed with dense bone tissue and the correct location of the roots of the teeth relative to the thickness of the bone. However, this study did not consider the structure of the tooth tissue, their thickness, endodontic intervention. Also, such aspects as the patient's general medical problems, bad habits, sex, and age were not taken into account, so this issue requires further study.

Thus, the presence of occlusal trauma is the initiating factor for the development of various pathologies in the dentoalveolar system. And the path of development of these pathologies depends on different indicators, where bone density and the position of teeth relative to it are of particular importance. Therefore, before the beginning of the orthodontic treatment, the orthodontist should conduct a full diagnosis of the patient, assess the quality of bone tissue, the position of the teeth, in order to further achieve the maximum acceptable result and avoid many complications.

CONCLUSION:

1) In a group of patients with bone density in the region of the lower incisors D3-D4, combined with the incorrect location of the roots in the thickness of the bone tissue, there was non-inflammatory generalized fast-progressive atrophy of bone tissue.
2) In a group of patients with a bone density of the lower jaw D1-D2, with the correct location of the roots of the teeth in the thickness of the bone tissue, generalized atrophy was observed in minimal volumes, most likely to be observed tooth erosion.

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REFERENCES:

1.Iliana L.P., Mirgoroskaya L.V., Evseeva I.P. 1999. Mestnye factory v geneze zabolevanii parodonta i metody ikh ustraneniya. Uchebnoe posobie dlya vrachei. Saint Petersburg, Russia.
2.Ron' G.I., Uvarova L.V., Elovikova T.M. Opyt sinkhronnoi vizualizacii mineral'noi plotnosti niznei chelusti bol'nogo parodontitom na trekhmernoi rekonstrukcii. Problems in Dentistry, 2015; 1: 15-19.
3.Stepanov A.E. 2000. Biomechanicheskie osnovy orthodontii v norme i pri zabolevaniyakh parodonta. Moscow: p 328.
4.Chugh Tina, Abhay Kumar Jain, Jaiswal Raj Kumar, Mehrotra Praveen. Bone density and its importance in orthodontics. Journal of oral biology and craniofacial research, 2013;3: 92-97.
5.Crabtree N., Ward K. Bone densitometry: current status and future perspective. Endocr Dev. Basel, Karger, 2015; 28: 72–83.
6.De Carvalho Crusoé Isabela Maria, de Freitas Deborah Queiroz, Ambrosano Glaucia Maria Bovi, Bóscolo Frab Norberto, Almeida Solange Maria. Bone density: comparative evaluation of Hounsfield units in multislice and cone-beam computed tomography. Braz Oral Res, 2012 Nov-Dec; 26 (6): 550-556.

7.Harrel S.K, Nunn M.E. The effect of occlusal discrepancies on periodontitis. Relationship of occlusal treatment to the progression of periodontal disease. J Periodontol, 2001 Apr; 72(4): 495 – 505.
8.Jeong Kyung-In, Kim Su-Gwan, Ji-Su Oh, and Jeong Mi-Ae. Consideration of Various Bone Quality Evaluation Methods. Implant Dentistry, 2013; 22(1): 55-591,
9.Park JU, Kook YA. Alveolar bone loss around incisors in surgical skeletal Class III patients. Angle Orthod, 2009; 79(4): 676-682.
10.Maran MN Masri Al, Mowaffak A Ajaj, Mohammad Y Hajeed, Muataz S Al-Eed. Evaluation of Bone thickness and density in the lower incisors' region in adults with different types of skeletal malocclusion using cone-beam computed tomography. The journal of contemporary dental practice, 2015 August; 16 (8): 630-639.
11.Mathews D., Kokosh V. Managing treatment for the orthodontic patient with periodontal problems. Semin. Orthod. 1997; 3: 21-38.
12.Mcnamara Jr. J. A., Ribbens K. Malocclusion and the periodontium// Monograph Number 15 Craniofacial Growth Series.
13.Mi-Young Lee, Jay Hyun Park et al. Bone density effects on the success rate of orthodontic microimplants evaluated with cone-beam computed tomography. AJO-DO February 2016; 149 (2): 217-224.
14.Nahm K-Y , Kang J-H, Moon S-C , Choi Y-S, Kook Y-A, Kim S-H, and Huang JC. Alveolar bone loss around incisors in Class I bidentoalveolar protrusion patients: a retrospective three-dimensional cone beam CT study. Dentomaxillofac Radiol., 2012 Sep; 41(6): 481–488.
15.Nahas-Scocate AC, de Siqueira-Brandao A, Patel MP, Lipiec-Ximenez ME, Chilvarquer I, do Valle-Corotti KM. Bone tissue amount related to upper incisors inclination. Angle Orthod 2014 Mar; 84(2): 279-285.
16.Nauert K, Berg R. Evaluation of labio-lingual bony support of lower incisors in orthodontically untreated adults with the help of computed tomography. J orofac Orthop 1999; 60(5): 321-334.
17.Tak I-H, Shin M-H, Kweon S-S, Nam H-S, Cauley JA, Kim O-J, Kim Y-J, Chung H-J, Kim O-S. The association between periodontal disease, tooth loss and bone mineral density in a Korean population. J Clin Periodontol, 2014; 41: 1139–1144.
18.Tsalikis L., Karadia S., Konstantinidis A., Kolokithos G. Recordint of dental and dentoskeletal periodontal status in dental students. Hellenic Orthodontic Review. 2001, 4 (2): 119-144.
19.William W. Hallmon. Occlusal Trauma: Effect and impact on the periodontium. Ann Periodontol. 1999 Dec; 4(1): 102-107
20.Berezin A.N., Kiselev G.L., Volkova A.I., Loschenov V.B., Sinyaeva M.L., Mamedov Ad.A, Lervkin V.V., Kharnas S.S. Investigation of normal and pathological tissue autofluorescence images. ALT'03 International Conference on Advanced Laser Technologies: Biomedical Optics, ed. by R. K. Wang, J. C. Hebden, A. V. Priezzhev, V. V. Tuchin. Proc. of SPIE, 2004, 5486: p 287 – 294.
21Dudnik O.V., Mamedov Ad.A., Dybov A.M., Kharke V.V. Clinical and diagnostic rationale for the final stage of othodontic treatment. Stomatologia. Moscow, 2017: 43-50.