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UNDIFFERENTIATED CONNECTIVE TISSUE DYSPLASIA AS A KEY FACTOR IN PATHOGENESIS OF MAXILLOFACIAL DISORDERS IN CHILDREN AND ADOLESCENTS

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ABSTRACT — In order to detect pathomorphological changes and identify the severity of maxillofacial disorders, 137 children with different degrees of connective tissue dysplasia (CTD) and 46 healthy children were examined by means of cone beam computed tomography to check their X-ray morphometric index as well as lower jaw optical density index. At the same time, the quantitative ultrasonic densitometry method was employed to evaluate the status of the peripheral skeleton bone tissue. The quantitative X-ray morphometric index in healthy children and children with CTD were found to have strong positive correlation with the osteodensitometry Z-criterion, reflecting reliably the bone tissue status in the peripheral skeleton. The progression of connective tissue dysplastic disorders in children, which correlates with the intensity of maxillofacial bone structures destruction and the severity of collagen degradation mechanisms, was accompanied by an increase in chronic productive inflammation; reduced in x-ray density; fibrous transformation of bone tissue; a decrease in the thickness of the lower jaw cortical plate and its dissociation; predominance of medium- and fine-meshed bone pattern; impaired space orientation and thinning of the bone trabeculas as well as pathological processes in the periodontium.

KEYWORDS — connective tissue dysplasia, child population, X-ray morphometric index, cone beam computed tomography, ultrasound osteodensitometry, maxillofacial area.

INTRODUCTION

The growing interest in connective tissue dysplastic disorders in childhood is due to the following factors: high prevalence (9.8–35.7%) with stable growth dynamics; multiple affected areas; predisposition to chronic nature of acute processes; significant polymorphism of clinical and morphological manifestations; difficulties in diagnosing certain clinical types; longer course of concomitant diseases; low effectiveness of treatment plans; longer convalescence; need to make additions to the treatment and diagnostic protocols as well as to include corrective therapy. In children with CTD, the frequency of referrals for medical assistance is six times as high compared to other groups of patients [1–3].

CTD is a nutritionally and genetically predetermined disorder affecting the development of connective tissue at the embryonic and postnatal stages, which manifests itself through defects in the main substance and fibrous structures, leads to homeostatic disorders at the levels of the body, inner organs and tissues, and features morphological and functional disorders of the locomotor and visceral organs with a progressive course, which determines the specifics of associated pathologies (Kadurina T. I., 2008).

The data accumulated by respective experts confirm that the connective tissue origin is to be found mainly in all maxillofacial components, while the structural and functional components of the connective tissue are actively involved in inflammatory, destructive and protective processes in various acute and chronic pathological conditions. There is special note to be made regarding the high prevalence of carious tooth lesions, periodontal pathologies, temporomandibular joint (TMJ) issues, dentofacial deformities and abnormalities, as well as occlusal disorders [4–12].

The authors have offered convincing proof showing an increase in the role played in clinical dentistry by morphological, anthropometric, and functional research methods [13–34]. The use of high-precision methods of X-ray examination allows not only minimizing the radiation harm to patients of all age categories, yet also analyzing the anatomical and topographic craniofacial features, as well as early and differential diagnostics of various diseases affecting jaw bones, periodontium, teeth, skull sinuses, and TMJ [35–47].

The need for a detailed study of the maxillofacial area of children belonging to the "critical" age groups is due to morphological and functional features, as well as to the intensive development and growth of their

organs and systems along with instability (lability) of dentofacial structures [48–60].

Until now, the available research data on the role of CTD in the development of child maxillofacial pathology has been fragmented. Also, there is no information available on peripheral skeleton bone strength in relation to the reference base of ultrasound osteodensitometry in children with CTD. Given that, studying the pathogenesis of the maxillofacial pathology in children with CTD through critical life periods appears relevant, while this is not only of diagnostic yet also has clinical value when explaining the tactics and monitoring the effectiveness of treatment and rehabilitation measures.

Aim of study

identification of pathomorphological maxillofacial changes in children with CTD based on X-ray morphometry of the lower jaw and the peripheral skeleton ultrasound osteodensitometry.

MATERIALS AND METHODS

As part of the work, 2013 through 2020 comprehensive clinical, paraclinical, and laboratory-instrumental studies were carried out involving 137 adolescents (76 girls, 61 boys; aged 12-16) with general somatic pathology and severe set of CTD symptoms, who were treated in the Pediatric Department of Filippsky Child Clinical Hospital (Stavropol, Russia). The diagnostics of undifferentiated CTD included the following symptoms: a minimum of six clinical and instrumental signs of connective tissue dysplasia; spread of the pathological process onto two or more organs (multi-organ nature) and systems (polysystem nature); signs of familial accumulation of collagenopathy (family history); biochemical and immunohistochemical evidence of impaired connective tissue metabolism (recommendation by T.I. Kadurina, 2009).

The evaluation of the adolescents' body structure, level of their individual physical development, harmoniousness in physical development, was done employing the Stuart scale, the WHO mass & height tables (WHO Standard, 2006), as well as anthropometric indices. Arachnodactyly and dolichostenomelia were diagnosed using the respective coefficients (Nechaeva G.I., 1994). Joint hypermobility was detected base on the P. Beighton criteria (1999). The muscular system status, the severity and the nature of the deformities affecting the thorax (Fokin A.A., 1984), the spine (Abalmasova E.A., 1973), and the lower extremities (Kadurina T.I., 2000) were evaluated.

Depending on the severity of external phenotypic manifestations and laboratory, clinical and instrumental signs, assessment of the CTD severity was done following the recommendations by L.N. Abbakumova, T.I. Kadurina (2008). In view of only external phenotypic characters, a mild degree of CTD corresponds to the total score below 24, a moderate degree to 24–34 points, while a severe degree of CTD scores a total of 35 or above. When doing laboratory and clinical-instrumental examination, a mild degree of CTD corresponds to a total score of less than 30, a moderate CTD degree means a score ranging between 30 and 44, while a severe degree would score 45 or more. The final diagnosis of CTD was set taking into account the diagnostic tables for the child category where the diagnostic level was +70 (E.P. Timofeeva, 1996).

Children with CTD (main group) were divided into three subgroups: Subgroup 1 — mild degree (n = 39); Subgroup 2 — moderate degree (n = 47); Subgroup 3 — severe degree (n = 51). The control group included 46 *healthy* and *basically healthy* (Health Groups I & II) adolescents (Yu. E. Veltishchev, 1994), comparable in age and gender.

Bone mineral density indices were diagnosed on an Omnisense 7000 ultrasound densitometer equipped with a special computer software for children; the SOS ultrasound wave velocity (m/s) in two points of the skeleton — in the middle of the tibia and at the radius' distal third. We identified the Z-score, which is the standard deviation of the actual bone strength in relation to the child's average age norm, and is expressed in SD — mean square deviations units from the average peak values. The obtained bone tissue evaluation data was compared to the Russian age standards (L. Shcheplyagina, 2006) and percentile table data of the respective ages for the ultrasonic densitometer. Subject to the recommendations of ISCD, the criteria for bone strength in children were used employing the Z-score: SD ≥ 0 (normal bone strength); SD ranging from –1 to 0 (a decrease tendency in the bone strength); SD from —2 to —1 (mild decrease in the bone strength); SD ≤ –2 (significant decrease in the bone strength) (Fig. 1).

Dental volumetric tomograms and orthopantomograms were performed in the child imaging software on a KaVo OP300 Maxio cone beam computed tomograph with cephalostat using the LowDoseTechnology™. The data was processed using the OnDemand3D™ Dental and OnDemand™ Project Viewer software products. The orthopantomograms were used to evaluated the quantitative indices (FI — Fuchs index, GI — Gonion index, AI — Antigonion index, MI — Mental index, X-ray index — X-ray examination index, PMI — panoramic mandibular index) and one qualitative (MCI — Mandibular Cortical index). The x-ray density of bone tissue (Hounsfield units; HU) was identified on 3D mode computed tomograms.

The interalveolar septa resorption degree relative to the tooth root length was determined through the

Fig. 1. *Quantitative ultrasound examination of the distal radius and tibia using an Omnisense 7000 densitometer*

Fuchs index. The evaluation codes for the FI were: 0 — tooth outside the bone tissue or the tooth is missing due to a periodontal pathology; 1 — bone resorption of more than ⅔ of the root length; 2 — bone resorption ranging from ⅓ to ⅔ of the root length; 3 — bone resorption up to ⅓ of the root length; 4 — lack of the alveolar bone resorption. The formula for calculating follows below:

$$\text{Fuchs Index} = \frac{(n \cdot 0) + (n \cdot 1) + (n \cdot 2) + (n \cdot 3) + (n \cdot 4)}{\text{number of teeth}}$$

Evaluation scale: bone resorption at the apex level — 0 points; bone resorption exceeding ⅔ of the root length — 0.25 points; bone resorption ranging from ⅓ to ⅔ of the root length — 0.5 points; bone resorption up to ⅓ of the root length — 0.75 points; no loss of bone tissue — 1 point (Fig. 2).

The cortical plate thickness was determined based on the J. Bras et al. method (1982) — GI, and the D. Ledgerton et al. method (1999) — A.I.

The GI determination method: a tangent is made at the lower jaw angle; further, a perpendicular is restored from the point of intersection with the mandibular angle.

The AI determination method: a straight line is drawn along the front border of the lower jaw ascending branch. Next, a tangent is made to the intersection with the lower border of the lower jaw, followed by restoration from this point of the perpendicular. In both methods, the cortical plate thickness is calculated along the perpendicular (Fig. 3).

The alveolar bone resorption degree was determined through the A. Taguchi et al. method (1993) — MI, and with the X-ray examination index — X-ray index.

The MI determination method: in the foramen mentale projection a tangent was made to the lower border of the lower jaw, after which a perpendicular

Fig. 2. *Fuchs Index*

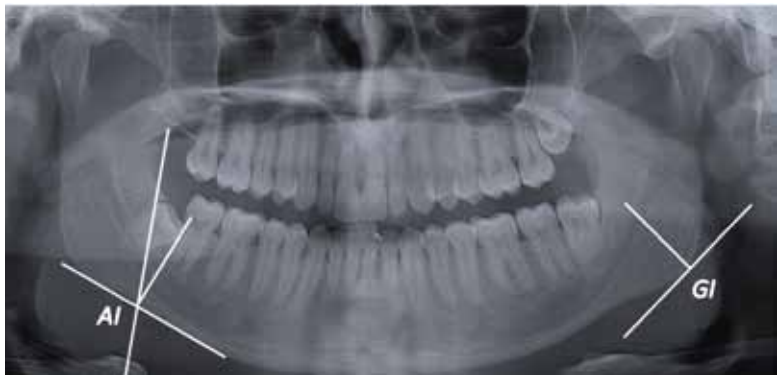

Fig. 3. *GI — Gonion Index, AI — Antigonion Index*

passing through the foramen mentale center was restored. The distance ratio from the alveolar process edge to the mandible lower border, to the distance from the foramen mentale center to the mandible lower border, was calculated.

The X-ray index determination method: in the foramen mentale projection, a tangent was drawn to the lower border of the mandible alveolar part, to which the perpendicular passing through the center of the foramen mentale was drawn. Through the Autodesk AutoCAD Architecture2018 software (2D format), the ratio of the lower jaw alveolar part to the tooth root total length was calculated (Fig. 4).

To improve the reliability of the data concerning the intensity of destructive processes in the mandibular bone, three variations of the PMI index were calculated — upper, middle and lower (D. Ledgerton et al., 1997).

The PMI determination method: below the foramen mentale, parallel to the mandibular bone lower border, a tangent was drawn. Further — a perpendicular passing through the center of the foramen mentale is made. The following values were calculated along the perpendicular: A — the cortical layer thickness; B — the distance between the foramen mentale lower edge and the mandibular bone lower border; C — the distance between the foramen mentale upper edge and the mandibular bone lower border. The distance between the foramen mentale center and the mandibular bone lower border was calculated as the half-sum between B and C. The PMI value was calculated as follows: the upper PMIs is the ratio of the cortical plate thickness at the foramen mentale level to the distance between the mandibular bone lower border and the foramen mentale upper point; the lower PMIi is the ratio of the cortical plate thickness at the foramen mentale level to the distance between the mandibular bone lower border and the foramen mentale lower point; the medium PMIm is the ratio of the cortical plate thickness at the foramen mentale level to the distance between the mandibular bone lower border and the foramen mentale center. In case there was lack of a clear visualization of the upper part of the mandibular bone lower cortical plate, we used the lowest thickness value of the compact plate located below the foramen mentale (Fig. 5).

Qualitative description of the cortical plate, located below the foramen mentale, was carried out by the E. Klemetti method (1994) — MCI. The evaluation criteria for morphological types were: C1 — smooth and clear inner border of the cortical plate; C2 — the cortical layer border features single crescent defects with bilateral or unilateral stratification of the plate; C3 — the cortical plate is porous, featuring a multilayer structure, with many defects, while the border is unclear and uneven (Fig. 6).

The mandible bone tissue optical density was identified based on the results of a mathematical reconstruction of the attenuation coefficients following the classifications by U. Lekholm and G. Zarb (1985), C. Mish (1992). Densitometric parameters (HU) offered reliable description of the x-radiation loss degree by the bone tissue. Subject to C. Ulm's recommendations (2009), the mandibular angle and the lower jaw body at the second premolar were used as *interest zones* (Fig. 7).

The mandible cortex thickness was identified at the foramen mentale level to clarify the sizes detected when calculating the MCI index through orthopantomograms (Fig. 8).

The statistical data processing was performed with the SPSS-14.0 software for Windows using parametric and nonparametric methods.

RESULTS AND DISCUSSION

An analysis of the osteodensitometry results in children with CTD, in view of the age standards and the percentile densitometer data, revealed that a decrease in strength, which depends on the microstructure, mineral density, elasticity, and thickness of the bone tissue cortical layer, is associated with a decrease in the broadband attenuation of ultrasonic vibrations. A downfall in this indicator, which determines the spatial orientation of bone trabeculae, is combined with an increase in the ultrasonic waves propagation velocity. As we see it, it is the degree of decrease in the ultrasound broadband attenuation — which develops against abnormal structure of elastin, collagen, proteoglycans and glycoproteins with existing defects in the main substance and the connective tissue fibrous structures — that can offer a proper reflection of the dysplastic disorders intensity. An analysis of bone tissue strength in children of Health Groups I and II showed that a decrease in the bone resistance to fractures below the respective reference values is due to lack of its mineral component casued by deficient calcium supply in the child's body, as well as a decrease in the calcium metabolic activity, proof to that being the positive dynamics of the ultrasonic vibrations propagation rate with no change in the broadband attenuation (Fig. 9).

Tables 1–4 offer the data on the index radiomorphometric assessment of the mandible bone tissue status in the studied groups.

An analysis of the mandible bone tissue status in the studied groups indicated that an increase in the CTD severity was associated with a tendency toward a decrease in radiomorphometric index values, the

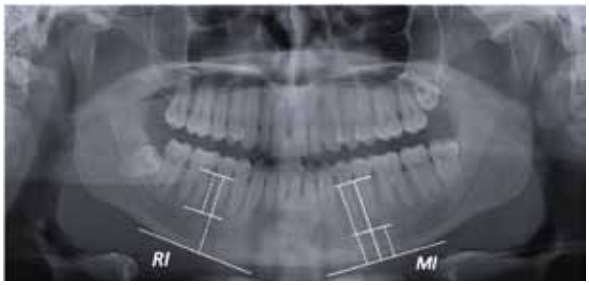

Fig. 4. *MI - Mental index, RI - X-ray index*

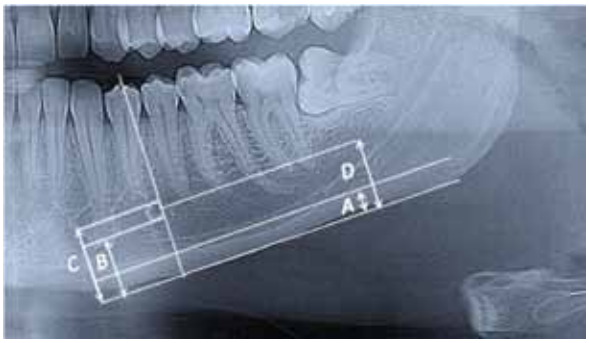

Fig. 5. *Anthropometric benchmarks for measuring and calculating the PMI index: PMIs = A/C; PMIi = A/B; PMIm = A/D*

exception being the X-ray index. According to the GI value in children of Health Groups 1 and 2, the cortical plate thickness at the mandibular angle is significantly above similar indicators for the children of Subgroup 1 (1.04–1.24 times as thick), the children of Subgroup 2 (1.05–1.44 times as thick), and children of Subgroup 3 (1.10–1.41 times as thick). As for AI, the cortex thickness at the lower jaw branch in the control group also prevails (by 1.02–1.05 times) over the values registered in the main group, yet the differences are not statistically significant. The MI indicator (the alveolar process (bone) resorption degree of the lower jaw), is also statistically significantly less (1.01–1.21 times) in children with CTD, if compared to patients of Health Groups I and II. The index values in patients with different levels of bone strength indicate that children with a mild decrease (SD ≤ –1) and a significant decrease (SD ≤ –2) in the bone strength, feature a decrease in the cortical bone thickness over the entire mandible surface not only in the control group, yet also in the main group, too. This lack of difference, as we see it, can be accounted for by the physiological adjustment and compensation mechanisms that are to be observed in children with CTD.

The radiological indices of GI, AI and MI proved to have strong positive correlation (r_p) with the oste-

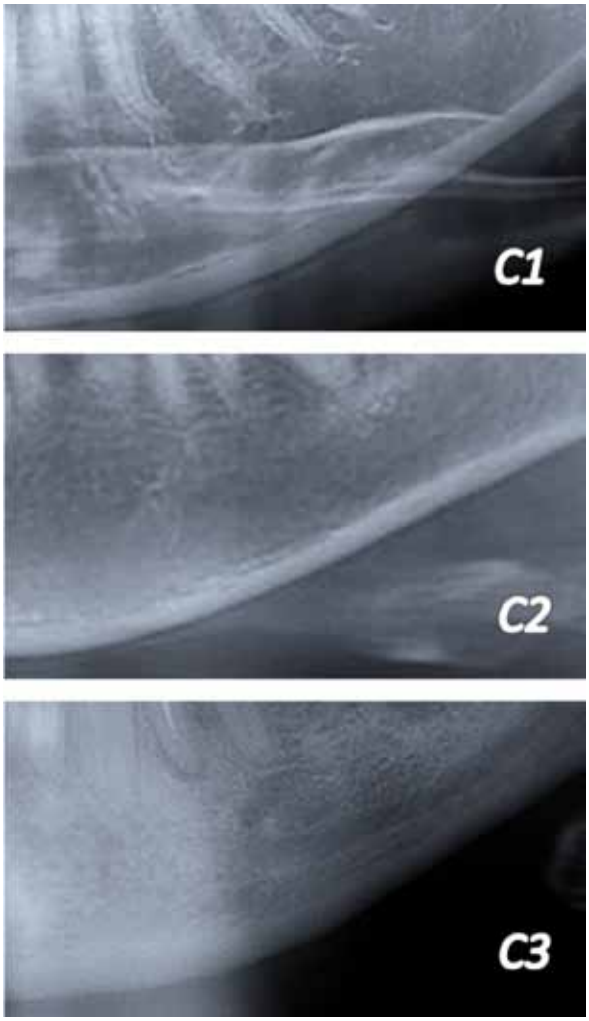

Fig. 6. *MCI — Mandibular cortical index: C1 — the cortical layer is normal; C2 — the cortical layer is slightly damaged; C3 — the cortical layer is significantly damaged*

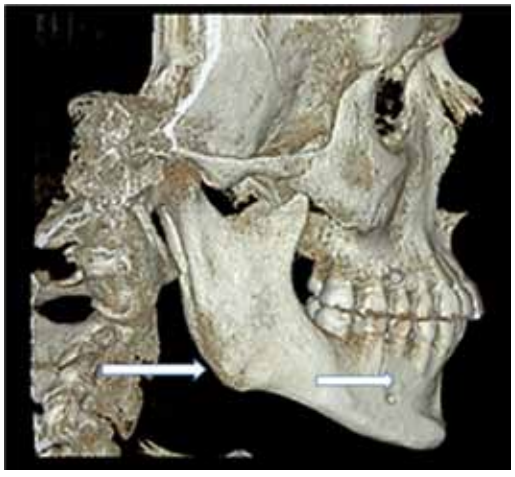

Fig. 7. *«Zones of interest» on a 3D panorama in sagittal projection VR mode with FOV 8 × 15 in the option "Shaded" "Bone"*

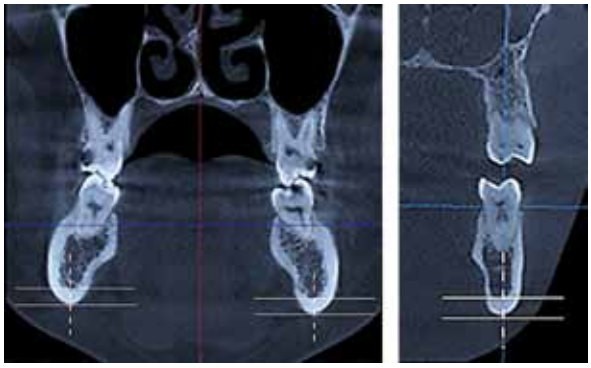

Fig. 8. The thickness of the cortical layer in the coronal, sagittal projections

odensitometry Z-criterion: 0.947 (p = 0.000059) for GI; 0.819 (p = 0.00031) for AI; 0.784 (p = 0.00083) for MI. The results of evaluating the values of PMIi, PMIm, and PMIs revealed a similar trend, which manifested itself through strong positive correlation dependences (r_p) with the Z-criterion: 0.816 (p = 0.000043) for PMI; 0.782 (p = 0.00027) for PMIm; 0.749 (p = 0.00069) for PMIs. Obviously, the peripheral skeleton bone tissue status offers a reliable reflection of the x-ray situation on the orthopantomograms, while an increased mandible porosity in children with CTD is diagnosed as a decrease in the cortical layer thickness both in the branch area and in the angle of the lower jaw, as well as changed topogra-

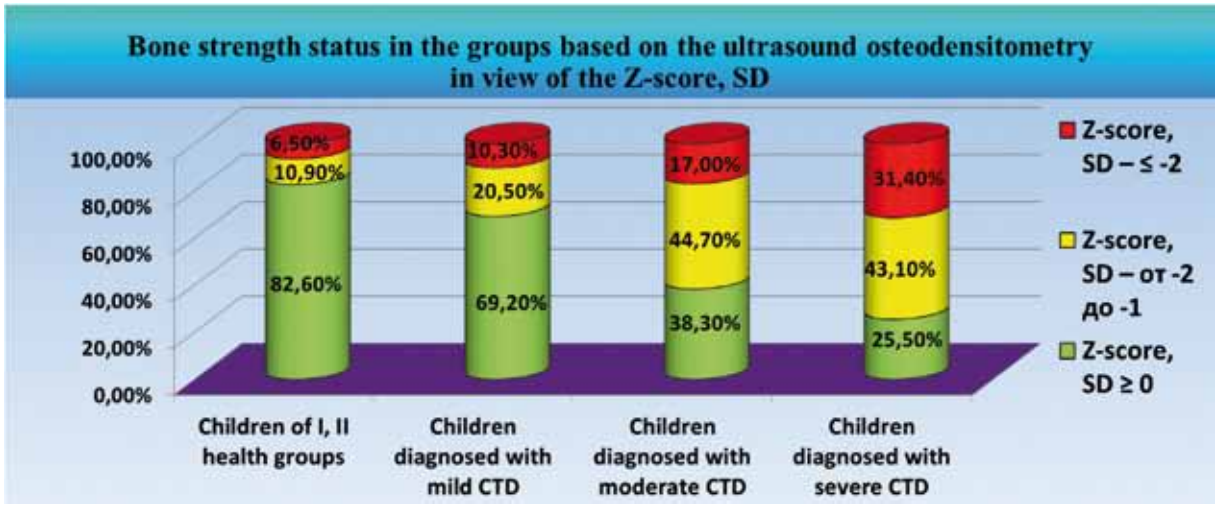

Fig. 9. Bone strength status in the groups based on the ultrasound osteodensitometry in view of the Z-score, SD

Table 1. *Radiomorphometric indices, mandible, depending on bone strength status; Health Groups I & II, (n = 46), (M ± m)*

Learning Indexes, Units	Bone strength status		
	Z-score ≥ 0 SD, n=38	Z-score ≤ -1 SD, n=5	Z-score ≤ -2 SD, n=3
FI, points	1,0	0,99 ± 0,01	0,97 ± 0,02
GI, mm	1,97 ± 0,58	1,59 ± 0,37	1,33 ± 0,24
AI, mm	4,39 ± 0,61	4,04 ± 0,92	3,63 ± 0,91
MI, mm	4,68 ± 0,52	4,76 ± 0,83	3,95 ± 0,89
X-ray index, points	1,0	1,01 ± 0,01	1,03 ± 0,02
PMIi, points	0,43 ± 0,09	0,39 ± 0,06	0,34 ± 0,08
PMIm, points	0,39 ± 0,08	0,35 ± 0,05	0,28 ± 0,07
PMIs, points	0,32 ± 0,07	0,31 ± 0,04	0,26 ± 0,06
MCI, mm	3,9 ± 0,1	3,9 ± 0,2	3,8 ± 0,3

Table 2. *Radiomorphometric indices, mandible, depending on bone strength status; children diagnosed with mild CTD, (n = 39), (M ± m)*

Learning Indexes, Units	Bone strength status		
	Z-score ≥ 0 SD, n=27	Z-score ≤ -1 SD, n=8	Z-score ≤ -2 SD, n=4
FI, points	0,96 ± 0,03	0,94 ± 0,05	0,88 ± 0,02
GI, mm	1,89 ± 0,52	1,36 ± 0,34	1,07 ± 0,23
AI, mm	4,27 ± 0,56	3,93 ± 0,79	3,54 ± 0,86
MI, mm	4,62 ± 0,47	4,72 ± 0,77	3,36 ± 0,81
X-ray index, points	1,03 ± 0,02	1,05 ± 0,04	1,09 ± 0,03
PMIi, points	0,41 ± 0,07	0,37 ± 0,03	0,31 ± 0,02
PMIm, points	0,38 ± 0,06	0,33 ± 0,04	0,26 ± 0,03
PMIs, points	0,31 ± 0,04	0,29 ± 0,02	0,24 ± 0,05
MCI, mm	3,8 ± 0,2	3,8 ± 0,3	3,7 ± 0,1

Table 3. *Radiomorphometric indices, mandible, depending on bone strength status; children diagnosed with moderate CTD, (n = 47), (M ± m)*

Learning Indexes, Units	Bone strength status		
	Z-score ≥ 0 SD, n=18	Z-score ≤ -1 SD, n=21	Z-score ≤ -2 SD, n=8
FI, points	0,89 ± 0,04*	0,85 ± 0,03*	0,79 ± 0,01*
GI, mm	1,87 ± 0,43*	1,28 ± 0,29*	0,99 ± 0,18*
AI, mm	4,24 ± 0,45*	3,88 ± 0,71*	3,50 ± 0,76*
MI, mm	4,59 ± 0,38*	4,69 ± 0,72*	3,32 ± 0,74*
X-ray index, points	1,08 ± 0,02*	1,09 ± 0,01*	1,12 ± 0,03*
PMIi, points	0,39 ± 0,04*	0,33 ± 0,01*	0,26 ± 0,02*
PMIm, points	0,31 ± 0,03*	0,30 ± 0,04*	0,24 ± 0,01*
PMIs, points	0,27 ± 0,03*	0,25 ± 0,01*	0,22 ± 0,04*
MCI, mm	3,7 ± 0,3*	3,6 ± 0,2*	3,5 ± 0,1*

Note: ** p <0.05 — the reliability of statistical differences compared with indicators of children of I, II health groups*

Table 4. *Radiomorphometric indices, mandible, depending on bone strength status; children diagnosed with severe CTD, (n = 51), (M ± m)*

Learning Indexes, Units	Bone strength status		
	Z-score ≥ 0 SD, n=13	Z-score ≤ -1 SD, n=22	Z-score ≤ -2 SD, n=16
FI, points	0,82 ± 0,03**	0,76 ± 0,01**	0,72 ± 0,02**
GI, mm	1,79 ± 0,36**	1,23 ± 0,26**	0,94 ± 0,19**
AI, mm	4,19 ± 0,41**	3,84 ± 0,64**	3,44 ± 0,71**
MI, mm	4,55 ± 0,36**	4,67 ± 0,61**	3,26 ± 0,66**
X-ray index, points	1,09 ± 0,03	1,12 ± 0,02**	1,14 ± 0,01**
PMIi, points	0,37 ± 0,02**	0,28 ± 0,03**	0,23 ± 0,01**
PMIm, points	0,29 ± 0,02**	0,27 ± 0,03**	0,21 ± 0,01**
PMIs, points	0,25 ± 0,01**	0,22 ± 0,02**	0,19 ± 0,03**
MCI, mm	3,7 ± 0,2**	3,6 ± 0,3**	3,5 ± 0,1**

Note: ** p <0.01 - the reliability of statistical differences compared with indicators of children of I, II health groups*

phy of the foramen mentale in relation to the mandible lower border.

A qualitative evaluation of the mandible cortical plate status through the MCI value determined an identical orientation with respect to the Z-criterion, just like in the previously analyzed X-ray indices, while the differences were statistically significant (p <0.05). In Health Groups I and II, as well as in Subgroup 1, the C3 type of cortical plate was not registered, while the occurrence of C1 and C2 types was 73.9% and 26.1%, and 61.5% and 38.5%, respectively, whereas the differences between the groups were considered unreliable (p <0.01). In Subgroups 2 and 3, a slightly damaged cortical layer prevailed (53.2% and 43.1%, respectively), and the differences between the studied groups, too, did not reveal statistically significant difference (p <0.01). The major difference between the children in Subgroups 2 and 3 was the occurrence of the C1 and C3 types: in children with mild CTD, this ratio was 31.9% and 14.9%, while in children with severe CTD — 23.5% and 33.4%, respectively, subject to the statistically significant differences (p <0.05). The qualitative evaluation of the mandible bone tissue in Subgroup 3 and the C3 type revealed erosion, lack of uniformity, and severe damage to the cortex through its entire length with significant attenuation, as well as a large-cellular pattern of the spongeous bone. It is to be noted that the MCI index is highly reliable and diagnostically significant, while the orthopantomograms obtained via CBCT, in contrast to the X-ray method, allow getting reliable results, as well as conducting objective differential diagnostics in a qualitative evaluation of the mandible cortical plate status.

A study of X-ray morphometric indices shows that in case of an increase in the dysplastic disorders severity in children, a decrease in the bone density comes combined with a decrease in cortex thickness and destructed interalveolar septa, while the share of patients with severely damaged lower jaw cortical plate is increasing (Fig. 10).

Unlike children of Health Groups I and II (Fuchs index in the group — 0.99 ± 0.01; X-ray index — 1.01 ± 0.01; MCI — 3.9 ± 0.1; cortex thickness — 2.8 ± 0.4; mandible body X-ray density — 1727.6 ± 302.1 HU; mandible X-ray density angle — 2181.4 ± 297.3HU), the patients with mild CTD (Fuchs index in the group — 0.93 ± 0.03; X-ray index — 1.06 ± 0.03; MCI — 3.8 ± 0.2; cortex thickness — 2.6 ± 0.1; mandible body X-ray density — 1538.9 ± 274.4HU; mandible X-ray density angle – 1936.7 ± 281.2HU) as well as the patients with moderate CTD (Fuchs index for the group — 0.84 ± 0.02; X-ray index — 1.10 ± 0.02; MCI — 3.6 ± 0.2; cortex thickness — 2.1 ± 0.3; X mandible body X-ray density — 1316.8 ± 251.7; mandible X-ray density angle — 1783.8 ± 264.5HU) featured a slight and unevenly decreased height of the interalveolar septa (no more than ⅓ of the root length), which came combined with a slight resorption (6–10%) of the mandible alveolar part. The children with severe CTD (Fuchs index in the group — 0.77 ± 0.02; X-ray index — 1.12 ± 0.02; MCI — 3.6 ± 0.2; cortex thickness — 1.9 ± 0.2; mandible body X-ray density — 1198.3 ± 236.2HU; mandible X-ray density angle — 1652.9 ± 249.6HU) were diagnosed with generalized, moderate, horizontal resorption of the mandible alveolar part, uniform de-

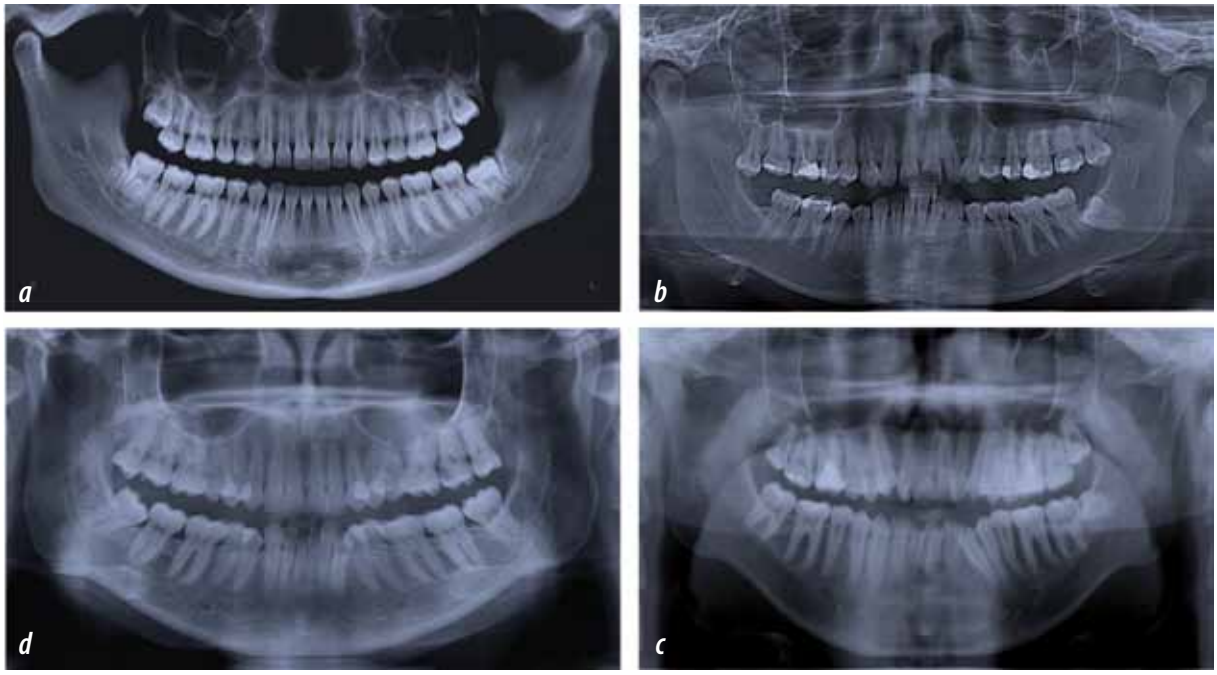

Fig. 10. *X-ray specifics of the mandible bone tissue status in the groups: a — patient A., 16 y.o., Health Group I; b — patient M., 15 y.o., mild CTD; c — patient K., 16 y.o., moderate CTD; d — patient S., 16 y.o., severe CTD*

crease in the interalveolar septa height (about ⅓ of the root length), and an early stage of destructive change (12%) of the bone tissue.

Visualization of CBC tomograms of transverse sections of the mandibular bones alveolar part in Health Groups I and II determines the following features — a thickened cortical layer; bone trabeculae represented by a large-mesh pattern with crossed bone beams; the functional trabecular package features a horizontal orientation; interalveolar ridges are of pointed triangular shape with a pronounced closing cortical plate. CBCT evaluation of the mandible alveolar part cross sections suggests that an increase in the CTD severity comes along with the following focus in the pathomorphological changes — decreasing thicknessof the cortical plates; predominance of medium- and fine-meshed patterns; destroying structure of the trabecular package with disturbed spatial orientation and thinning bone trabeculae; dissociation of the inner cortical plate; interalveolar ridge shape getting more of something semi-oval or flattened. The X-ray examination data makes it obvious that the bone resorption intensity is most prominent in children with severe CTD.

This suggestion gets confirmed through generalized chronic productive inflammation, which leads to a uniform decrease in the interalveolar septa height within a range of ⅓ of the root length; a slight expansion of the periodontal gap; a decrease in the optical density and a disturbed microarchitectonics in the mandible body (thinned bone beams; increased transparency of the bone pattern; fibrous transformation of the bone tissue structure; medium and fine-mesh pattern of the spongeous bone; porosity; lack of contours; eroded thinned closing cortical plate along its with surface). The systematization of the available research data as well as the outcomes of our own studies indicates that patients with CTD feature the following pathomorphological changes — catabolism prevalence over synthesis and recovery; connective tissue edema; fibrous structures and major substance decomposition; violation of fibrillogenesis; reduced blood vessels in the microvasculature; development of perivascular dense productive infiltrates; fiber homogenization and changed ratio between certain types of collagen; connective tissue hyalinosis and sclerosis. The TMJ capsule-ligamentous complex responds to chronic productive inflammation with irreversible deformities in the articular disc, disturbed integrity of the intraarticular ligaments, joint bone elements hypoplasia, and periodontal disease — impaired function (plastic, protective, barrier, trophic, shock-absorbing functions), bone resorption, tooth mobility, and the development of secondary traumatic occlusion.

CONCLUSIONS

1. Comprehensive evaluation of the mandible bone tissue status using X-ray morphometric indices and X-ray density indices in children with CTD, allows identifying the nature and the degree of dysplastic disorders, detecting the manifestations of irreversible periodontal bone resorption, and can serve the basis for the developing a set of dental measures, as well as for designing proper approaches implying medication, non-medication, and symptom-based treatments.
2. Strong positive correlation relationship between quantitative X-ray morphometric indices and the osteodensitometry Z-criterion, which were detected in children with CTD, reveal that the peripheral skeleton bone tissue status offers a reliable reflection of the radiological picture observed on orthopantomograms. Quantitative calculation of X-ray morphometric indices in the dentist's clinical practice is not only a highly reliable method for screen-diagnosing the quality of skeleton bones in childhood, yet is also an effective way of early detection of decreasing bone strength.
3. The data obtained through identifying the mandible mineral density, its cortical layer morphological structure, the cortex thickness at the level of the foramen mentale, demonstrate a statistically significant decrease in the cortical plate thickness, as well as a decrease in the bone optical density in children affected with CTD. The data can be well used when examining patients in dental offices as indicators of the osteopenia syndrome progress with an increased risk of osteoporosis.
4. The progression of the child dysplastic disorders involving connective tissue, which correlates with the intensity of bone structures destruction at the maxillofacial area and with the collagen degradation progress, is associated with an increase in chronic productive inflammation, reduced X-ray density; fibrous transformation of bone tissue; a decrease in the thickness and the dissociation of the mandible cortical plates; prevalence of medium- and fine-meshed bone pattern; disturbed space orientation and bone trabeculae thinning; development of pathologies in the periodontium, which leads to the development of secondary traumatic occlusion.
5. A qualitative evaluation of the mandible cortical layer status should be performed through cone beam computed tomography in a panoramic mode, which can be explained with higher specific sensitivity, sensitivity, accuracy, and prognostic value in terms of negative and positive outcomes, in contrast to similar data obtained through orthopantomography of maxilla bones.
6. When examining groups of children thus aiming at developing risk groups involving impaired musculoskeletal system development, we would recommended employing quantitative ultrasound osteodensitometry based on average age standards and percentile scales, whereas children with bone deficiency would need further comprehensive examination, correction with medication, preventive care, outpatient monitoring and densitometric control.

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