Journal of Critical Reviews

ISSN- 2394-5125 Vol 7, Issue 9, 2020

INFLUENCE OF IODINE DEFICIENCY ON THE DENTAL STATUS OF THE ADULT POPULATION RESIDING IN AN AREA WITH NATURAL IODINE DEFICIENCY

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Received: 27.03.2020 ***Revised: 19.04.2020*** ***Accepted: 26.05.2020***

Abstract
The aim of the work is to characterize the dental and hygienic status of the oral cavity in middle-aged patients residing in the area with natural iodine deficiency, depending on the severity of iodine deficiency disorders. In 193 patients aged 35-44 years who applied for dental care, the level of ioduria, thyroid volume, plasma level of thyroid stimulating hormone (TSH) and free thyroxine, as well as the indices, such as DEF *(*decayed, extracted, filled teeth), PMA (papillary marginal attachment), CPI (community periodontal index), and OHI-S (simplified oral hygiene index) reflecting the patient dental status, have been assessed. High prevalence of iodine deficiency (59.5%) has been noted among patients requiring prosthodontic treatment, 14.1% of them had severe iodine deficiency with the ioduria median of 75.5 μg/L. The ioduria severity is correlated with the thyrotropin and free thyroxine level in the blood plasma. Uncompensated iodine deficiency negatively affects the prevalence and intensity of dental caries, the condition of oral mucosa and periodontal tissues, and the hygienic status of the oral cavity. High and average values of Spearman's rank correlation coefficient have been found for the levels of dental indices, ioduria and blood plasma thyroid hormones in the adult population residing in iodine-deficient area.

Keywords: thyroid gland, iodine deficiency, thyroid stimulating hormone, thyroxine, DEF, PMA, CPI, OHI-S.

DOI: http://dx.doi.org/10.31838/jcr.07.09.130

INTRODUCTION

Endocrine pathology has a pronounced effect on the development and progression of diseases in the oral tissues [1, 3]. Iodine-containing thyroid hormones, acting as pleiotropic tissue growth factors, control the formation of craniofascial structures, as well as the differentiation and proliferation of oral cells in the antenatal and postnatal periods of the body development.

Iodine deficiency is one of the most common human diseases [6] and has wide range of manifestations. At a mature age, hypothyroidism, goiter and its complications, and cognitive impairment are most often detected [22].

Due to its geographical location, more than half of the territory of Russia is endemic for goiter [6, 15]. Despite the measures taken for the production and distribution of iodized salt, the iodine supply of the population and the frequency of endemic goiter are not normal. According to endemiological studies [19], the prevalence of goiter in children and adolescents in Russia ranges from 5% to 31%. The ioduria median is 82.2 μg/L with fluctuations in individual areas from 17 μg/L to 125 μg/L.

The territory of the Republic of Bashkortostan is the area of natural iodine deficiency [8, 10], where the volume of mass iodine prophylaxis remains insufficient. Only 37% of Ufa families consume iodized salt [20], and the majority of the region's population remains in conditions of iodine deficiency. It has been shown that functional insufficiency of thyroid gland aggravates the dental morbidity of the population, contributing to an increase in the incidence rate of periodontal diseases, alveolar bone resorption, and to a decrease in tooth enamel resistance [1, 3, 16]. However, a number of issues related to the state of the dentofacial system in patients residing in areas of iodine deficiency, as well as optimization of methods of prevention and treatment of dental disorders in these conditions remain open.

This study was aimed at characterization of the dental and hygienic status of the oral cavity in middle-aged patients residing in the area of natural iodine deficiency, depending on the severity of iodine deficiency disorders.

METHODS

Materials and study design

The research was conducted in two stages. At the first stage, 392 patients (28 men and 366 women) aged 25-44 years, who applied for orthopedic treatment of dentition defects and had been permanently residing in the mountain and foothill areas of the Urals in the Republic of Bashkortostan, were examined. Pregnant and lactating women; individuals taking levothyroxine or thyreostatic drugs and those who took amiodarone the year before the study; as well as patients with acute diseases, diabetes mellitus, oncological diseases and chronic diseases in the acute stage of their progress, were all excluded from the examination.

The examination of patients at the first stage included questioning, external examination, the examination of oral cavity, teeth and periodontium, as well as the assessment of the severity of the iodine deficiency disorders.
At the second stage of the research, 193 patients aged 35-44 years (with the mean age of 38 ± 4.3 years) were examined more profoundly. The thyroid gland volume, the levels of TSH and free thyroxine (cT_4) in the blood plasma, prevalence and intensity of dental caries, and periodontal and oral hygiene status were determined.

Methods

Assessment of the iodine deficiency severity was carried out according to the criteria recommended by ICCIDD (International Council for the Control of Iodine Deficiency Disorders) of the World Health Organization [23]. Iodine content in the urine from morning portion was determined by the cerium-arsenite method (Merk reagent kit), the volume of the thyroid gland – by ultrasound (SonoScape apparatus), TSH and cT_4 levels – by enzyme-linked immunosorbent assay (ELISA) (VectorBest reagent kit, StatFox2100 analyzer). The prevalence and intensity of dental caries were assessed with the DEF index, gingival condition – with the PMA index according to the method of E. Schoup, J. Massler (1945) modified by C. Parma (1960), the periodontal health status – with the CPI proposed by L.A. Leus (1988), oral hygiene – with OHI-S according to J.S.Greene, J.K.Vermillion (1964). Statistical processing of the results was carried out using the Statistica 6.0 (Stat Soft) software package. Differences between the

samples were calculated by the Student's t-test and Mann-Whitney's U-criterion, correlation relationships were estimated using Spearman's rank correlation coefficient (r_s).

RESULTS

When assessing the severity, three degrees are indicated: mild, moderate, and severe [23]. Mild iodine deficiency is characterized by the ioduria level in the range of 50–99 μg/L, and the prevalence of goiter in the population can vary from 5% to 20%, while cretinism does not occur. Moderate iodine deficiency is characterized by the ioduria level of 20-49 μg/L, the frequency of goiter occurrence can reach 21-30%. With the severe iodine deficiency, the ioduria median decreases to less than 20 μg/L, and the prevalence of goiter increases up to 30%.

Study of ioduria among the adult population of the region (Table 1) revealed that only in 133 patients out of 392 examined (33.9%), the ioduria level corresponded to the physiological norm with the recommended degree of iodine supply of 100 - 199 μg/L. Severe iodine deficiency was found in 14.1% of patients, moderate and mild iodine deficiency was detected in 26.3% and 20.7% of patients, respectively. The ioduria level of more than 200 μg/L was detected in 5.1% of the examined patients. The ioduria median in the studied area was 75.3 [50.4 - 122.3] μg/L.

Table 1: The prevalence of iodine deficiency (abs./%) and the ioduria level in patients residing in certain districts of the Republic of Bashkortostan

District	n	Ioduria level, μg/L					Me[Q_1-Q_3]
		<20	21-49	50-99	100-199	>200	
Beloretsky	79	9/11.4	14/17.7	23/29.1	31/39.2	2/2.6	82.1[54.3-130.5]
Ishimbaysky	110	19/17.3	21/19.1	18/16.4	39/35.4	13/11.8	80.7 [56.3-122.2]
Karaidelsky	69	6/8.7	18/26.0	14/20.4	27/40.5	3/4.4	81.8[57.2-131.7]
Meleuzovsky	134	21/15.7	50/37.3	26/19.4	35/26.1	2/1.5	60.0[36.1-110.4]
Total	392	55/14.1	103/26.3	81/20.7	133/33.9	20/5.1	75.5[50.4-122.3]

Prolonged uncompensated iodine deficiency is one of the causes of thyroid hormonal dysfunction. Studying the functional state of the thyroid gland during the second stage of the research revealed that in none of the districts, the median of thyroid volume went beyond the physiological norm equaling for women to 7-18 cm^3 (Table 2).

Table 2: The functional state of the thyroid gland in middle-aged patients (35-44 years old) in certain districts of the Republic of Bashkortostan, Me [Q_1-Q_3]

District	n	Thyroid volume, cm^3	TSH, mIU/L	cT_4, nmol/L
Beloretsky	46	10.4 [7.9-13.1]	2.86 [1.85-4.63]	10.75 [9.5-14.75]
Ishimbaysky	52	14.0 [10.0-20.9]	2.84 [1.6-4.22]	11.72 [11.15-14.10]
Karaidelsky	50	13.7 [11.7-19.6]	2.53 [1.73-4.16]	12.3 [11.7-14.0]
Meleuzovsky	45	16.4 [11.1-22.5]	2.99 [1.3-5.01]	12.15 [9.4-14.55]
Total	193	14.1 [11.1-19.7]	2.92 [1.68-4.17	12.12 [10.82-14.09]

Individual data analysis revealed that the thyroid volume in patients of the Meleuzovsky district exceeded the physiological norm in 33.3% of cases, in Karaidelsky district - in 28%, in Ishimbaysky district - in 25%, in Beloretsky district - in 15.2%. In general, among all examined patients, 26.2% had an increase in the thyroid volume.

The levels of TSH and cT_4 in the blood are considered to be the main markers of the thyroid system functional state. For women residing in the studied areas, the medians of these hormones concentration were within the framework of reference fluctuations, which, according to the data of the produced test systems, equaled to 0.3–4.0 mIU/L for TSH and 10–25 nmol/L for cT_4. At the same time, in 25.4% of the women examined, the TSH level exceeded the upper limit of the normal range, and in 7.4% of patients, it was at the upper limit of the reference range, which allowed suggesting hypothyroidism in 33.2% of patients. In the blood plasma of 6.7% of patients, the TSH level was less than 0.3 mIU/L indicating the possibility of subclinical hyperthyroidism; and only one patient had cT_4 level (25.8 nmol/L) higher than the physiological level at TSH concentration within the normal limits equaling to 1.24 mIU/L. At the same time, a decrease in cT_4 secretion to less than 10.0 nmol/L was found in 24.4% of the patients, which indicated hypofunction of the thyroid gland.

Thus, according to the results of the study of the levels of thyroid hormones in the blood plasma of 193 women aged 35-44 years and residing in the iodine-deficient area, more than a quarter of them suffered functional insufficiency of thyroid gland.

It is important that according to laboratory studies, the frequency of hypothyroidism detection in patients depended on the iodine deficiency severity (ioduria level). In individuals with the physiological and excessive level of ioduria (> 200 μg/L), medians of TSH and cT_4 levels in blood plasma (Table 3) were within the range of reference fluctuations.

Table 3: Levels of thyroid hormones in the blood plasma of middle-aged dental patients (35-44 years old) with varying iodine deficiency severity, Me [Q1-Q3]

Iodine supply	n	Ioduria level, μg/L	TSH, mIU/L	cT_4, nmol/L
Physiological norm	66	141.9 [116-178.5]	1.92 [1.73-3.03]	13.8 [11.4-15.3]
Mild iodine deficiency	40	78.5[a] [68.4-84.7]	2.93[a] [2.3-3.91]	12.6[a] [8.3-14.8]
Moderate iodine deficiency	50	37.2[a,b] [32-42.4]	3.41[a,b] [2.72-4.34]	11.8[a,b] [8.8-13.9]
Severe iodine	27	17.4[a,b;c]	3.88[a,b]	10.3[a,b]

deficiency		[16.1-19.2]	[2.91-4.66]	[8,7-12,9]
Excessive intake of iodine	10	318.9[a,b,c,d] [301.4-343.5]	2,79[a,d] [1.43-3.65]	16.9[a,b,c,d] [10.3-19.6]

Notes: significance of differences for this and the following tables was as follows: [a)] – P<0.05 with the group of patients with physiological level of iodine supply, [b)] – with the group of patients with mild iodine deficiency, [c)] – with the group of patients with moderate iodine deficiency, [d)] – with the group of patients with severe iodine deficiency.

In groups of patients with iodine deficiency, statistically significant increase in TSH level and decrease in cT_4 level were revealed. The ioduria level had moderate negative correlation with TSH level (rs = -0.69, P<0.001) and positive correlation with cT_4 level (rs = 0.63, P<0.001), which evidenced the thyroid function dependence on the degree of iodine supply.

Study of the dental status in patients showed that the prevalence of dental caries among the adult population residing in the iodine-deficient area was 100%. Caries intensity (Table 4) in individuals with compensated and mild iodine deficiency was high - the DEF index was 15.6 ± 0.64 and 16.0 ± 1.06 scores, respectively. In groups of patients with moderate and severe iodine deficiency, excessively high caries intensity was revealed – the DEF index was 18.0 ± 0.62 and 21.6 ± 0.82 scores, respectively.

Table 4: Caries intensity in middle-aged patients (35-44 years old) with varying iodine deficiency severity, M ± m

Iodine supply	n	Indexes (scores)			
		DEF	D	F	E
Physiological norm	66	15.6±0.64	2.9±0.21	3.9±0.30	8.8±0.34
Mild iodine deficiency	40	16.0±1.06	3.2±0.18	2.3±0.21[a]	10.5±0.52a
Moderate iodine deficiency	50	18.0±0.62[a,b]	4.0±0.29[a,b]	2.4±0.13[a]	11.6±0.38[a]
Severe iodine deficiency	27	21.6±0.82[a,b,c]	5.6±0.31[a,b,c]	5.1±0.24[a,b,c]	10.9±0.30[a]
Excessive intake of iodine	10	18.4±1.09[a,b,d]	4.5±0.28[a,b,c,d]	4.1±0.52[b,c,d]	9.8±0.26[a,c,d]

Significantly higher values of the E and D indices were noted in patients with iodine deficiency (teeth removed and affected by caries). Correlation analysis showed moderate negative relationship between the ioduria level and the DEF index (rs = -0.68, P = 0.025), and strong one – between the ioduria level and the D index (rs = -0.72, P = 0.018). The relationship between the DEF index and TSH level (rs = 0.48, P = 0.036), as well as the DEF index and cT_4 level (rs = -0.57, P = 0.029) was also determined.

In the groups of patients with iodine deficiency, more pronounced changes in the PMA and CPI indices were observed compared to the group of patients with the physiological level of iodine supply (Table 5). Increase in the PMA median in groups of patients with mild and moderate iodine deficiency from 27.3 [11.0-44.4]% to 48.3 [36.1-58.3]% and 50.5 [37.2- 59.7]%, respectively, was the result of the detecting in them of a large number of patients with mild and moderate gum disease.

Table 5: The effect of iodine deficiency on PMA and CPI indexes, Me [Q1-Q3]

Iodine supply	n	Indexes	
		PMA, %	CPI, scores
Physiological norm	66	27.3 [11.0-44.4]	1.34 [0.66-1.04]
Mild iodine deficiency	40	48.3[a] [36.1-58.3]	2.33[a] [1.38-2.86]
Moderate iodine deficiency	50	50.5[a] [37.2-59.7]	2.73[a] [1.56-2.26]
Severe iodine deficiency	27	57.2[a,b] [36.8-68.1]	3.33[a,b,c] [2.83-4.33]
Excessive intake of iodine	10	54.2[a] [45.5-60.7]	2.78[a] [1.8-3.77]

In patients with severe iodine deficiency, severe gum disease along with the mild and moderate ones, was detected. However, the correlation was not statistically significant (rs = -0.44, p = 0.085) between the ioduria level and the PMA index.

CPI results also demonstrated the adverse effect of iodine deficiency on the periodontal status of patients. CPI allowed determining the prevalence and intensity of signs of periodontal disease - bleeding on probing, supra- and subgingival calculus, periodontal pockets of various depth. In groups of iodine-deficient patients, CPI was statistically significantly higher than in the group of individuals with the physiological level of micronutrient supply. In patients with mild iodine deficiency, CPI increased more than two times, in patients with moderate and severe iodine deficiency - 2.8 times and more than 3 times, respectively. This dependence was also confirmed by the results of determining the correlation coefficient between the ioduria level and CPI (rs = -0.82, p = 0.011), between the TSH level and CPI (rs = 0.79, p = 0.027), as well as between cT_4 and CPI (rs = - 0.70, p = 0.038).

Oral hygiene status determined using the simplified oral hygiene index of Greene and Vermillion (OHI-S) was satisfactory in patients with compensated iodine deficiency and poor in groups of patients w

ith iodine deficiency. The insufficient intake of iodine contributes to the deterioration of the oral hygiene (Table 6). Thus, the OHI-S median increases to 166.3% (p = 0.045) in patients with mild iodine deficiency, to 224.1% in patients with moderate iodine deficiency, and to 255.4% in patients with severe iodine deficiency, compared to the group of patients with compensated iodine deficiency. The correlation coefficient calculation revealed the correlation between ioduria level and OHI-S (rs = -0.381, p = 0.036), between TSH level and OHI-S (rs = 0.392, p = 0.05), and between cT_4 and OHI-S (rs = - 0.456, p = 0.046).

Table 6: Oral hygiene status (OHI-S) of patients depending on the iodine deficiency severity, Me [Q1-Q3]

Iodine supply	n	OHI-S, scores
Physiological norm	66	0.83 [0.65-1.38]
Mild iodine deficiency	40	1.38 [0.85-1.45][a]
Moderate iodine deficiency	50	1.86 [1.40-2.15][a,b]
Severe iodine deficiency	27	2.12 [1.72-2.64][a,b,c]
Excessive intake of iodine	10	1.42 [0.96-1.68][a,c,d]

Studying of lipid peroxidation and antioxidant protection of mixed saliva in patients residing in the iodine-deficient area and suffering from iodine deficiency of varying severity revealed the development of regular changes in oxidative-antioxidant status (Table 7).

Table 7: The indicators of the system of lipid peroxidation and antioxidant protection of the oral fluid, depending on the iodine deficiency severity (ioduria level), Me [Q1-Q3]

Patient group	n	Thiobarbituric acid reactive substances (TBARS), µmol/L	Superoxide dismutase (SOD), U/mg protein	Glutathione peroxidase (GP), U/mg protein	Catalase, µmol/min/mg protein
Physiological norm, 100-199 mcg/L	26	0.19 [0.16-0.21]	50.3 [44.2-58.4]	0.35 [0.26-0.40]	12.4 [11.9-13.3]
Mild iodine deficiency, 50-99 mcg/L	20	0.28 [0.23-0.30] p<0.001	41.65 [40.2-50.6] p=0.003	0.30 [0.24-0.34]1 p=0.036	12.1 [11.4-12.3] p=0.304
Moderate iodine deficiency, 20-49 mcg/L	26	0.36 [0.31-0.41] p<0.001 p_1=0.013	40.8 [37.7-42.4] p<0.001 p_1=0.940	0.23 [0.21-0.25] p<0.001 p_1=0.019	11.0 [10.4-12.1] p=0.003 p_1=0.028
Severe iodine deficiency, <20 mcg/L	22	0.34 [0.28-0.40] p<0.001 p_1=0.015 p_2=0.738	40.2 [36.4-42.3] p<0.001 p_1=0.803 p_2=0.907	0.24 [0.19-0.30] p<0.001 p_1=0.041 p_2=0.608	10.8 [10.4-12.5] p=0.003 p_1=0.038 p_2=0.414

In iodine-deficient patients, lipid peroxidation was intensified (Figure 1). The level of secondary lipid peroxidation products - substances that reacted with thiobarbituric acid (TBARS) – in mixed saliva of the patients with mild iodine deficiency increased to 142.1%, with moderate iodine deficiency - up to 189.5%, and with severe iodine deficiency – up to 178.9%, compared to the patients with physiological level of iodine supply.

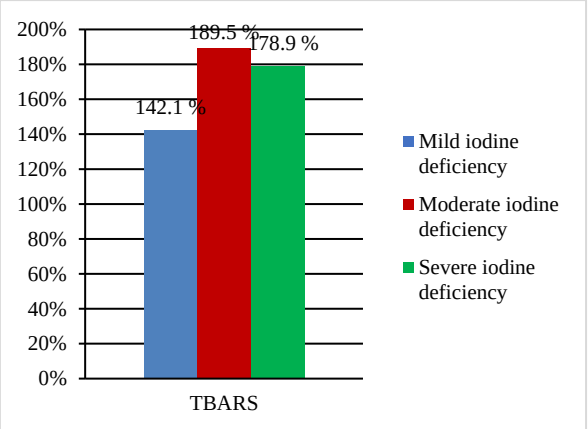

Fig. 1: The level of TBARS in the oral fluid in the groups of patients with iodine deficiency of varying severity (in % to the physiological level taken as 100%)

As can be seen from the data presented, the glutathione peroxidase activity in the oral cavity decreases most significantly in patients with moderate and severe iodine deficiency – to 65.75% ($p < 0.001$) and 68.6% ($p < 0.001$), respectively. The activity of superoxide dismutase and catalase decreases less significantly, but also reaches statistical significance. Catalase activity decreases to the least extent.

DISCUSSION

The results of studying the oral hygiene, periodontal and dental hard tissue statuses, as well as lipid peroxidation in middle-aged adults (35-44 years old) residing in an area with natural iodine deficiency have shown that insufficient intake of this microelement contributed to deterioration of dental health.

In patients with compensated iodine deficiency (ioduria level of 100-190 μg/L), the prevalence of dental caries was 100%, its intensity according to the DEF index was as follows: DEF = 15.6 ± 0.64, while the D component was equal to 2.9 ± 0, 21, the F component – to 3.9 ± 0.30, and the E component – to 8.8 ± 0.34. In patients with iodine deficiency of varying severity, the prevalence of dental caries was also 100%, and the DEF index was equal to 18.6 ± 0.64 (according to WHO, the level of caries intensity over 16.3 was very high in this age group). In this group of patients, the D, F and E components equaled to 4.4 ± 0.11, 3.2 ± 0.18, and 11.0 ± 0.20, respectively. At the same time, in terms of the structure of the DEF index, on average, the studied groups of patients did not differ from each other: decayed teeth (D) were 23.6% and 23.7%, respectively, filled teeth (F) – 17.2% and 17.3%, extracted teeth (E) - 59.2% and 59.0%, which reflected the high level of extracted teeth.

The DEF index in the group of patients of 35-44 years of age residing in the studied areas of Bashkiria significantly exceeded the similar indexes both for Russia as a whole (13.93 scores), and for individual regions, as well as for other countries [2, 5, 11]. The prevalence of dental caries among adults in most countries reaches 100%. In various regions of Russia, many countries of Western Europe, Latin America and Australia, a high level of caries intensity is noted in the studied age group of patients [17]. According to the national dental examination according to WHO criteria, conducted in the Russian Federation in 2008 in different age groups of patients in seven federal districts, the average DEF index for 35-44 year olds was 13.35 ± 0.70 in the Central Federal District, 16.26 ± 0.88 in the North-Western Federal District, and 12.4 ± 0.62 in the South Federal District, 14.62 ± 0.76 in the Volga Federal District, 14.87 ± 0.68 in the Ural Federal District, 12.2 ± 0.58 in the Siberian Federal District, and 12.21 ± 0.58 in the Far Eastern Federal District [11].

In the Russian Federation, the D component on average for this population group is 3.72, the F component is 5.88, and the E component is 4.78 [3]. According to the results of the studies, in patients with iodine deficiency, the D and E components are higher, and the F component is lower than these indicators for Russia in general, which characterizes, on the one hand, the effect of iodine deficiency on dental caries development, and on the other hand, the quality and level of dental care for the key age groups residing in the examined area. However, it must be taken into account that the prevalence and intensity of dental caries in various population subgroups depend on many other factors, including the hygienic, socio-demographic, climatic and geographical, and environmental conditions of residence. Thus, multidirectional changes (decrease, stabilization, increase) in the prevalence and intensity of dental caries depending on age, residence in rural or urban areas, the level of fluoride in drinking water [11], the level of education and awareness of the population about the main dental diseases, lifestyle, and provision of dental care have been defined [5, 12]. The fluoride level in drinking water of the Republic of Bashkortostan ranges from 0.215 mg/L to 0.382 mg/L [21]. As evidenced by the results of studies, the influence of the iodine supply degree on the intensity of dental caries is characterized not only by the dynamics in DEF changes, but also by the statistically significant negative correlation between the ioduria level and the DEF index.

The effect of thyroid hormones on the oxidant-antioxidant system in the oral fluid in patients with iodine deficiency can also be associated with indirect effects, namely with the varying intensity of dental caries established in the conducted studies, the oral hygiene status in women with the physiological level of iodine intake and with the deficiency of this microelement. Study results allow concluding that hypothyroidism affects the state of oxidative processes in the oral fluid, but its impact is moderate or even weak. It is possible that the indicators of the oxidant-antioxidant system in the oral fluid of patients with iodine deficiency are more influenced by the oral hygiene status and the presence of inflammatory processes in periodontal and dental tissues.

Deterioration of the periodontal state, oral hygiene level, carious intensity and lipid peroxidation in patients with iodine deficiency is undoubtedly associated with a decrease in their thyroid gland functional state. This is evidenced not only by the correlation between the ioduria level and the levels of TSH and cT_4 in the blood plasma, but also by the exceptional dependence of the thyroid gland on the iodine intake from the environment necessary for biosynthesis of its hormones.

The literature contains significant material on the biological and clinical significance of the thyroid gland, including for the dentofacial pathology development. However, this information concerns mainly childhood, the period of growth and development of the body, while clinical observations in middle-aged individuals are of a rather sporadic nature. In goiter-endemic areas, the incidence rate of dental caries is approximately by 20% higher than in the non-goiter-endemic areas. Herewith, multiple caries with high and very high intensity of tooth decay is detected more often [3].

Hypothyroidism in adult patients is accompanied by an increase in the incidence rate of chronic catarrhal gingivitis [18]. It is detected in individuals with diffuse enlargement of the thyroid gland against the background of iodine deficiency in 78.5% of cases. The prevalence of periodontal diseases by CPI value is 90%, the intensity is 5.42 ± 0.13 scores, the oral hygiene level is unsatisfactory by the OHI-S value – 2.34 ± 0.27 scores, the prevalence of inflammatory changes by the PMA index is 32.16% , and the value of the SBI (sulcus bleeding index) corresponds to the moderate gingival inflammation – 1.48 ± 0.12 scores [18]. In middle-aged patients with hypothyroidism, the total number of teeth with noncarious defects (wedge-shaped defect, dental hyperesthesia, erosion and abrasion of enamel) was 6 times higher than in individuals without a history of thyroid disease [7].

Impaired thyroid function exacerbates the course of chronic generalized periodontitis: more severe disease manifestations are demonstrated in patients with hypothyroidism [14]. In patients with endemic goiter (euthyroid phase), mild periodontitis is found in 16.7% of cases, moderate periodontitis – in 53.5% of cases, and severe periodontitis – in 30.0% of cases. In patients with goiter (hypothyroid phase), mild periodontitis is not detected, moderate periodontitis is revealed in 40% of cases, and severe one –in 60% of cases.

In patients with hypothyroidism, chronic generalized periodontitis is characterized by a prolonged silent disease progression with such clinical manifestations as generalized gingiva retention combined with clinical attachment loss, more frequent detection of periodontal pathogens, the absence of immunocompetent cells in the contents of periodontal pockets, decrease in the IgM level in the mixed saliva, an increase in some pro-inflammatory interleukins [13].

Experimental hypothyroidism caused by thyroidectomy or introduction of thyreostatics leads to stereotypic changes in periodontal tissues: dystrophic, atrophic and destructive shifts of parenchymal structures, mucinous edema of the stroma, suppression of reparative processes [14]. These shifts are stipulated by hypoxia, a drop in the level of basic metabolism,

and a slowdown in redox and biosynthetic processes in the tissues. As a result, there is a decrease in proliferation and cell development, a slowdown in physiological regeneration processes, and mucinous edema in the interstitial substance leads to swelling and loosening of collagen fibers, cell compression, degeneration, necrobiosis and atrophy.

Thyroidectomy in mature rats leads to destructive changes in the dental hard tissues, hemodynamic disturbances with the development of pulp edema. In the enamel, there is interprismatic substance disruption, as well as gaps appearance, disturbance of prisms location, decrease in their sizes, dystrophic changes, followed by demineralization, destruction and erosion of enamel [4]. Inhibition of the biosynthesis of iodinated thyroid hormones by Mercazolil leads to pronounced changes in the periodontal status: an increase in the gingival recession severity, alveolar ridge atrophy, increased dental mobility, decrease in resistance of dental hard tissues to the effects of cariogenic factors and aggravation of carious processes [9]. According to the authors of this study, these disorders are associated with a decrease in the synthesis of local stress-limiting proteins (heat shock proteins, etc.), with the change in the mineralizing properties of saliva, and with an increase in the intensity of lipid peroxidation.

Authors of other studies also indicated violations of the ultrastructure, macro- and microelement composition of hard dental tissues during caries in patients with hypothyroidism [16].

The biosynthesis and physiological effects of thyroid hormones are regulated not only by the classical hypothalamus-pituitary-thyroid gland feedback system, but also by complex mechanisms associated with peripheral transformations. Iodinated hormones can exert influence on the dentofacial system by various mechanisms, including changes in the function of the salivary glands, oxidative-antioxidant balance of the oral fluid, bone and phosphorus-calcium metabolism, and the oral cavity immune response. However, these issues require further focused research.

CONCLUSION

In middle-aged patients with dentition defects residing in the area of natural iodine deficiency, high prevalence of iodine deficiency has been noted – 59.5%, the ioduria median among the examined groups of patients equaled to 75.5 μg/L. Subclinical hypothyroidism resulting from thyroid gland deficiency was revealed in one third of patients aged 35-44 years and having applied for dental care. The iodine deficiency severity in this case correlated with the TSH ($rs = -0.69$, $P < 0.001$) and cT_4 ($rs = 0.63$, $P < 0.001$) levels in blood plasma. Uncompensated iodine deficiency negatively affects the prevalence and intensity of caries (DEF), periodontal and the oral mucosa statuses (PMA and CPI), and the oral hygiene level (OHI-S). This is confirmed by the moderate and strong correlations between the ioduria level, TSH and cT_4 levels in blood plasma, and the DEF, CPI and OHI-S values in patients with iodine deficiency. In the mechanisms of influence of iodinated thyroid hormones on the oral diseases development many issues remain unclear.

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