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COMPARATIVE ASSESSMENT OF CLINICAL AND LABORATORY PARAMETERS WHEN USING REMINERALIZING AGENTS FOR TEETH WHITENING

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СРАВНИТЕЛЬНАЯ ОЦЕНКА КЛИНИКО-ЛАБОРАТОРНЫХ ПОКАЗАТЕЛЕЙ ПРИ ИСПОЛЬЗОВАНИИ РЕМИНЕРАЛИЗУЮЩИХ СРЕДСТВ ДЛЯ ОТБЕЛИВАНИЯ ЗУБОВ

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A comparative evaluation of clinical-laboratory indicators was done using different teeth whitening methods. Eighty employees of the aviation plant of Ryazan, working under harmful conditions aged 25–40 (40 women and 40 men), were examined. The control group consisted of 30 practically healthy people without harm. After teeth whitening, 20 % of patients were divided into two groups (40 people each): Group 1 used remineralizing APF thixotropic gel, and Group 2 – remineralizing gel based on hydroxyapatite. The content of trace elements (calcium, potassium, iron, zinc, copper, and selenium) in the oral fluid was determined at different observation periods and increased oral fluid after bleaching levels K, Ca, Fe, Zn, Cu, and Se. In Group 1, there was a multi-directional dynamic after bleaching and remineralizing therapy, which provided stabilization of microelements with their normalization to 14 days. After remineralizing therapy in 2 groups, K, Ca, and Fe have increased ($p<0.001$), as 14 days are approaching the norm ($p<0.001$). As a result of 20 % peroxide treatment, the sensitivity of all groups of patients on all criteria has increased reliably. Remineralizing therapy effectively reduced hypersensitivity. The most effective was the use of thixotropic gel APF.

Keywords: teeth whitening, remineralizing therapy, chemical elements, results

Проведена сравнительная оценка клинико-лабораторных показателей при использовании разных средств отбеливания зубов. Обследовано 80 сотрудников авиационного завода г. Рязани, работавших в условиях вредностей в возрасте 25–40 лет (40 женщин и 40 мужчин). Контрольная группа состояла из 30 практически здоровых людей без вредностей. После отбеливания зубов 20 % перекисью карбамида пациентов разделили на 2 группы (по 40 человек): 1 группа – применяли реминерализующий АПФ тиксотропный гель, 2 группа – реминерализующий гель на основе гидроксиапатита. Определяли содержание микроэлементов (кальций, калий, железо, цинк, медь и селен) в ротовой жидкости в разные сроки наблюдения. Выявлено повышение в ротовой жидкости после отбеливания уровней K, Ca, Fe, Zn, Cu, Se. В 1 группе отмечалась разнонаправленная динамика после отбеливания и реминерализующей терапии, которая обеспечивала стабилизацию микроэлементов с их нормализацией к 14 суткам. После реминерализующей терапии во 2 группе K, Ca и Fe повысились ($p<0,001$), а к 14 суткам показатели приблизились к норме ($p<0,001$). В результате обработки 20 % перекисью карбамида достоверно повысилась чувствительность у всех групп пациентов по всем критериям. Реминерализующая терапия эффективно снижала гиперчувствительность. При этом наиболее эффективным являлось применение АПФ тиксотропного геля.

Ключевые слова: отбеливание зубов, реминерализующая терапия, химические элементы, результаты

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BH – Belle hydroxyapatite
Ca – calcium
Cu – copper
DHII – dental hyperesthesia intensity index
DHPI – dental hyperesthesia prevalence index
Fe – iron
ICP-AES – inductively coupled plasma atomic emission spectrometry
ICP-MS – inductively coupled plasma mass spectrometry
K – potassium
OHI-S – oral hygiene index
Se – selenium
Sh – Sherbet APF Thixotropic Gel
Zn – zinc

Dentists have no unambiguous opinion on the effectiveness and safety of teeth whitening methods. The most common and relevant problem in this manipulation is the hypersensitivity of dentin [1]. Some authors consider carbamide and hydrogen peroxide preferable for whitening devital teeth due to their wide availability [2]. The need for an endless search for ways to lighten teeth has already engaged dentists for many years [3, 4]. Many studies confirm improving patients' quality of life after bleaching [5, 6]. However, publications are proving the negative impact of bleaching on the quality of life of specific categories of citizens in certain areas [7, 8]. Today, a group of people are exposed to occupational hazards (for example, workers in different factories facing production factors). Therefore, a comparative assessment of clinical and laboratory performance when using various teeth whitening means looks relevant.

The study aimed to conduct a comparative analysis of clinical-laboratory indicators at teeth whitening with the subsequent use of various remineralizing agents in patients working at harmful production.

Material and Methods. Eighty practically healthy test subjects aged 25–40 were employees of Ryazan's aviation repair plant. They worked there for 3 to 5 years and were exposed to harmful production factors. There were 40 women and 40 men. The Control Group consisted of 30 practically healthy people not working in hazardous industries. The criteria for including patients in the examination were dental discoloration and voluntary consent for inclusion in the study. If patients have suffered from severe somatic abnormalities in the decompensation stage, oncological diseases, immunodeficiency, acute infections, pregnancy, lactation, alcohol, drug addiction, smoking, and refusal to participate in the study, such patients are excluded in the study.

Bleaching of 20 vital teeth was carried out on all patients (1.5, 1.4, 1.3, 1.2, 1.1, 2.1, 2.2, 2.3, 2.4, 2.5, 3.4, 3.3, 3.3, 3.1, 4.4, using «Carbamide Carbamiva 20 %», Russia)

Then two groups were formed (40 people each): 1 group – a remineralizing APF thixotropic gel was used, with 1.23 % active Ions acidic fluoride (Sherbet APF Xotropic Gel, French Vanila; USA); 2 group – used remineralizing gel based on hydroskiapatite (Belle hydroxyapatite, South Korea).

A prerequisite for inclusion in the study was the conduct of sanitation, prevention, and oral hygiene for all patients under examination. They also received information about the needs and rules of individual oral hygiene. It was recommended «white diet». All patients were given individual hygiene indices OHI-S (Green – Vermillion, 1964) and periodontal index PMA (S. Parma, 1960). To estimate hyperesthesia before, after, and 14 days after remineralizing therapy, the dental hyperesthesia prevalence index (DHPI) (Storin G. B., 1986), the dental hyperesthesia intensity index (DHII) (Storin G. B., 1986) and the Schiff test (2009). In addition, all subjects studied the concentration of chemical elements in the oral fluid (atomic-emission spectrometry (ICP-AES) and mass-inductively-coupled plasma spectrometry (ICP-MS) before bleaching, after bleaching, after remineration therapy and 14 days after bleaching. They studied the dynamics of common Ca, K, Fe, Zn, Cu, and Se. Reference limits of elements in the oral fluid were (mmol/l): K 500–1000; Ca 40–80; Fe 0.2–0.6; Zn 0.25–1; Cu 0.02–0.06; Se 0.02–0.4.

Methods of descriptive statistics, the Friedman rank criterion, the Wilcoxon criterion, the labeling criterion in the case of two dependent samples, and the one-factor dispersal analysis of independent samples were used for the statistical evaluation of data. Data was analyzed using the statistical program SPSS Statistics, version 23 (IBM, USA).

Results and Discussion. When assessing the dental status before bleaching, 57.3 % of the subjects had good hygiene. At the same time, 42.7 % of patients had a satisfactory level of hygiene according to the OHI-S index. All patients had slight localized or generalized inflammatory changes in the periodontitis. Gingivitis was also diagnosed as mild, with a PMA of 6.3±0.32.

The results of the hypersensitivity study after the application of 20 % peroxide bleaching, as well as the subsequent remineralization, are presented in Table 1. There was a reliable increase in sensitivity in all groups of patients on all evaluated criteria. The DHII index recorded mild hypersensitivity, DHPI localized form.

The dynamics of the DHII index depended on the study group. Thus, the tendency to decrease hypersensitivity after applying remodeling therapy was observed in both groups. The DHII was 0.99±0.12 and 0.88±0.11 in group 2 and group 1, respectively.

In the study of hypersensitivity prevalence, the localized form of hypersensitivity was retained in both groups. However, a downward trend was observed in 2 groups of subjects ($p=0.38$). The DHPI index of 4.26±0.73 was the correct decrease ($p=0.033$) in 1 study group

The results of the Schiff test after bleaching showed no sensitivity in 20 % of patients. In group 2, there was an upward trend ($p=0.26$). In 1 observation group, the Schiff sample decreased from 0.86±0.1 to 0.81±0.11 ($p=0.75$) (Table 1).

Thus, teeth lightening with a 20 % urea peroxide whitening system has led to a reliable increase in tooth sensitivity in all patients. A localized form of mild hypersensitivity was observed. The use of remineralizing therapy led to a decrease in hypersensitivity in both groups. The most effective was remineralizing APF thixotropic gel with 1.23 % active Ions Acid Fluoride.

The analysis of the biochemical study revealed an elevated content of some trace elements in the oral fluid (Table 2). Thus, K levels (1118.50±130.9 mmol/l) and Ca (111.8±13.04 mmol/l) were higher than 87 % and 91 %, respectively. Values of Fe (0.75±0.12 mmol/l), Zn (1.54 0.62±mmol/l), Cu (0.069±0.02 mmol/l) and Se (0.078±0.099 mmol/l) were also raised ($p<0.05$). This was probably due to the toxic substances used in the production (nitrolaca, nitrox, kerosene, gasoline, solvent, AMG-10 oil, fuel TS-1). These indicators may indicate reduced remineralization of saliva in macro- and micronutrient-derived patients. The results of our research correspond to the study of some authors [9–11] on the influence of industrial hazards on mineral exchange. Examination of the dynamics of chemical elements in the oral fluid after 20 % of peroxide carbamide (20 % $CO(NH_2)_2$) on the teeth tissue showed a decrease in K (848.3±131.3 mmol/l), Ca (57.3±9.2 mmol/l), Fe (0.29±0.15 mmol/l), Zn (0.24±0.28 mmol/l), Cu (0.0279±0.012 mmol/l) Se and (0,019±0,005 mmol/l) compared to reference values ($p<0.05$).

Table 1

Results of hypersensitivity indices values in two dependent samples (label criterion)

№	Compared variable pair	S-statistics	Z-statistics	p-level
1	Dental hyperesthesia intensity index & dental hyperesthesia intensity index+ teeth bleaching	100.0000	3.750000	0.000177
2	Dental hyperesthesia prevalence index & dental hyperesthesia prevalence index + teeth bleaching	100.0000	3.750000	0.000177
3	Schiff sensitivity scale & Schiff sensitivity scale + teeth bleaching	100.0000	3.750000	0.000177
5	Dental hyperesthesia intensity index + teeth bleaching & dental hyperesthesia intensity index+ teeth bleaching +BH	0.00	1.500000	0.133614
6	Dental hyperesthesia prevalence index + teeth bleaching & dental hyperesthesia prevalence index + teeth bleaching +BH	41.17647	0.485071	0.627626
7	Schiff sensitivity scale + teeth bleaching & Schiff sensitivity scale + teeth bleaching +BH	50.00000	−0.353553	0.723674
9	Dental hyperesthesia intensity index + teeth bleaching & dental hyperesthesia intensity index + teeth bleaching + Sh	26.66667	1.549193	0.121335
10	Dental hyperesthesia prevalence index + teeth bleaching & dental hyperesthesia prevalence index + teeth bleaching +Sh	20.00000	2.065591	0.038867
11	Schiff sensitivity scale + teeth bleaching & Schiff sensitivity scale + teeth bleaching +Sh	33.33333	0.866025	0.386476

Table 2

Dynamics of the level of chemical elements in the oral fluid after bleaching and the use of remineralizing agents

Element	Recovery period	20 % $CO(NH_2)_2$ t-dependent sample test. Significant level difference $p<0.05$									
		Average	SD	N	d	SD(d)	t	df	p	Confidence interval	Confidence interval
K	immediately after applying BH	1726.45*	261.1689	20	−878.200	324.4500	−12.1049	19	0.000000	−1030.05	−726.353
K	since 14 days after applying BH	574.665*	11.4563	20	1151.795	261.8558	19.67107	19	0.000000	1029.243	1274.347
K	immediately after applying Sh	1043.650*	24.7499	20	−202.450	128.3189	−7.05573	19	0.000001	−262.505	−142.395
K	since 14 days after applying Sh	861.080*	163.7870	20	182.5700	170.1106	4.799688	19	0.000125	102.9558	262.1842
Ca	immediately after applying BH	97.15000*	11.69919	20	−39.8350	12.85577	−13.8574	19	0.000000	−45.8517	−33.8183
Ca	since 14 days after applying BH	72.85500*	1.77659	20	24.29500	11.84338	9.173944	19	0.000000	18.75213	29.83787
Ca	immediately after applying Sh	65.32000	7.65036	20	−5.11500	13.91558	−1.64384	19	0.116655	−11.6277	1.397693
Ca	Since 14 days after applying Sh	64.25500	16.54017	20	1.065000	17.79377	0.267668	19	0.791839	−7.26274	9.392740
Fe	immediately after applying BH	1.001350*	0.538924	20	−0.705665	0.508688	−6.20386	19	0.000006	−0.943738	−0.467592
Fe	since 14 days after applying BH	0.461855*	0.182244	20	0.539495	0.534852	4.510960	19	0.000239	0.289177	0.789813
Fe	immediately after applying Sh	0.093265*	0.042996	20	0.208730	0.161095	5.794519	19	0.000014	0.133335	0.284125
Fe	since 14 days after applyingSh	0.445145*	0.115237	20	−0.351880	0.118400	−13.2910	19	0.000000	−0.407293	−0.296467
Zn	immediately after applying BH	0.626095*	0.231561	20	−0.381865	0.418969	−4.07609	19	0.000644	−0.577948	−0.185782
Zn	since 14 days after applying BH	0.811600*	0.014620	20	−0.185505	0.231442	−3.58449	19	0.001977	−0.293823	−0.077187
Zn	immediately after applying Sh	0.751165*	0.050651	20	−0.482005	0.272163	−7.92024	19	0.000000	−0.609381	−0.354629
Zn	since 14 days after applyingSh	0.945670*	0.229658	20	−0.194505	0.244514	−3.55747	19	0.002102	−0.308941	−0.080069
Cu	immediately after applying BH	0.062850*	0.022919	20	−0.034950	0.023959	−6.52357	19	0.000003	−0.046163	−0.023737
Cu	since 14 days after applying BH	0.028545*	0.004689	20	0.034305	0.022317	6.874397	19	0.000001	0.023860	0.044750
Cu	immediately after applying Sh	0.020500*	0.002482	20	0.007989	0.014562	2.453451	19	0.023975	0.001174	0.014804
Cu	since 14 days after applyingSh	0.040580*	0.018008	20	−0.020080	0.018166	−4.94332	19	0.000090	−0.028582	−0.011578
Se	immediately after applying BH	0.038630*	0.037029	20	−0.018688	0.038461	−2.17295	19	0.042639	−0.036688	−0.000687
Se	since 14 days after applying BH	0.020635*	0.002673	20	0.017995	0.036409	2.210348	19	0.039547	0.000955	0.035035
Se	immediately after applying Sh	0.019360	0.001106	20	0.002538	0.006852	1.656132	19	0.114118	−0.000669	0.005744
Se	since 14 days after applyingSh	0.022420*	0.001041	20	−0.003060	0.001439	−9.50696	19	0.000000	−0.003734	−0.002386

*p<0,001.

In the second group examined K content in oral fluid increased reliably after remineralizing therapy ($p<0.001$) and, by 14 days, significantly decreased ($p<0.001$), approaching the average values (Table 2). In the study of the dynamics of Ca and Fe, there was a significant decrease in their levels after bleaching ($p<0.001$). By the 14th day after remineralizing therapy, it increased, approaching the norm. The level of Zn increased by 14 days, but did not reach the original value (Table 2).

Studies of the dynamics of Ca (57.3±9.3 mmol/l) and K (848.3±131.3 mmol/l) in the oral fluid showed a reliable reduction after bleaching ($p<0.001$). The results of our research differ from those obtained by the authors [12–14] who observed an increase in calcium in the oral fluid after bleaching. A unique role, apparently, in our research is that we attribute to the negative influence of harmful factors leading to increased Ca in the oral fluid. This may be due to a deficiency of elements in the hard tooth tissue. Further observation revealed a mixed trend in the rates after bleaching and remineralizing therapy (Fe, Zn, Cu and Se) by 14 days of observation in both groups were the same. The exception was K and C concentrations, which stabilized and were within the norm 14 days later. However, the Ca level was significantly higher and K was lower in 2 groups of subjects compared to 1 group ($p<0.001$) (Table 2).

Conclusion. Thus, teeth lightening with a 20 % urea peroxide whitening system has led to a reliable increase in tooth sensitivity in all patients. A localized form of mild hypersensitivity was observed. The use of remineralizing therapy reduced hypersensitivity in both groups. At the same time, the remineralizing APF thixotropic gel with 1.23 % active Acid Fluoride ions turned out to be the most effective.

The biochemical analysis revealed elevated K, Ca, Fe, Zn, Cu, and Se levels before bleaching in individuals associated with exposure to harmful production factors. The 20 % of carbamide peroxide exposure to tooth tissues reduced these elements. Remineralizing agents caused varying levels of chemical elements in the studied groups. By 14 days, however, the micronutrient values were close to normal.

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