Dental status and oxidative homeostasis state in patients exposed to occupational vibration: reduced glutathione content in oral fluid

LIDIYA CHERKASHYNA[1,A,F], IHOR HAIDASH[2,B,D], OLEH SHABELNIK[2,B,D], ANTON SHKLYAR[3,A,B,C], ROMAN SUKHONOSOV[3,A,C], GANNA BARCHAN[3,E,F], YURII LAKHTIN[4,C,E], NADIIA DEMIKHOVA[4,B,E], ALEKSANDR ORLOVSKIY[4,D,F]

[1]Kharkiv Medical Academy of Postgraduate Education, Ukraine; [2]Lugansk State Medical University, Ukraine; [3]Kharkiv National Medical University, Ukraine; [4]Sumy State University, Ukraine

A – research concept and design, B – data collection, C – data analysis and interpretation, D – article writing, E – critical review of the article, F – final approval of the article

Dental status and oxidative homeostasis state in patients exposed to occupational vibration: reduced glutathione content in oral fluid

Cherkashyna L[1], Haidash ¸[2], Shabelnik Î[2], Shklyar A[3], Sukhonosov R[3], Barchan G[3], Lakhtin Y[4],Demikhova N[4], Orlovskiy A[4].

[1]Kharkiv Medical Academy of Postgraduate Education, Ukraine; [2]Lugansk State Medical University, Ukraine; [3]Kharkiv National Medical University, Ukraine; [4]Sumy State University, Ukraine

***The aim** of the research involved determination of reduced glutathione content in oral fluid of patients exposed to occupational vibration depending upon their dental status.*

***Materials and methods.** The assessment of dental status (DS) and reduced glutathione (RG) content in oral fluid (OF) was carried out in three groups of patients: control group (n=129) included the persons exposed to occupational vibration whose results of comprehensive medical examination excluded the presence of vibration disease (VD); the second group (n=63 patients with the VD stage I) and the third group (n=66 patients with VD stage II), who underwent treatment at the clinical department of the Research Institute of Occupational Hygiene and Occupational Diseases of Kharkiv National Medical University of the Ministry of Health of Ukraine. DS determination was carried out according to the method of K. M. Kosenko (Patent No. 57512, Ukraine) for in-patients and controls (during medical checkups) using the following indices: PMA, OHI-S, DMFT, with assessment of vacuum-pressory resistance of gingival capillaries (VPRC) (according to V. I. Kulazhenko) and community periodontal index of treatment needs (CPITN). RG content (activity) in OF was determined according to Garishvili. Primary data were statistically processed with the determination of accuracy by Student's test.*

***Results.** Assessment of metabolic indices, which characterize the state of oxidative homeostasis enzyme chain, showed that RG content in OF depending upon VD severity reliably (p<0.05) reduced. RG content depending upon PMA intensity in patients with VD ranged from 23.5±0.8 mg/cm^3 to 28.6±0.3 U/min and was reliably (p<0.05) lower in patients with VD stage I versus controls (23.2±1.0 U/min and 26.7±0.3 U/min respectively, when PMA>2.1) and also reliably lower in patients with VD stage II versus patients with VD stage I (29.9±0.9 U/min and 26.2±0.4 U/min respectively, when PMA>1.0). RG content depending upon OHI-S values in patients with VD ranged from 33.4±1.2 U/min to 24.1±1.1 U/min and was reliably (đ<0.05) lower in patients with OHI-S values equal to 1.7 U and higher versus controls (24.1±1.1 U/min and 27.1±0.2 U/min, respectively) and also reliably lower in patients with VD stage II versus patients with VD stage I (27.3±0.4 U/min and 33.4±1.2 U/min, respectively, with OHI-S≤0.6 U). A comparative analysis showed that the activity of the enzymatic protection of the periodontal membrane could be also determined by the state of hard tissues, in particular by such DS index as DFMT. The activity of RG in VD stage I was shown to be reliably (p<0.05) reduced in patients with DFMT index exceeding 15 pts (in DFMT≤10 pts RG activity was 32.2±0.4 U/min, whereas in DFMT exceeding 15 pts it was equal to 26.7±0.6 U/min). Somewhat different pattern of RG activity in OF was found in patients with VD stage II: RG activity in OF was reduced in all DFMT values in these patients and its reduction*

Stan uzębienia i stan homeostazy oksydacyjnej u pacjentów narażonych na drgania zawodowe: obniżona zawartość glutationu w płynie z jamy ustnej

Czerkaszyna L[1], Haidash ¸[2], Szabelnik Î[2], Shklyar A[3], Suchonosov R[3], Barchan G[3], Lakhtin Y[4],Demichowa N[4], Orłowski A[4].

[1]Charkowska Akademia Medyczna Kształcenia Podyplomowego, Ukraina; [2]Państwowy Uniwersytet Medyczny w Ługańsku, Ukraina; [3]Charkowski Narodowy Uniwersytet Medyczny, Ukraina; [4]Państwowy Uniwersytet Sumy, Ukraina

***Celem** badań było określenie stopnia obniżenia zawartości glutationu w płynie z jamy ustnej chorych narażonych na drgania zawodowe w zależności od stanu uzębienia.*

***Materiały i metody.** Ocenę stanu uzębienia (DS) i obniżonej zawartości glutationu (RG) w płynie z jamy ustnej (OF) przeprowadzono w trzech grupach badanych: grupa kontrolna (n=129) obejmowała osoby narażone na drgania zawodowe, u których wyniki kompleksowego badania lekarskiego wykluczyło obecność choroby wibracyjnej (VD); grupa druga (n=63 chorych w I stopniu VD) i grupa trzecia (n=66 chorych w II stopniu VD), którzy przebyli leczenie w oddziale klinicznym Instytutu Higieny Pracy i Chorób Zawodowych Charkowskiego Narodowego Medycznego Uniwersytetu Ministerstwa Zdrowia Ukrainy. Oznaczenie DS przeprowadzono według metody KM Kosenko (patent nr 57512, Ukraina) dla hospitalizowanych i kontrolnych (podczas badań lekarskich) przy użyciu następujących wskaźników: PMA, OHI-S, DMFT, z oceną podciśnieniowo-ciśnieniową odporności naczyń włosowatych dziąseł (VPRC) (według VI Kulazhenki) i środowiskowego wskaźnika potrzeb leczenia przyzębia (CPITN). Zawartość (aktywność) RG w OF określono według Garishvili. Dane pierwotne zostały przetworzone statystycznie z określeniem dokładności testem Studenta.*

***Wyniki.** Ocena wskaźników metabolicznych charakteryzujących stan łańcucha enzymów homeostazy oksydacyjnej wykazała, że zawartość RG w OF w zależności od ciężkości VD niezawodnie zmniejsza się (p<0,05). Zawartość RG w zależności od intensywności PMA u chorych na VD wahała się od 23,5±0,8 mg/cm^3 do 28,6±0,3 U/min i była znamiennie (p<0,05) niższa u chorych w I stadium VD w porównaniu z grupą kontrolną (23,2±1,0 U/min i odpowiednio 26,7±0,3 U/min, gdy PMA>2,1), a także znamiennie niższa u chorych w II stopniu VD w porównaniu z I stopniem VD (odpowiednio 29,9±0,9 U/min i 26,2±0,4 U/min, gdy PMA>1,0) . Zawartość RG w zależności od wartości OHI-S u chorych na VD wahała się od 33,4±1,2 U/min do 24,1±1,1 U/min i była znamiennie (p<0,05) niższa u chorych z wartościami OHI-S równymi 1,7 U i wyższe w porównaniu z grupą kontrolną (odpowiednio 24,1±1,1 U/min i 27,1±0,2 U/min), a także znamiennie niższa u chorych w II stopniu VD w porównaniu z I stopniem VD (27,3±0,4 U/min i 33,4±1,2 U/min , odpowiednio, z OHI-S≤0,6 U). Analiza porównawcza wykazała, że aktywność ochrony enzymatycznej błony przyzębia może być również determinowana stanem tkanek twardych, w szczególności takim wskaźnikiem DS jak DFMT. Wykazano, że aktywność RG w I stadium VD jest znamiennie (p<0,05) obniżona u chorych ze wskaźnikiem DFMT powyżej 15 pkt (w DFMT ≤10 pkt. aktywność RG wynosiła 32,2±0,4 U/min, natomiast w DFMT powyżej 15 pkt. było równe 26,7±0,6 U/min). Nieco inny wzorzec aktywności RG w OF stwierdzono u chorych w II stadium VD: aktywność RG w OF*

was shown to be dependent on an increase in DMFT index. In DMFT≤10 the patients with VD stage II were found to have a reliable (p<0.05) reduction in RG activity in OF versus the control group (30.1±0.3 U/min and 23.8±0.5 U/min, respectively) and this activity was shown to be inhibited in DFMT increase (23.8±0.5 U/min with DFMT≤10 and 19.3±0.9 U/min with DFMT≥20 pts, respectively). RG content depending upon VPRC in VD patients ranged from 29.2±0.1 U/min to 29.2±0.1 U/min and was reliably (p<0.05) lower in patients with their VPRC values ≤40 sec. Assessment of RG activity in OF of VD patients with different levels of CPITN showed that RG content in persons requiring comprehensive treatment (also including prosthetic treatment; CPITN≥3.1 pts) was reliably reduced (versus corresponding groups of patients but with low CPITN values) both in VD stages I and II (24.1±1.0 U/min and 19.3±0.9 U/min, respectively).

Conclusions. *Increases in the rate and expression of periodontal lesions (by PMA index) depending upon the presence and severity of VD with a proper decrease in the level of RG content in OF were registered. An activation of the enzymatic chain of antioxidant protection in patients with VD under low HI values and a simultaneous inhibition of enzymatic activity under high HI values were found out. VD stage I revealed an increased RG activity versus controls (p<0.05), while VD stage II demonstrated a reliable (p<0.05) reduction of the above activity. Moreover, an unsatisfactory state of the oral cavity hygiene contributed to enzymatic protection of their periodontium in patients with VD (irrespective of its stage). Regularities were revealed, which supported the benefit of pathogenetic relationships between the state of the periodontal microcirculatory bed and enzymatic activity of OF in patients with VD. Both patients with VD and persons, who are exposed to occupational vibration, need for diagnosis of activity of enzymes in OF since, as our analysis of findings has shown, DS indices are interdependent with activity of the enzymatic chain of the antioxidant protection of OF.*

Key words: *dental status, periodontal membrane, reduced glutathione, vibration disease*

Pol Med J, 2022; L (295); 391–393

była zmniejszona we wszystkich wartościach DFMT u tych chorych i wykazano, że jej zmniejszenie jest zależne od zwiększenia wskaźnika DMFT. W DMFT≤10 u chorych w II stadium VD stwierdzono znamienne (p<0,05) zmniejszenie aktywności RG w OF w porównaniu z grupą kontrolną (odpowiednio 30,1±0,3 U/min i 23,8±0,5 U/min) i to wykazano, że aktywność ta jest hamowana pod względem zwiększenia DFMT (odpowiednio 23,8±0,5 U/min przy DFMT≤10 i 19,3±0,9 U/min przy DFMT≥20 pkt). Zawartość RG w zależności od VPRC u chorych na VD wahała się od 29,2±0,1 U/min do 29,2±0,1 U/min i była znamiennie (p<0,05) niższa u chorych z wartościami VPRC ≤40 sek. Ocena aktywności RG u chorych na VD z różnym poziomem CPITN wykazała, że zawartość RG u osób wymagających kompleksowego leczenia (w tym leczenia protetycznego; CPITN≥3,1 pkt.) była wiarygodnie obniżona (w porównaniu z analogicznymi grupami chorych, ale z niskimi wartościami CPITN) zarówno w I i II stopniu VD (odpowiednio 24,1±1,0 U/min i 19,3±0,9 U/min).

Wnioski. *Zarejestrowano zwiększenie częstości i ekspresji zmian przyzębia (według wskaźnika PMA) w zależności od obecności i nasilenia VD z odpowiednim zmniejszeniem stężenia RG w OF. Stwierdzono aktywację łańcucha enzymatycznego ochrony antyoksydacyjnej u chorych na VD przy niskich wartościach HI i jednoczesne hamowanie aktywności enzymatycznej przy wysokich wartościach HI. Stadium I VD wykazywało podwyższoną aktywność RG w porównaniu z grupą kontrolną (p<0,05), natomiast stadium II VD wykazywało wiarygodne (p<0,05) zmniejszenie powyższej aktywności. Ponadto niezadowalający stan higieny jamy ustnej przyczynił się do ochrony enzymatycznej ozębnej u chorych na VD (niezależnie od jej stadium). Wykazano prawidłowości, które przemawiają za korzyścią patogenetycznych zależności między stanem łożyska mikrokrążenia przyzębia a aktywnością enzymatyczną OF u chorych na VD. Zarówno chorzy na VD, jak i osoby narażone na drgania zawodowe wymagają kontrolowania aktywności enzymów w OF, ponieważ, jak wykazała nasza analiza wyników, wskaźniki ZD są współzależne od aktywności łańcucha enzymatycznego ochrony antyoksydacyjnej.*

Słowa kluczowe*: stan uzębienia, błona przyzębia, zredukowany glutation, choroba wibracyjna*

Pol Merkur Lekarski, 2022; L (295); 391–393

Vibration disease (VD) is characterized by involvement of different organs and systems, development of polyneuropathy, angiospastic and angiodystonic syndromes with various forms of the course, complications and dysfunctions [1,20]. Few researches, which contain clinical recommendations, were dedicated to problems in the clinical picture, diagnosing and treatment of pathologies of organs and systems in the oral cavity [11,16,17,22,23]. Today, the problem of the concomitant pathology of the internal organs [5,7,14,18,21,26] in patients with the oral cavity pathology is growing of all the greater relevance, including the research of oxidative homeostasis [2,4,8,15,27]. At the same time, a high level of oral morbidity, first of all periodontal pathology, has been registered in people exposed to chronic occupational vibration [28]. Among other things such patients have revealed structural-functional changes, which can be characterized as systemic maladaptive state [6,10]. The most characteristic signs of this state include hypoactivity of local protective factors, changes in the normal haemomicrocirculation and nervous reception in tissues of the oral cavity, affection of their trophism with subsequent appearance and progression of basic oral diseases, first of all the carious process, inflammatory diseases of the periodontium and diseases of the mucous membrane [1,9,24].

The purpose of the research consisted in study of the reduced glutathione level in the oral fluid of the patients, who have an occupational contact with vibration, depending upon their dental status.

MATERIALS AND METHODS

The study of the dental status (DS) and reduced glutathione (RG) content in the oral fluid (OF) was conducted in patients of three groups: the control group (n=129) contained the persons, who were exposed to occupational vibration and results of their complete health examination excluded the presence of VD; the second (n=63 cases with VD stage I) and third (n=66 cases with VD stage II) groups included the patients, who were treated at the clinical department of the Research Institute of Occupational Hygiene and Occupational Diseases of Kharkiv National Medical University of the Ministry of Health of Ukraine [5]. DS was assessed according to *K.M. Kosenko* (Patent No. 57512, Ukraine) in in-patients and controls (during medical examinations), using: papillary-marginal-alveolar index (PMA), simplified oral hygiene index (OHI-S) and carious lesion intensity index (DMFT)] with assessment of the vacuum-pressory resistance of gingival capillaries (VPRC) (according to V.I. Kulazhenko) and community periodontal index of treatment needs (CPITN) [9]. The content of RG was determined according to *R. Olinescu's* method [12]. This method is based on revealing the used glutathione, whose sulfhydryl groups in combination with *Elimans'* liquor produce yellow colouring. The above content is determined using a spectrophotometer with λ=412 nm; the enzymatic activity was assessed calorimetrically by the degree of chemical decomposition of hydrogen peroxide.

Primary materials were statistically processed with determination of reliability according to paired t-test. Results of the research were statistically analysed with help of variation statistics and assessment of normality of distribution and reliability of findings [3,13,19,25].

RESULTS AND DISCUSSION

Our analysis of the metabolic indices, which characterize the state of the enzymatic chain of oxidative homeostasis, enabled us to reveal that the content of RG in OF reliably (p<0.05) changed

depending upon the severity of VD. The level of RG content in patients with VD ranged depending upon the severity of PMA from 23.5±0.8 mg/cm^3 to 28.6±0.3 U/min and was reliably ($p<0.05$) lower in patients with VD stage I versus controls (respectively, 23.2±1.0 U/min and 26.7±0.3 U/min, when PMA>2.1) as well as it was reliably ($p<0.05$) lower in patients with VD stage II versus cases with VD stage I (respectively, 29.9±0.9 U/min and 26.2±0.4 U/min, when PMA>1.0). Even in cases of minimum lesions of the periodontal membrane (PMA<1.1) the under the presence of VD we registered a reliably ($p<0.05$) lower level of RG content (patients: 28.6±0.3 U/min; controls: 32.1±0.1 U/min).

The level of RG content depending upon the values of OHI-S in patients with VD ranged from 33.4±1.2 U/min to 24.1±1.1 U/min and was reliably ($p<0.05$) lower in cases with OHI-S values equal to 1.7 U and larger versus the controls (respectively, 24.1±1.1 U/min and 27.1±0.2 U/min) as well as reliably ($p<0.05$) lower in patients with VD stage II versus cases with VD stage I (respectively, 27.3±0.4 U/min and 33.4±1.2 U/min, when OHI-S≤0.6 U).

The activity of enzymatic protection of the periodontium, as it was revealed by results of our comparative analysis, also depended upon the state of hard tissues, particularly upon such an index of DS as DMFT. It was found out that in VD stage I the

Table 1. The level of reduced glutathione content (M±m, U/min) in the oral fluid depending upon the dental status indices and severity of vibration disease
Tabela 1. Stężenie obniżonej zawartości glutationu (M±m, U/min) w płynie z jamy ustnej w zależności od wskaźników stanu uzębienia i nasilenia choroby wibracyjnej

Dental status indices		Controls		Clinical groups of patients					
				VD – stage I		VD – stage II		Total	
		Abs.	M±m	Abs.	M±m	Abs.	M±m	Abs.	M±m
PMA	≤1.0 (P)	21	32.1±0.1	10	27.4±0.8	3	26.9±0.7 [a]	13	28.6±0.3
	1.1÷2.0 (M)	103	29.1±0.2	44	29.0±0.9	42	26.2±0.4 [a, b]	86	28.4±0.4
	2.1÷3.0 (A)	5	26.7±0.3	9	23.2±1.0 [a]	21	23.8±1.1 [a, c]	30	23.5±0.8 [a]
OHI-S	≤0.6 U	9	31.7±0.4	5	33.4±1.2	1	27.3±0.4 [b]	6	30.5±1.1
	0.7÷1.6 U	102	28.2±0.3	36	28.5±0.9	25	27.1±0.6	61	27.8±0.4
	1.7 U and ≥	18	27.1±0.2	22	24.1±1.1 [a, c]	40	24.3±0.9 [a, c]	62	24.2±0.7 [a]
DMFT	≤10	70	30.1±0.3	14	32.2±0.4	8	23.8±0.5 [a, b]	22	28.4±0.7
	11÷15	41	29.3±0.4	26	29.3±0.8	16	23.6±0.6 [a, b]	42	26.6±0.6
	15÷20	15	26.2±0.2	17	26.7±0.6 [c]	28	21.2±0.4 [a, b, c]	45	24.3±0.5 [a]
	>20	3	26.1±0.3	6	24.0±0.7 [a, c]	14	19.3±0.9 [a, b, c]	20	22.1±0.8 [a]
VPRC	>40 sec.	128	29.7±0.2	57	29.2±0.1	50	21.3±0.3 [a, b]	107	25.7±1.2 [a]
	≤40 sec.	1	22.4±0.0	6	23.4±0.7 [a, c]	16	19.2±0.6 [a, b]	22	21.6±0.9 [a]
CPITN	0.0÷2.0 pts	67	31.6±0.1	29	29.3±0.8	14	24.6±0.7 [a, b]	34	26.7±0.6 [a]
	2.1÷3.0 pts	47	28.2±0.4	21	26.8±0.6 [c]	25	23.2±0.3 [a, b]	46	24.5±0.4 [a]
	3.1÷4.0 pts	2	25.8±0.3	13	24.1±1.0	27	19.3±0.9 [a, b, c]	40	21.3±0.7 [a]
Total		129	29.6±0.2	63	27.1±0.6 [a]	66	22.4±0.5 [a, b]	129	23.2±0.3 [a]

Notes: [a]– a reliable difference in the level of RG content in OF of patients with VD versus the controls, on the level of at least $p<0.05$; [b] – a reliable difference in the level of RG content in OF of patients with VD depending upon the degree of its severity, on the level of at least $p<0.05$; [c] – a reliable difference in the level of RG content in OF of patients within their clinical group depending upon the indicative value of DS, on the level of at least $p<0.05$

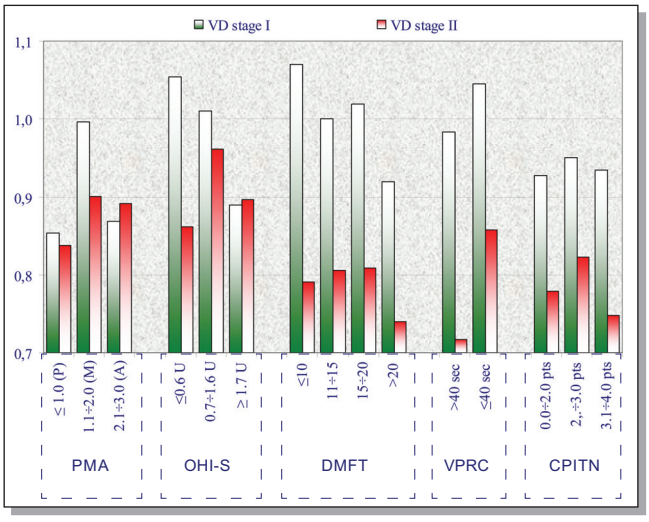

Figure 1. A relative level of reduced glutathione (1.0 – the control group value) in the oral fluid of patients depending upon indices of their dental status and degree of severity of vibration disease
Rycina 1. Względny poziom zredukowanego glutationu (1,0 – wartość grupy kontrolnej) w płynie z jamy ustnej chorych w zależności od wskaźników ich stanu uzębienia i stopnia nasilenia choroby wibracyjnej

activity of RG was reliably ($p<0.05$) reduced in patients with DMFT values larger than 15 pts (when DMFT≤10 pts the activity of RG was 32.2±0.4 U/min, whereas with DMFT>15 pts it was 26.7±0.6 U/min). The activity of RG in OF of patients with VD stage II was characterized by somewhat different regularity: with all values of their DMFT those patients revealed a reduced activity of RG in OF and its decrease depended upon an increase of DMFT index. When DMFT≤10, patients with VD stage II revealed a reliable ($p<0.05$) decrease of RG activity in OF versus the control group (respectively, 30.1±0.3 U/min and 23.8±0.5 U/min) and an inhibition of this activity, when DMFT value increased (respectively, 23.8±0.5 U/min with DMFT≤10 pts and 19.3±0.9 U/min with DMFT≥20 pts). The presence of VD stage II caused a lower level of RG activity in OF, with inhibition of this activity depending upon an increase of DMFT index; the above fact can be regarded as an indicator for choosing the tactics of prevention and treatment of periodontal pathology in this category of patients.

The level of RG content depending upon the value of VPRC in patients with VD ranged from 29.2±0.1 U/min to 29.2±0.1 U/min and was reliably ($p<0.05$) lower in patients with VPRC values ≤40 sec. For example, in VD stage I: if VPRC was reduced the RG activity in the patients' OF was reliably ($p<0.05$) lower (with VPRC>40 sec it was equal to 29.2±0.1 U/min, but with VPRC ≤40 sec it was only 23.4±0.7 U/min). A more expressed reduc-

tion of RG activity was found out in OF of patients with VD stage II that manifested with both a reduced activity of RG with normal values of VPRC and in case of a higher vacuum-pressory compliance of capillaries (respectively, 21.3±0.3 U/min and 19.2±0.6 U/min; $p<0.05$).

Our analysis of RG activity in OF of patients having VD with different levels of their generalized CPITN revealed that in the patients, who needed for combined therapy (including prosthodontic treatment, CPITN≥3.1 pts), the level of RG was reliably decreased (versus respective groups of patients, but with low CPITN values) both in VD stage I and VD stage II (respectively, 24.1±1.0 U/min and 19.3±0.9 U/min).

It should be noted that in the patients, who needed for combined therapy with surgical or nonsurgical debridement, as well as in the patients who revealed presence of a supra- or subgingical calculus, their RG activity was reliably lower in cases with VD stage II (respectively, VD stage I – 26.8±0.6 U/min and VD stage II – 23.2±0.3 U/min).

CONCLUSIONS

1. Increases in the rate and expression of periodontal lesions (by PMA index) depending upon the presence and severity of VD with a proper decrease in the level of RG content in OF were registered.
2. An activation of the enzymatic chain of antioxidant protection in patients with VD under low OHI-S values and a simultaneous inhibition of enzymatic activity under high OHI-S values were found out. VD stage I revealed an increased RG activity versus controls ($p<0.05$), while VD stage II demonstrated a reliable ($p<0.05$) reduction of the above activity. Moreover, an unsatisfactory state of the oral cavity hygiene contributed to enzymatic protection of their periodontium in patients with VD (irrespective of its stage).
3. Regularities were revealed, which supported the benefit of pathogenetic relationships between the state of the periodontal microcirculatory bed and enzymatic activity of OF in patients with VD.
4. Both patients with VD and the persons, who are exposed to occupational vibration, need for diagnosis of activity of enzymes in OF since, as our analysis of findings has shown, DS indices are interdependent with activity of the enzymatic chain of the antioxidant protection of OF.

Prospects of further researches are associated with study of oxidative homeostasis indices and relationships between DS and severity and duration of the course of VD.

REFERENCES

1. Abolmasov NN. Strategiya i taktika profilaktiki zabolevaniy parodonta. Stomato-logiya. 2003;4:34-39.
2. Barchan GS, Cherkashyna LV, Shklyar AS. et al. Immune disorders in recurrent respiratory infections on the background of undifferentiated connective tissue dysplasia. Azerbaijan Med J. 2020; 1: 10-17. https://doi.org/10.34921/amj.2020.27.15.002
3. Demikhova NV, Smiianov VA, Prikhodko OA. et al. Information and telecommunication technologies and problem-based learning (PBL) in the formation of competitive competence in medical masters of Sumy state university. Azerbaijan Med J. 2016; 2: 95-101.
4. Demikhova N, Sukhonos V, Vynnychenko L. et al. Activation of lipid peroxidation in patients with renal hypertension. Georgian Med News. 2013; 215: 51-55.
5. Demikhov O, Dehtyarova I, Rud O. et al. Arterial hypertension prevention as an actual medical and social problem. Bangladesh J Med Sci. 2020; 19(4): 722-729. DOI: https://doi.org/10.3329/bjms.v19i4.46632.
6. Izmerov NF, Suvorov GA. Fizicheskiye faktory proizvodstvennoy i prirodnoy sredy. Gigiyenicheskaya otsenka i kontrol': Meditsina, 2003; 147.
7. Gaiseniuk F, Driianskaia V, Drannik G. et al. Proinflammatory cytokines in patients with pyelonephritis Lik Sprava, 2013; 6: 32-37.
8. Korol L, Stepanova N, Vasylchenko V. et al. Plasma oxalic acid as a trigger for oxidative processes in end-stage renal disease patients. Ukrainian J Nephrol Dialysis. 2021; 1: 46-53.
9. Kutsevlyak VI. Profilaktika stomatologicheskikh zabolevaniy. Uchebnoye posobiye dlya studentov stomatologicheskogo fakul'teta, vrachey-internov. Khar'kov: KHNMU, 2001; 217.
10. Lakhman OL, Kolesov VG, Pankov VA. Vibratsionnaya bolezn' ot vozdeystviya lo-kal'noy vibratsii u gornorabochikh v usloviyakh Sibiri i Severa. – Irkutsk: NTS RVKH VSNTS SO RAMN, 2008; 420s.
11. Lakhtin IV. Comparative evaluation of short- and long-term treatment of periodontitis with alpha-lipoic acid. Georgian Med News, 2013; 218: 19-22.
12. Lemeshko VV, Nikitchenko YUV, Yevich YEV. Glutationperoksidaza i glutationtrans-feraza. Ukrainskiy Biokhimicheskiy Zhurnal. 1987; 8: 59-57.
13. Loboda A, Smiyan O, Popov S. et al. Child health care system in Ukraine. Turk Pediatri Arsivi. 2020; 55: S98-S104.
14. Marushchak Ě, Krynytska I, Mazur L. et al. The relationship between experimental alimentary obesity and hard tooth tissues mineralization. Jordan Med J. 2017; 51(1): 25-33.
15. Marushchak M, Maksiv K Krynytska I, et al. Glutathione antioxidant system of lymphocytes in the blood of patients in a setting of concomitant chronic obstructive pulmonary disease and arterial hypertension. Pol Merkur Lekarski. 2019; 47(281): 177-182.
16. Nesina IA, Poteryayeva IA, Kuzin YeG. Reabilitatsionnyye tekhnologii lits vibroopasnykh professiy na sovremennom etape. Meditsina truda i promyshlennaya ekologiya. 2008; 11:20-25.
17. Orlov YeV, Fedorov SM, Selinskiy GD. Sindrom vozdeystviya na slizistuyu vysokochastotnoy vibratsii i zvukovogo polya. Vestnik dermatologii i venerologii. 1998; 4: 27-28.
18. Popov S, Demikhova N, Melekhovets O. et al. Application of „reytoil" in prevention of atherosclerosis in diabetes patients. Łkars`ka sprava. 2012; 8: 119-126.
19. Prokopenko O, Holmberg R, Omelyanenko V. Information and communication technologies support for the participation of universities in innovation networks (comparative study). Innovative Marketing. 2018; 14(3): 17-29.
20. Rybalov O, Yatsenko P, Moskalenko P. et al. The effectiveness of physical factors in the treatment of compression-dislocation dysfunction of the temporomandibular joint. Georgian Med News, 2016; 251: 26-31.
21. Shkatula YV, Badion YA, Kasian SN. et al. Predictive capabilities of using the shock index and its modifications for assessing hemodynamic disorders in victims with traumatic injuries. Azerbaijan Med J. 2021; 1: 117-122. DOI: 10.34921/amj.2021.1.015
22. Shcherba V, Krynytska I, Marushchak M, et al. Does thyroid dysfunction influence inflammatory mediators in experimental periodontitis? Endocrine Regulations. 2021; 55(3): 101-111.
23. Smiianov YV, Lakhtin YV. The influence of stress-strain processes in tooth enamel on the marginal permeability of class i restorations with a different design of the edge of the carious cavity. Wiadomosci Lekarskie. 2018; 71(1): 135-139.
24. Sokolova II, Kashaba MA. Ctan tkanyn parodontu u osib, yaki mayut' profesiynyy kontakt z vibratsiyeyu. Visnyk problem biolohiyi ta medytsyny. 2013; 2(103):335-340.
25. Sysoyeva L, Bielova I, Ryabushka L.et al. Determinants of management of central bank to provide the economic growth: An application of structural equation modeling. Estudios de Economia Aplicadathis. 2021; 39(5).
26. Teslyk T, Yarmolenko O, Bumeister V. et al. The remodeling of lungs under the influence of alloxan-induced hyperglycemia. Romanian J Diab Nutr Metab Dis. 2020; 27(1): 45-49.
27. Vasylchenko VS, Korol LV, Kuchmenko OB, et al. The oxidative status in patients with chronic kidney disease. Ukrainian Biochem J. 2020; 92(5): 70-77.
28. Verbovoy AF. Sostoyaniye kostnoy tkani u bol'nykh vibratsionnoy bolezni. Gigiyena i sanitariya. 2004;4:35-37.

Disclosure: The authors declare no conflict of interest.

Received: 28.08.2021
Revised: 13.09.2021
Accepted: 28.12.2021

Address for correspondence:
Demikhova Nadiia
Sumy State University of Sumy
40007 Sumy, Rymsky-Korsakov St. 2, Ukraine
e-mail:n.demyhova@med.sumdu.edu.ua