PROCESSES OF LIPIDS PEROXIDATION AND ANTIOXIDANT ACTIVITY OF THE ORAL FLUID FOR PATIENTS WITH ACUTE ODONTOGENIC OSTEOMIELITIS COMPLICATED WITH PHLEGMONS OF DIFFERENT LOCATION

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Introduction

Quantity of patients with pyoinflammatory diseases in the maxillofacial area is increasing [2]. It's determined by different reasons: the virulence and pathogenicity of the microorganisms was changed and there resistance to the antibiotics was increased as well, the immunological reactivity of the microorganism was greatly changed. In this connection the big attention is pied to the pathogenesis of this pathology last time. There is no doubt that processes of the free radical oxidation (FRO) have extremely important role in the life activity of cells [5]. But processes of the lipids peroxidation (LP) and antioxidant activity (AA) for patients with pyoinflammatory diseases in the maxillofacial area are not studied well till now [4].

Aim of the work was to study the LP processes in the oral fluid (OF) for patients with odontogenic phlegmons of different locations and there dynamics during the treatment.

Objects and methods. We examined 64 patients with odontogenic osteomilelitis of the lower jaw complicated with phlegmon of the maxillofacial area. The phlegmon of one cellular space was formed for 38 persons (group 1), 26 persons had phlegmon of two and more cellular spaces (group 2). The group of control consisted of 15 persons without somatic and pyoinflammatory pathologies of the maxillofacial area. All patients had the primary surgical d-bridement (PSD-B) of the suppurative focus during the first day of the treatment. Bacteriological examination of the wound exudation was performed during the operation, complex anti-inflammatory therapy course was prescribed to the patients. Antibacterial, desensitizing and disintoxication medicines were obligatory included into the treatment. During the examination we didn't fix the further spread of the pathological process for all patients as well as the acute complications development (mediastinitis, sepsis etc). OF sampling was performed 4 times: the first test was performed during the first day of treatment in the hospital and before PSD-B of the suppurative focus; the second test was made on the second day of the treatment (next day after the PSD-B), the third test was made on the 4 day of treatment; the fourth test was made the last day of the treatment. LP and AA levels were checked in the OF with biochemiluminometer BHL-06 with the method of induced chemiluminescence in the reaction of Fenton [1]. We fixed the maximal intensity of the luminescence (Imax, mV), pro rata to the LP, lightsum (S, mV/s) of the luminescence inversely proportional to AA and tgα2 (tangent of angle of reduction of the indication after the maximal intensity achievement characterized with the speed reduction of the free radical processes). Final data was processed statistically with tables application package «Statistica 6.0» and «Excel». We evaluated the statistical significance of difference between the dependent groups taking into consideration the sign allocation using variance analysis by Fridman and density-free test by Vilcocson considering the Bonferoni amendment (p x 6). In order to evaluate the statistical significance between independent groups, we used Mann-Whetny criteria (U) [3].

TABLE 1
LP and AA indices in the oral fluid for healthy patients.

Indices	n	M	σ	Me	LQ	UQ
S, [mV•s]	15			4,51	3,5	4,8
I_{max}, [mV]	15	0,43	0,08	0,42	0,38	0,5
tg α2	15			-0,1	-0,12	-0,1

Results. LP and AA indices in the oral fluid for healthy patients (TAB.1)

LP indices in the OF for patients with odontogenic phlegmons in dynamic are presented in the table 2. Comparative indices of the LP and AA in the oral fluid for patients with different location of pyoinflammatory processe in the maxillofacial area discovered statistically significant differences between all indices we were studying during the treatment (TAB.2). Thus, we found out the higher activity of LP processes and lower AA and speed reduction for PL in the OF for patients with different phlegmons in respect of the patients group with odontogenic phlegmon of one cellular space during the treatment course.

We discovered the influence of the standard method of treatment with odontogenic phlegmons on the indices LP

TABLE 2
Dynamics for PL in the OF for patients with odontogenic phlegmons.

Test	Indices	Group 1 Me (LQ; UQ)	Group 2 Me (LQ; UQ)	p	
1	S [mV·s]	5,43(4,25;7,11)	6,34(4,51;10,15)	0,04	p<0,05
	I_{max} [mV]	0,55(0,41;0,71)	0,65(0,48;0,97)	0,04	
	tg α2	-0,14(0,16;-0,12)	-0,16(-0,18;-0,12)	0,04	
2	S [mV·s]	5,92(4,22;7,8)	6,55(5,76;8,85)	0,04	
	I_{max} [mV]	0,66(0,49;0,76)	0,75(0,61;0,91)	0,03	
	tg α2	-0,13(-0,16;-0,12)	-0,17(-0,19;-0,14)	0,03	
3	S [mV·s]	5,42(4,07;8,1)	6,67(5,4;8,76)	0,04	
	I_{max} [mV]	0,63(0,49;0,75)	0,8(0,5;0,87)	0,02	
	tg α2	-0,16(-0,18;-0,12)	-0,18(-0,22;-0,14)	0,02	
4	S [mV·s]	5,26(3,63;6,69)	6,05(4,9;8,1)	0,03	
	I_{max} [mV]	0,5(0,41;0,59)	0,61(0,41;0,84)	0,04	
	tg α2	-0,13(-0,14;-0,12)	-0,16(-0,18;-0,12)	0,01	

and AA in the oral fluid with density-free dispersion method by Fridman (TABs. 3-8). Data of the table there demonstrates that indices of the lightsum in the OF for patients with phlegmons of one cellular space on the next day after the PSD-B of the suppurative focus (S2=5,92(4,22;7,8) mV·s) and on the 4th day of the treatment. (S3=5,42(4,01;8,7) mV·s) is higher than at the first day of the tretment (S1=5,43(4,25;7,11) mV·s). So, antioxidant activity of the OF for patients with phlegmons of one cellular space is reducing on the next day after the operation according to the first day of the treatment and remains reduced till the 4th day of the examination.

TABLE 3
Comparative evaluation of the maximal intensity of the luminescence (Imax) in OF for patients with phlegmons of one cellular space during the tretment.

Friedman ANOVA p<0,0008			
Indices for comparison	p	p taking into consideration the correction Bonferoni (x6)	
S1/S2	0,0001	0,0006	p<0,001
S1/S3	0,007	0,04	p<0,05
S1/S4	0,32	1,92	p>0,05
S2/S3	0,02	0,12	p>0,05
S2/S4	0,13	0,78	p>0,05
S3/S4	0,14	0,84	p>0,05

TABLE 4
Comparative evaluation of the maximal intensity of the luminescence (I_{max}) in OF for patients with phlegmons of one cellular space during the tretment.

Friedman ANOVA p<0,0000001			
Indices for comparison I_{max}	p	p taking into consideration the correction Bonferoni (x6)	
I_{max} 1/ I_{max} 2	0,0007	0,004	p<0,01
I_{max} 1/ I_{max} 3	0,00002	0,0001	p<0,001
I_{max} 1/ I_{max} 4	0,11	0,66	p>0,05
I_{max} 2/ I_{max} 3	0,26	1,32	p>0,05
I_{max} 2/ I_{max} 4	0,0008	0,004	p<0,01
I_{max} 3/ I_{max} 4	0,01	0,06	p>0,05

LP process activity in the OF for patients of the group I was raising correspondently to the first day of the treatment in the clinic (0,55(0,41;0,71) mV) next day after the operation (0,66(0,49;0,76) mV) and kept the more high level till the 3rd day after the operation (0,63 (0,49;0,75) mV). But this indices became weak till 0,5 (0,41;0,59) mV by the day of recovery comparing to the first day of the treatment after the PSD-B of the suppurative focus (0,55(0,41;0,71) mV), p=0,004. Thus, variable dynamics of the LP activity in the OF was fixed for patients with odontogenic phlegmons. After the PSD-B of the suppurative focus the activity of the free radical processes is increasing but it reduces till the initial indices by the end of the treatment. It was not possible to find out the changes of LP in the OF by the end of the treatment in the clinic accordingly to the indices of the 1^{t} test.

The TABLE 5 says that the speed of the reduction of LP in the OF for patients with phlegmons of one cellular space was reducing by the 4th day of the treatment accordinly to the indices of the first day of the treatment. But to the end of the treatment this indices was the same as the initial one determined at the first day of the treatment in the hospital.

TABLE 5
Comparative evaluation of indices characterizing the sped reduction of free radical processes (tg α2) in OF for patients with phlegmons of one cellular space during the treatment.

Friedman ANOVA p<0,0006			
Indices for comparison	p	p taking into consideration the correction Bonferoni (x6)	
tg 1/ tg 2	0,07	0,42	p>0,05
tg 1/ tg 3	0,00001	0,00006	p<0,001
tg 1/ tg 4	0,75	4,5	p>0,05
tg 2/ tg 3	0,14	0,84	p>0,05
tg 2/ tg 4	0,23	1,38	p>0,05
tg 3/ tg 4	0,06	0,36	p>0,05

TABLE 6
Comparative evaluation of the lightsum of luminescence (S) in OF for patients with phlegmons of two and more cellular spaces during the tretment.

Friedman ANOVA p<0,005			
Indices for comparison	p	p taking into consideration the correction Bonferoni (x6)	
S1/S2	0,42	2,52	p>0,05
S1/S3	0,35	2,1	p>0,05
S1/S4	0,01	0,06	p>0,05
S2/S3	0,24	1,44	p>0,05
S2/S4	0,03	0,18	p>0,05
S3/S4	0,04	0,24	p>0,05

TABLE 7
Comparative evaluation of the maximum lightsum of luminescence (Imax) in the OF for patients with phlegmons of two and more cellular spaces.

Friedman ANOVA p<0,0001			
Indices for comparison	p	p taking into consideration the correction Bonferoni (x6)	
I_{max} 1/ I_{max} 2	0,008	0,04	p<0,05
I_{max} 1/ I_{max} 3	0,07	0,52	p>0,05
I_{max} 1/ I_{max} 4	0,04	0,24	p>0,05
I_{max} 2/ I_{max} 3	0,01	0,06	p>0,05
I_{max} 2/ I_{max} 4	0,009	0,05	p>0,05
I_{max} 3/ I_{max} 4	0,04	0,24	p>0,05

Indices of the TABLE 6 demonstrate that statistically significant difference of AA in the tests of the OF during the treatment of patients with phlegmons of two and more cellular spaces wasn't discovered.

So, processes of the LP in the OF pass more actively after the PSD-B of the suppurative focus that at the first day of the treatment before operation. Examining the table Nr 8 we discovered that the speed of the processes reduction of PL in the OF for patients of the group 2 reduced by the 4 day correspondently to the second day of the treatment. Results of LP and AA in the OF comparison with phlegmons of one cellular space and practically healthy people are presented in the TABLE 9. Results of comparative evaluation of LP and AA in the OF comparison with odontogenic phlegmons of two and more cellular spaces and practically healthy people are presented in the TABLE 10.

Presented data confirm that LP and AA indices of the oral fluid for patients with phlegmons are authentically different from the indices of the health people during examination when standard treatment was applied. Processes activity of the LP is higher but AA and the speed of the reactions reduction of the free radical oxidation is less for patients with pyoinflammatory diseases than in the group of control.

Thus, basing on the examinations results data we could make next conclusions. Patients with odontogenic phlegmons had more high level of the LP, less level of AA and the speed of the free radical processes reduction in the OF during the treatment regarding to the indices of the healthy people. For patients with phlegmons of one cellular space the reduction of the AA in the OF was evident, LP activity augmentation the next day after the PSD-B of the suppurative focus and reduction of the slowing-down speed of LP processes by the 4 day of the treatment. Dynamics of AA in the OF was not determined for patients with phlegmons of two and more cellular spaces. LP activity was increasing after the operation and the speed of the LP processes slowing-down was reducing by the 4 day of the treatment. Indices under examination for both groups of patients were no different by the end of the treatment from indices received the first day of the treatment in the hospital. It demonstrates the keeping of LP and AA deviation in the oral fluid from the norm even by the end of the treatment in the hospital. Patients with different phlegmons had higher activity of LP processes, less AA level and the speed of the LP reduction in the OF regarding to the persons with phlegmons with one cellular space during the treatment.

Conclusion. Results of LP processes examination in the OF for patients with odontogenic phlegmons of different location and there dynamics during the treatment give basis to make conclusion that LP and AA indices could be additional criteria for diagnostic when verifying the diagnose and confirming the level of the pyoinflammatory process location.

TABLE 8
Comparative evaluation of indices characterizing the speed of free radicals reduction processes (tg α2), in OF for patients with phlegmons of two and more cellular spaces.

Friedman ANOVA p<0,003			
Indices for comparison	p	p taking into consideration the correction Bonferoni (x6)	
tg 1/ tg 2	0,34	2,04	p>0,05
tg 1/ tg 3	0,08	0,48	p>0,05
tg 1/ tg 4	0,55	3,3	p>0,05
tg 2/ tg 3	0,0002	0,001	p<0,01
tg 2/ tg 4	0,65	3,9	p>0,05
tg 3/ tg 4	0,05	0,3	p>0,05

TABLE 9
Indices for comparative evaluation of LP and AA in the OF for patients with phlegmons of one cellular space and practically health people.

Indices	Patients, Me (LQ; UQ)	Healthy people, Me (LQ; UQ)	p
S1 [mV·s]	5,43(4,25;7,11)	4,51(3,5;4,8)	0,02
$I_{max}1$ [mV]	0,55(0,41;0,71)	0,42(0,38;0,5)	0,01
tg α2 1	-0,14(0,16;-0,12)	-0,1(-0,12;-0,1)	0,01
S2 [mV·s]	5,92(4,22;7,8)	4,51(3,5;4,8)	0,01
$I_{max}2$ [mV]	0,66(0,49;0,76)	0,42(0,38;0,5)	0,00004
tg α2 2	-0,13(-0,16;-0,12)	-0,1(-0,12;-0,1)	0,002
S3 [мВ·s]	5,42(4,07;8,1)	4,51(3,5;4,8)	0,01
$I_{max}3$ [mV]	0,63(0,49;0,75)	0,42(0,38;0,5)	0,001
tg α2 3	-0,16(-0,18;-0,12)	-0,1(-0,12;-0,1)	0,005
S4 [мВ·s]	5,26(3,63;6,69)	4,51(3,5;4,8)	0,03
$I_{max}4$ [mV]	0,5(0,41;0,59)	0,42(0,38;0,5)	0,04
tg α2 4	-0,13(-0,14;-0,12)	-0,1(-0,12;-0,1)	0,007

TABLE 10
Indices of comparative evaluation of LP and AA in the OF for patients with odontogenic phlegmons of two and more cellular spaces and practically healthy people

Indices	Patients, Me (LQ; UQ)	Healthy people, Me (LQ; UQ)	p
S1 [mV·s]	6,34(4,51;10,15)	4,51(3,5;4,8)	0,003
$I_{max}1$ [mV]	0,65(0,48;0,97)	0,42(0,38;0,5)	0,0002
tg α2 1	-0,16(-0,18;-0,12)	-0,1(-0,12;-0,1)	0,00008
S2 [mV·s]	6,55(5,76;8,85)	4,51(3,5;4,8)	0,0000001
$I_{max}2$, mV	0,75(0,61;0,91)	0,42(0,38;0,5)	0,000008
tg α2 2	-0,17(-0,19;-0,14)	-0,1(-0,12;-0,1)	0,00006
S3 [mV·s]	6,67(5,4;8,76)	4,51(3,5;4,8)	0,000005
$I_{max}3$ [mV]	0,8(0,5;0,87)	0,42(0,38;0,5)	0,00003
tg α2 3	-0,18(-0,22;-0,14)	-0,1(-0,12;-0,1)	0,000006
S4 [mV·s]	6,05(4,9;8,1)	4,51(3,5;4,8)	0,0008
$I_{max}4$ [mV]	0,61(0,41;0,84)	0,42(0,38;0,5)	0,008
tg α2 4	-0,16(-0,18;-0,12)	-0,1(-0,12;-0,1)	0,0005

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STERILIZATION DECOMPOSITION EVALUATION OF COMPOSITE MATERIALS BASED ON CARBON FIBERS FOR USE IN MEDICINE

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Introduction

Radiolucent composite materials have superior properties to insufficiently radiolucent metal alloys and unreinforced polymers with poor mechanical properties. Their use as medical device materials requires an understanding of the micromechanical properties that provisionally define their behavior. Sterilization is a mandatory process for such materials used in a range of medical applications, e.g., intraoperative guides, screening equipment accessories and patient support systems. The steam or dry heat sterilization processes widely employed in medical practice can affect the micromechanical properties of polymeric composites, particularly in the interface region between the polymer matrix and the reinforcing fibers. However, the effect of sterilization processes on the properties of materials used in medical devices is often ignored [1]. The structural integrity and the overall performance of fiber reinforced polymer composites are strongly influenced by the stability of the fiber/polymer interfacial region. Absorption of moisture causes dilatational expansion and induces stresses associated with moisture-induced expansion, which degrade the structural stability [2-5]. This may induce plastic deformation by plasticization or differential strains [2]. These effects may greatly alter the physical, chemical and mechanical properties of the material at different scales [6]. This results in a significant mismatch in moisture-induced volumetric expansion between the matrix and the fibers, and leads to the evolution of localized stress and strain fields in fibrous composites [6]. Several variables affect the performance of composite materials, including matrix, reinforcement, manufacturing method and reinforcement orientation. It is necessary to investigate both microscopic and macroscopic changes in mechanical and structural properties due to the sterilization processes that are employed. The aim of this study was to prepare a composite material with suitable mechanical, structural and radiolucent properties after repeated sterilization by widely-used techniques.

Materials and methods

Composites based on carbon T300 fibers (plain weave fabrics, Toray, Japan) and/or polyetheretherketone (Porcher Industrie, France) and polyphenylenesulfide (TenCate, Holland) were prepared. T300/polyetheretherketone (PEEK) was cured under a pressure of 0.08 MPa at 395°C. T300/polyphenylene sulfide (PPS) was cured under a pressure of 1.0 MPa at 310°C. The mechanical properties were measured before sterilization (A), after 1 sterilization process period (B1), and after 30 (B30) sterilization process periods. An autoclave (Steridент, Prodenta, CZ) for steam sterilization (134°C, 304 kPa, 10 min) was used for this purpose. The ultimate strength in bending and the modulus of elasticity in bending in the direction of the fiber axis were determined with a four-point and three-point bending set-up using the Inspekt 100 HT material tester (Hagewald & Peschke, Germany), in accordance with ISO 14125.

Results

The flexural properties after multiple sterilizations were tested and compared with those of the corresponding unsterilized samples (FIGS. 1 and 2). The modulus of elasticity in bending is influenced by multiple sterilizations only in the case of T300/PEEK composite (PEEK). The inexpressive decrease in the modulus is equal to approx. 3-4% after 30 sterilization cycles. In the case of ultimate strength in bending, no decrease was observed. From this point of view, we can state that no weakening of the reinforcement-matrix bond occurred.

The influence of multiple sterilization processes on changes in the structural integrity of the composites was studied by an image analysis of cross sections. From the point of view of image analysis, we can state that no weakening of the reinforcement-matrix bond occurred (for illustration, see FIGs. 3 and 4).

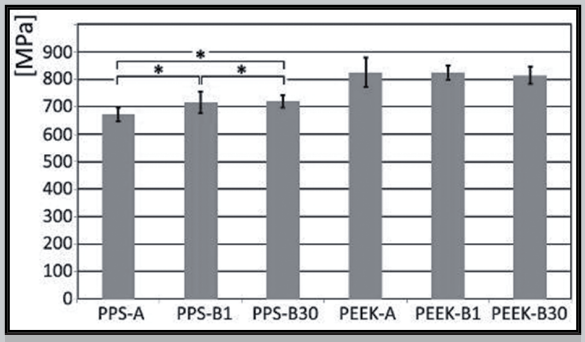

FIG. 1. The ultimate strength in bending (*denotes statistically significant differences, newman-keuls post-hoc test, α = 0.05).