ORIGINAL ARTICLE

IMMUNITY CHANGES IN PATIENTS WITH ACUTE MAXILLOFACIAL ODONTOGENIC INFECTIONS DURING TREATMENT STAGES: AN ANALYSIS

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ABSTRACT

The aim: Evaluate the expediency of using different methods of treatment for patients with acute purulent-odontogenic inflammatory processes in both the main and control groups. This assessment will be based on various indicators of non-specific immunity.

Materials and methods: This study involved the evaluation of the humoral component of nonspecific immunity in 114 patients. We assessed changes in total protein and its fractions, C-reactive protein (CRP), lysozyme, and immunoglobulins (A, M, and G) during three distinct time intervals: 1-3 days, 5-7 days, and 8-14 days after treatment initiation. Statistical analysis was conducted using Statistica 10.0 (StatSoft, Inc., USA) and Microsoft Office Excel 2010.

Results: At different postoperative follow-up periods, a significant improvement in humoral nonspecific immunity indicators ($p>0.05$) was observed when comparing patients treated with and without platelet-rich plasma. This improvement is expected to enhance reparative processes and expedite recovery.

Conclusions: The incorporation of platelet-rich plasma, immunocorrective, and adaptogenic therapy into the comprehensive treatment of acute purulent odontogenic inflammatory processes in the maxillofacial region not only leads to pronounced and enduring positive outcomes but also results in substantial improvements, including the potential normalization of key humoral and cellular factors associated with innate immunity.

KEY WORDS: Infectious and inflammatory processes of the maxillofacial area, treatment, platelet-rich plasma, immunity indicators

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INTRODUCTION

Purulent inflammatory processes occupy a significant position in the realm of surgical dentistry due to various factors, including host organism changes and infectious agent properties [1-3].

Improving diagnostic and treatment methodologies for patients afflicted with odontogenic inflammatory diseases in the maxillofacial and neck regions remains a critical concern in practical healthcare. This is driven by their high incidence, severe symptoms, and frequent complications, which can disrupt the dentoalveolar system and lead to aesthetic facial defects, including deformities stemming from postoperative scars, thus directly affecting patient well-being.

Numerous methods and strategies for treating purulent wounds have been explored, yet none are universally effective [4-6]. Contemporary standards for managing patients with purulent inflammatory diseases in the maxillofacial and neck regions include surgical interventions to drain purulent foci, antimicrobial therapy, detoxification, anti-inflammatory measures, and homeostasis correction [4, 7]. Nonetheless, the prevalence of these pathologies continues to rise. This increase can be attributed to factors such as the growing antibiotic resistance of microorganisms, their virulence, and adaptability [8, 9].

Platelet-rich plasma (PRP), a blood concentrate containing 3-5 times the normal platelet count, has emerged as a valuable tool in maxillofacial surgery and surgical dentistry [10-12]. Upon activation, platelets release specific biological factors that stimulate mesenchymal progenitor cell migration and proliferation, foster neoangiogenesis, and promote tissue regeneration in both hard and soft tissues [10-14]. This study aims to provide an overview of PRP's success and discuss the technical preparation and biological foundations of its clinical use.

THE AIM

The aim of this work was to evaluate the expediency of using different methods of treatment for patients with acute purulent-odontogenic inflammatory processes

Table I. Indicators of the Humoral Component of Innate (Non-specific) Immunity in the Treatment of Acute Purulent Odontogenic Inflammatory Processes in the Maxillofacial Area at Different Postoperative Time Points.

Indicators of humoral activity. Factors of innate immunity	Average statistical norm	1-3 days		5-7 days		8-14 days	
		The main group (n=60)	Control group (n=54)	The main group (n=60)	Control group (n=54)	The main group (n=60)	Control group (n=54)
Total protein, g/l	74,00±8,10	62,12±2,12	58,85±2,32	67,21±2,14	62,13±2,18	73,60±4,20°	68,25±4,22
α1-globulins, %.	4,20±0,70	3,30±0,82	3,21±0,84	3,85±0,83	3,42±0,82	4,12±0,85	3,72±0,86
α2-globulins, %.	8,70±1,30	7,20±1,56	7,12±1,62	7,94±1,60	7,36±1,63	8,45±1,60	8,12±1,64
β-globulins, %.	9,90±1,90	13,00±2,63	13,25±2,68	10,28±2,60	12,15±2,69	10,00±2,63	11,24±2,65
γ-globulins, %.	15,50±2,10	27,30±3,24*	27,90±3,30*	19,24±3,18	24,40±3,31**	16,18±3,32°	21,25±3,30
Albumin, %.	61,70±2,30	49,10±2,21*	48,13±2,48*	57,28±2,22°	53,06±2,44**	61,40±2,22°°	55,20±2,48°
C-reactive protein, mg/l	5,00±0,50	27,15±6,25*	27,93±6,32*	10,18±6,21°	18,56±6,30**,°°	7,16±2,70°	12,48±3,42**,°
Lysozyme titer, μg/ml	3,74±0,03	1,16±0,15*	1,09±0,17*	3,04±0,17*,°°,▲	1,25±0,20*	3,47±0,19°°,▲	2,00±0,21*,°°
IgA, g/l	2,54±0,62	2,90±0,39	2,90±0,40	2,67±0,40	2,80±0,44	2,50±0,41	2,65±0,45
IgM, g/l	1,47±0,43	1,70±0,29	1,75±0,31	1,53±0,28	1,69±0,33	1,48±0,30	1,54±0,32
IgG, g/l	12,10±2,35	12,98±1,89	13,07±1,92	12,80±1,90	12,94±1,92	12,10±1,92	12,46±1,94

Notes:

*p<0.01; **p<0.05 - Indicates a significant difference in values compared to the established average statistical norm;

°p1 <0.05; °°p1 <0.01 - Represents a significant difference in values when compared to the data recorded during the initial postoperative period (days 1-3).

▲p2 <0.01 - Demonstrates a significant difference in values compared to the control group.

in both the main and control groups. This assessment will be based on various indicators of non-specific immunity.

MATERIALS AND METHODS

The study involved 114 patients with infectious and inflammatory processes of the maxillofacial area. Of these, 60 patients were treated using the developed treatment and prevention complex (referred to as the main group), while the remaining 54 patients underwent treatment according to standard protocols for surgical patient management.

The etiology of clinical and laboratory changes was determined through the examination of specific indicators of non-specific immunity. These obtained values were subsequently compared to established reference values. The dynamics of the humoral component of non-specific immunity were evaluated through alterations in total protein and its fractions, C-reactive protein (CRP), lysozyme, as well as immunoglobulins A, M, and G within the patients' blood.

Assessments were conducted at three distinct time points: 1-3 days, 5-7 days, and 8-14 days postoperatively.

Statistical analysis was carried out using Statistica 10.0 (StatSoft, Inc., USA) and Microsoft Office Excel 2010. For normally distributed samples, descriptive statistics were employed, with quantitative characteristics being represented as mean (M) ± standard deviation (SD).

RESULTS

The examination of the immune status of patients afflicted with acute purulent odontogenic processes in the maxillofacial region during varying postoperative intervals relied on laboratory parameters.

The assessment of non-specific immunity dynamics encompassed the investigation of cellular components, including neutrophils evaluated through tests measuring spontaneous nitroblue tetrazolium (NST sp.) and stimulated nitroblue tetrazolium (NST stim.) reduction, non-enzymatic lysosomal cationic proteins (lysosomal cationic test - LCT), phagocytic index (FI), phagocytic count (PC), phagocytosis completion index (PCI), and natural killer cells expressing CD16+ and CD56 (NK cells). Humoral factors were assessed by evaluating protein levels and its fractions, C-reactive protein, tetralysocyme (TL), as well as immunoglobulins of classes A, M, and G in blood serum. Neutrophil functionality was assessed by determining the overall oxygen-dependent bactericidal activity of peripheral blood neutrophils using either spontaneous (NST sp.) or stimulated (NST stim.) tests.

The results of the study regarding the humoral component of innate (non-specific) immunity in the treatment of acute purulent odontogenic inflammatory processes in the maxillofacial area at various postoperative time points are presented in Table I.

On day 1-3 of the postoperative period, a decrease in the content of total protein in the blood by 16.05% in the main group and by 20.47% in the control group

Table II. Indicators of the cellular link of innate (nonspecific) immunity in the treatment of acute purulent odontogenic processes at different times of the postoperative period.

Indicators. Cellular factors of innate immunity	Average statistical norm	1-3 days		5-7 days		8-14 days	
		The main group (n=60)	Control group (n=54)	Main group (n=60)	Control group (n=54)	Main group (n=60)	Control group (n=54)
NST spons.test, %	9,34±0,40	17,48±1,08 *	17,52±1,09 *	10,21±0,25 °,▲	15,10±0,86 *	9,40±1,12 °,▲▲	13,25±0,87 *,°
NST stim.test, %	62,00±9,40	27,70±5,20 *	27,68±5,31 *	58,41±5,21 °,▲▲	33,12±5,30 **	61,00±5,40 °,▲▲	44,10±5,35 °°
Lysosomal cation test, %.	84,10±2,50	73,80±2,78 **	73,49±2,83 **	79,20±2,71°°	75,14±2,68	83,90±2,74	80,13±2,72
Phagocytic indicator, %.	56,20±4,62	30,60±2,73 *	20,87±2,79 *,▲▲	48,70±2,74 ▲	26,53±2,82 *	55,18±2,73 ▲	32,80±2,80 *
Phagocytic number, abs.	12,80±1,40	9,90±1,96	8,34±1,90	11,90±2,05	9,09±1,93	12,52±2,10	10,25±1,90
Phagocytosis completion rate, %.	39,00±2,80	30,73±3,06 **	26,21±2,44 *	38,70±2,91 ▲▲	29,22±2,46 *	39,00±2,44 °°	32,75±2,83
NK cells $CD16^+$, $CD56^+$	15,60±2,65	23,30±3,47 **	24,20±3,05 **	20,60±3,06	24,00±3,10 **	16,30±3,12	20,85±3,18

Notes:
*p<0.01; **p<0.05 - significant difference in values relative to the average statistical norm.
°p1 <0.01; °°p1 <0.05 - significant difference in values compared to the data on days 1-3 of the postoperative period.
▲p2 <0.01; ▲▲ p2 <0.05 - significant difference in values compared to the control group.

compared to the normal values (p>0.05) was established; the fraction of α-globulins in the blood of patients in the main group was 18.60% and in the control group - 20.00% lower than the average (p>0.05). In the main group, the fraction of α-globulins in the blood was 1.7% higher than in the control group (p1 >0.05). The concentration of β-globulins in the blood of patients increased relative to the norm: by 31.31% in the main group and by 33.84% in the control group (p>0.05); in patients of the main group, the content of β-globulins in the blood exceeded the same indicator in patients of the control group by 1.92% (p1 >0.05). In all patients, a significant increase in the content of γ-globulins in the blood was observed in relation to the normative data: by 74.19% in the main group and by 80.00% in the control group (p<0.01). The concentration of γ-globulins in the blood of patients in the main group was 2.15% lower than in patients in the control group (p1 >0.05). There was a decrease in the concentration of albumin in the blood: by 20.42% in the main group and by 22.00% in the control group compared to the average (p<0.01). However, in patients of the main group, the albumin content in the blood did not differ significantly from the data in the control group (p_1 >0.05).

The concentration of C-reactive protein (CRP) in the blood of the subjects remained elevated, surpassing normative data (27.15±6.25 mg/l and 27.93±6.32 mg/l vs. 5.00±0.50 mg/l, respectively, p<0.01). Simultaneously, the lysozyme titer in the blood decreased significantly, showing a reduction of 69.00% in the main group and 70.86% in the control group compared to the average values (p<0.01). In patients from the main group, there were increases in blood concentrations of IgA by 14.17%, IgM by 15.65%, and IgG by 7.27%, although these changes were not statistically significant (p>0.05). In contrast, patients in the control group exhibited elevated levels of IgA by 17.7%, IgM by 19.05%, and IgG by 8.02%, with no statistically significant differences between the groups (p1 >0.05).

On days 5-7 of the postoperative period, total protein content in the blood increased by 8.19% in the main group and by 5.57% in the control group compared to the data from days 1-3 of the postoperative period (p2 >0.05). The α-globulin fractions in the blood increased on average by 12.38% in the main group and by 4.45% in the control group (p2 >0.05). Conversely, the concentration of β-globulins decreased in both groups on day 5-7 of the postoperative period, showing a reduction of 20.92% in the main group and 8.30% in the control group (p2 >0.05). A notable decrease in γ-globulin levels in the blood of subjects was observed, with a decrease of 29.52% in the main group and 12.54% in the control group. It is noteworthy that in the control group, the concentration of γ-globulins in the blood was 57.42% higher than the average (p>0.05). The concentration of albumin in the blood of the study population increased

significantly on day 5-7 of the postoperative period, rising by 16.66% in the main group (p1 <0.05) and by 10.24% in the control group (p1 <0.05) compared to the data from days 1-3 after treatment. Importantly, in patients in the control group, the albumin content in the blood remained significantly lower than normative values (p<0.05). In patients from the main group, the concentration of albumin in the blood was 7.37% higher than in patients from the control group (p1 <0.05).

In the main group, on day 5-7 of the postoperative period, there was a significant decrease in C-reactive protein content in the blood by 62.50% (p1 <0.05), compared to 33.55% in the control group (p1 <0.01), relative to the data from day 1-3 of the postoperative period. However, in the control group, the analyzed CRP index, with a value of 18.56±6.30 mg/l, remained significantly higher than the average statistical norm (p<0.05).

The lysozyme titer in the blood of patients in the main group increased, reaching a value of 3.04±0.17 µg/ml, which was significantly higher than that on days 1-3 of the postoperative period (p1 <0.01) and markedly higher than the value (1.25±0.20 µg/ml) in patients from the control group (p2 <0.01). There was a decrease in the content of IgA, IgM, and IgG in the blood, although these changes were not statistically significant (p1 >0.05), indicating a reduction in the inflammatory response.

On day 8-14 of the postoperative period, in patients with acute purulent odontogenic inflammatory processes in the main group, blood protein content increased (p1 <0.05), as did albumin and lysozyme titer (p1 <0.01). This was accompanied by a decrease in the concentrations of γ-globulin and C-reactive protein (p1 <0.05) compared to the data from days 1-3 of the postoperative period. All other analyzed parameters remained within reference values (p>0.05).

In the control group of patients, the concentration of C-reactive protein (CRP) in the blood remained elevated (p1 <0.01), while the lysozyme titer and albumin levels remained lower (p1 <0.01 and p1 <0.05, respectively) compared to the data from days 1-3 of the postoperative period. It is worth noting that the concentration of CRP in the blood was also higher (p < 0.05), and the lysozyme titer in the blood was lower (p < 0.01) compared to normative values

The results of indicators of the cellular link of innate (non-specific) immunity in the treatment of acute purulent odontogenic processes at different times of the postoperative period are presented in Table II.

During the initial period of the postoperative phase (days 1-3), there was an increase in neutrophil surface triggering (NSTsp.) to 17.48±1.08% in the main group and 17.52±1.09% in the control group, relative to the average statistical norm (p<0.01). Concurrently, during this research period, the neutrophil surface triggering stimulation (NSTstim.) decreased to 27.70±5.20% in the main group and 27.68±5.31% in the control group, relative to normative values (p<0.01).

Thus, in patients of the main group during days 1-3 of the postoperative period, lysosomal cationic protein content decreased to 73.80±2.78%, and in patients of the control group to 73.49±2.83%, compared to the average statistical norm (p<0.05); in patients of the main group the phagocytic index was 1.8 times higher (30.60±2.73% vs. 56.20±4.62%, p<0.01), the phagocytic number was 1.3 times higher (9.90±1.96 abs. vs. 12.80±1.40 abs., p>0.05), and the phagocytosis completion rate (PCR) was 1.3 times lower (30.73±3.06% vs. 39.00±2.80%, p<0.01) compared to the average statistical norm. In patients of the control group, there was a decrease in the phagocytic index by 2.7 times, phagocytic number by 1.5 times, and PAE by 1.5 times (p<0.01).

The cytotoxic activity of NK cells occurs in the absence of sensitized lymphocytes, characteristic of cellular immunity reactions. In patients of the main group, the content of NK cells CD16+ , CD56+ was 1.5 times higher (23.38±3.47%), and in patients of the control group, it was 1.6 times higher (24.20±3.05%) compared to average values (15.60±2.65%) during days 1-3 of the postoperative period (p<0.01). It should be noted that a significant difference between the groups was only observed in the phagocytic index (p2 <0.05) during this analyzed research period.

On the 5th-7th day of the postoperative period, in the main group, we observed a significant decrease in NST spons. (p1 <0.01) and NK cells CD16+ , CD56+ (p1 >0.05), alongside an increase in NST stim. (p1 <0.05), lysosomal cation test (p1 <0.05), phagocytic index, phagocytic number, and phagocytosis completion index (p1 >0.05) relative to data from the first 1-3 days post-treatment. Conversely, in the control group on the 5th-7th day postoperatively, the dynamics of the studied parameters did not significantly differ from the data observed during the first 1-3 days post-treatment (p1 >0.05). Notably, NST sp. and NK cells CD16+ , CD56+ values were significantly higher (p>0.01), while NST stim. (p<0.05), phagocytic index (p<0.01), and PFD (phagocytosis completion index) (p<0.05) were below normative values.

As a result of the study, it was demonstrated that on the 5th-7th day of the postoperative period, patients in the main group exhibited significantly lower NST spons. values (p2 <0.01) and higher NST stim., phagocytic index, and phagocytosis completion index values (p2 <0.05) compared to patients in the control group.

In the control group, on the 8th – 14th day of the postoperative period, NST sth. values were significantly higher than both the average data and the values from the first 1-3 days of the postoperative period (p1 <0.01), while the phagocytic index values were below normative values (p1 <0.01). In contrast, in the main group on the 8th-14th day of the postoperative period, NST stm. (p2 <0.05) and phagocytic index (p2 <0.01) were higher, and NST sp. (p2 <0.05) values were lower than those in the control group

DISCUSSION

The treatment of patients with acute purulent odontogenic processes of the maxillofacial area is complex, comprehensive and timely. According to many authors, existing treatment methods are characterized by trauma, a long recovery period and frequent complications, which is associated with increased antibiotic resistance of microorganisms, their virulence and variability [8, 9].

The results of recovery are significantly improved with the use of platelet-enriched plasma at the treatment stages, the main characteristics of which are the presence of a large number of platelets in it, which during activation change their shape and secrete specific biological factors that induce migration and proliferation of mesenchymal progenitor cells, stimulate neoangiogenesis and regeneration in both hard and soft tissues [10-12].

According to many authors [13, 14] plasma enriched with platelets is widely used in maxillofacial surgery and surgical stomatology.

The effectiveness of recovery in the postoperative period is determined by the improvement of the patient's physical condition, which is confirmed by immunological parameters.

According to the results obtained by us, in the patients of the main group who received platelet-enriched plasma, the indicators of humoral (non-specific) immunity approached the norm for 1-3 days, in particular, the content of total protein, α-globulins, β-globulins, γ-globulins in the blood and albumins. However, the content of CRP and IgA, IgM, IgG in the blood remained high.

On the 5th-7th day of the postoperative period, the treatment led to positive changes in the indicators of the humoral arm of nonspecific immunity, most notably in patients with acute purulent odontogenic inflammatory processes, who were treated with our proposed pharmacotherapy, that the decrease in the content of C-reactive protein and IgA, IgM, IgG in the blood (p>0.05) was confirmed, which indicates a decrease in the inflammatory reaction.

On the 8th-14th day of the postoperative period in the main group, the application of our proposed treatment and prophylactic model resulted in all cellular immunity indicators returning to values within the range of the average statistical norm (p>0.05). Additionally, NST spons. values were lower, NST stim. (p2 <0.01), and the indicator of phagocytosis completion (p2 <0.05) were higher than those observed during the first 1-3 days of the postoperative period.

The presence of an infectious and inflammatory process led to an increase in the intrinsic (spontaneous) enzymatic activity of neutrophilic granulocytes, indicating their antigenic overload, while simultaneously reducing the coefficient of neutrophil chemiluminescence stimulation, confirming a decrease in the reserve potential of phagocytic cells.

CONCLUSIONS

In conclusion, our study of the key components of non-specific immunity in the treatment of acute purulent odontogenic inflammatory processes in the maxillofacial region revealed significant alterations in both humoral and cellular factors, involving both decreases and dangerous increases in many of the parameters studied. Conventional standard treatment, following traditional protocols, failed to produce significant and sustained improvements in non-specific immunity factors. However, the inclusion of platelet-rich plasma, immunocorrective therapy, and adaptogenic therapy in the comprehensive treatment of acute purulent odontogenic inflammatory processes in the maxillofacial region not only resulted in the most pronounced and sustained positive outcomes but also led to significant improvements and even normalization of key humoral and cellular factors of innate immunity.

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