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Plasma levels of C-reactive protein and Interleukin-6 as markers of inflammation in patients with operative treated fractures

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Abstract

Conditions that affect plasma concentrations of acute-phase proteins include infections, trauma, surgical treatment, burns, tissue ischemia (infarctions), various immunological inflammatory conditions and cancer. The cytokine Interleukin-6 (IL-6) is the main stimulator for the production of numerous acute-phase proteins. It has been established that the induction of C-reactive protein (CRP) and production of serum amyloid A is caused by the cytokines IL-6 and IL-1 or TNF-alpha. Elevated levels of IL-6 during acute injuries or stress are often used as an indicator of systemic inflammation and are predictors of preoperative morbidity.

We undertook this prospective randomized study in 90 patients undergoing surgery procedure after high-energy trauma, low-energy trauma and open fracture to define plasma levels of IL-6 and CRP over a 2-week period. We presented our results at seven time points, namely 6 hours pre-operatively and post-operatively in 2, 4, 5, 7 and 14 days respectively. We have attempted to find out whether IL-6 and CRP levels returned to baseline during this study period.

In our study, we determined the influence of the examined parameters CRP and IL-6 in plasma on the early detection of surgical postoperative inflammation in operatively treated fractures. With the obtained results of our examined parameters, we can state that is provided a place for the routine procedure of CRP and IL-6 as predictors of possible postoperative inflammation.

Key words: C-reactive protein, Interleukin-6, plasma, trauma, inflammation

Introduction

Physical trauma is one of the leading causes of mortality and morbidity across all ages, with the possibility of post-traumatic or postoperative infection as a less common complication. Patients with injuries or infections are exposed to metabolic, hemodynamic, and immunological responses, which are partly controlled by endogenous cytokines (Guirao & Lowry, 1996).

Cytokines produced during an inflammatory process are the main stimulators for the production of acute-phase proteins. The changes in the concentration of acute-phase proteins depend on their production in hepatocytes. Conditions that affect plasma concentrations of acute-phase proteins include infections, trauma, surgical treatment, burns, tissue ischemia (infarctions), various immunological inflammatory conditions, and cancer.

Cytokines are intracellular signaling polypeptides produced by previously activated cells. Many cytokines have multiple sources, multiple targets of action, and

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several functions. There are various inflammatory cytokines that participate in the stimulation of acute-phase protein production, including IL-6 (interleukin-6), IL-1B, TNF-alpha, interferon-gamma, transforming growth factor-beta, and to some extent IL-8 (Wigmore et al., 1997).

The cytokine IL-6 is the main stimulator for the production of numerous acute-phase proteins. It has been established that the induction of C-reactive protein (CRP) and production of serum amyloid A is caused by the cytokines IL-6 and IL-1 or TNF-alpha, while fibrinogen induction is stimulated by IL-6, which is inhibited by IL-1, TNF-alpha, and transforming growth factor-beta (Mackiewicz et al., 1991).

All interleukins also play a role in B cell response, particularly IL-1, IL-4, IL-5, and IL-6, which are also known as B cell-stimulating factors. Postoperatively, macrophages are considered to play a key role in tissue remodeling and healing, and they are responsible for the initial secretion of cytokines such as IL-1 and IL-6. It is also known that cytokines TNF-alpha and IL-1 are essential for initiating bone repair. They participate in intramembranous bone formation, trabecular bone remodeling, and maintaining overall homeostasis in the body (Kon et al., 2001).

Elevated levels of IL-6 during acute injuries or stress are often used as an indicator of systemic inflammation and are predictors of preoperative morbidity. TNF-alpha and IL-1 are the primary drivers of IL-6 production. After injury, IL-6 levels in circulation are detected after 60 minutes, peaking between 4 and 6 hours, and can persist in the blood for up to 10 days.

The relatively long half-life of IL-6 makes it easily detectable. The level of IL-6 is proportional to the extent of tissue damage during surgery. IL-6 not only stimulates PMN (polymorphonuclear activation) during injury and inflammation, but may also delay it. The presence of inflammatory polymorphonuclear cells (PMN) after injury can explain the effects of injury on distant tissues, such as the lungs and kidneys. IL-6 can also serve as an anti-inflammatory mediator during injury but through a different mechanism of action (Heremans et al., 1992). It is capable of attenuating the activity of TNF and IL-1 by promoting the release of sTNFRs (soluble TNF receptors) and IL-1ra.

Prolonged persistence of IL-6 is a sign of present immunosuppression and increased postoperative inflammatory morbidity, i.e., high levels of IL-6 48 hours after surgery indicate a possible infectious complication. IL-6 is a cytokine with approximately 26 kD, produced in mononuclear phagocytes, endothelial cells from blood vessels, fibroblasts, and other cells under the influence of IL-1, and to a lesser extent under the influence of TNF.

It has been established that there is a significant correlation between IL-6 concentrations 6 hours postoperatively and CRP levels 48 hours postoperatively. Some studies have noted that IL-6 concentration depends on the age of a healthy person, and a significant correlation has been found between the preoperative levels of IL-6 and TNF-alpha and age (Wei et al., 1992).

Though CRP and IL-6 have been proved to be of high sensitivity but relatively low specificity. Both of the two biomarkers have been established as parameters assessing inflammation after surgery of bones. As for CRP, it is hard to interpret early postoperative infection because studies have shown that CRP will elevate as long as 3 months after the surgery even in the absence of infection (Ettinger et al., 2019). IL-6, a major endogenous protein mediator of the acute phase inflammation, returns to normal level soon after surgery. Studies have shown that IL-6 not only elevated because of surgical inflammation. Recently, Maniar et al. (2019) have investigated the serum levels of IL-6 and CRP in the hours and days immediately postoperatively to understand their normal trajectory. However, with the promotion of enhanced recovery after surgery (ERAS), many methods have been used to minimize surgical trauma and reduce inflammation (Park et., 2008). Little is known of the curve in the hours and days of CRP and IL-6 immediately postoperatively under an ERAS scenario.

Therefore, we undertook this prospective study in 90 patients undergoing surgery procedure after high-energy trauma, low-energy trauma and open fracture to define plasma levels of IL-6 and CRP over a 2-week period. We presented our results at seven time points, namely 6 hours pre-operatively and post-operatively in 2, 4, 5, 7 and 14 days respectively. We have attempted to find out whether IL-6 and CRP levels returned to baseline during this study period.

Material and methods

Our prospective randomised study included 90 patients, aged 20 to 80 years. Depending on the severity of the injury, the mechanism of the injury and the extent of the operative treatment, the patients were divided into three groups:

1. In the first group (n=30) were patients injured by trauma with a more extensive strength (high-energy trauma). This includes operatively treated fractures of long bones, pelvis and spine

2. In the second group (n=30) were patients injured by low-energy trauma and they were treated operatively

3. In the third group (n=30) were patients with different degrees of open fractures that were surgically treated.

In defining of the patients status, the anamnesis and the medical examination were included in order to recognize the existence of any previous disease. Those who had comorbidities known to affect plasma levels of IL-6 and CRP such as inflammatory arthritis, autoimmune disorders, history of cancer or long-term steroid intake were excluded.

Venous blood samples in the amount of 10 ml were

taken in EDTA (K3) from the patients in the admission department up to 6 hours after the injury. The blood samples taken were kept at a temperature of 2-6 °C for up to 24 hours. After that, they were centrifuged and stored at a temperature of -20 °C, until the immunoassay was performed. Quantitative measurements of CRP and IL-6 were made from the same samples.

A complete blood-cell count along with CRP and IL-6 was measured 6 hours pre-operatively and post-operatively, and 2, 4, 5, 7 and 14 days respectively.

Assessment of plasma IL-6 was done using the electrochemiluminescence immunoassay (Cobas E601 analyzer; Roche Diagnostics GmbH, Germany) (normal range, 0–7 pg/mL). Quantitative assessment of CRP was done using an immunoturbidometric assay (Cobas analyzer; Roche Diagnostics GmbH) (normal value < 5.0 mg/L).

In some previous studies, authors found that erithrocyte sedimentation rate (ESR) is a less sensitive parameter compared to CRP and IL-6 (Xu et al., 2019). Thus, we did not include ESR as a parameter in the current study.

Statistical analysis

The following methods of descriptive statistics were used to describe the obtained results: arithmetic mean, standard deviation, minimum, maximum, median, standard error, frequencies. Considering the high variability of the investigated parameters, mostly non-parametric tests were used, but also parametric ones, where the conditions for their application were possible. The following methods of analytical statistics (statistical tests for tied and untied samples) were used to test the null hypothesis and draw valid conclusions: *one-way ANOVA*, LSD test, Kruskal-Wallis H test, Mann-Whitney U test, Friedman test and Wilcoxon test.

In all statistical tests, the levels of probability of realization of the null hypothesis according to international standards for bio-medical sciences were 0.05 and 0.01.

Results and discussion

In our study were included 90 patients age ranged from 20 to 80 years, there were 52 women (57.77%) and 38 men (42.22%) in all three patients' groups. It is characteristic that in the second group of patients (with low-energy injuries), the representation of the female gender is 66.6% of 30 patients, because it goes in favor of the occurrence of osteoporosis in the female population as a cause of possible fractures in the event of an injury of less intensity.

The results of CRP plasma measurements in all time points of the study and in all studied groups are shown in Table 1, where it can be noted that the CRP plasma levels in all studied groups in the pre-operative period are significantly increased compared to the reference levels in healthy people. After 6 hours of the operation, a pronounced increase in CRP plasma levels was obtained, especially in the 1st and 3rd groups of surgically treated patients, and there is a significant, i.e. highly significant, difference with the CRP plasma levels in the patients before the surgical treatment ($p<0.05$; $p<0.01$).

Table 1. Measurements of CRP (mg/L) in plasma samples in the 1st, 2nd and 3rd group of patients at all measurements time point of the study

Group 1 n=30	Pre-op.	6 hours post-op.	2 days post-op.	4 days post-op.	5 days post-op.	7 days post-op.	14 days post op.
Mean	56.03	84.75	132.68	92.27	84.38	66.99	40.43
SD	45.22	53.88	64.92	57.03	47.65	50.68	31.45
Min	1.02	24.60	27.30	6.53	14.30	9.48	1.05
Max	163	240	326	210	170	226	98.20
Group 2 n=30	Pre-op.	6 hours post-op.	2 days post-op.	4 days post-op.	5 days post-op.	7 days post-op.	14 days post op.
Mean	14.57	27.31	89.29	57.17	33.69	23.49	9.40
SD	18.88	23.15	48.26	41.98	24.99	21.66	8.51
Min	0.50	4.80	17.90	10.20	8.59	3.70	0.43
Max	66.80	97.60	204	184	110	88	23.3
Group 3 n=30	Pre-op.	6 hours post-op.	2 days post-op.	4 days post-op.	5 days post-op.	7 days post-op.	14 days post op.
Mean	11.76	32.07	95.50	58.98	44.88	47.37	14.96
SD	17.93	29.99	67.35	33.63	30.11	31.93	18.70
Min	0.49	1.91	24.40	15.50	8.10	9.20	0.74
Max	48.90	1.10	242	110	93.60	100	60.60

Table 2. Measurements of IL-6 (pg/mL) in plasma samples in the 1st, 2nd and 3rd group of patients at all measurements time point of the study

Group 1 n=30	Pre-op.	6 hours post-op.	2 days post-op.	4 days post-op.	5 days post-op.	7 days post-op.	14 days post op.
Mean	41.65	49.76	46.63	43.93	40.96	41.99	36.12
SD	14.53	15.49	13.79	15.82	12.76	14.75	13.97
Min	10.61	21.5	19.14	5.75	17.09	9.28	10.12
Max	67.3	72.11	68.82	72.38	65.49	64.04	57.4
Group 2 n=30	Pre-op.	6 hours post-op.	2 days post-op.	4 days post-op.	5 days post-op.	7 days post-op.	14 days post op.
Mean	26.8	33.26	29.61	26.23	24.87	22.20	19.04
SD	13.12	12.22	11.55	12.27	9.66	11.75	12.28
Min	8.85	15.32	11.37	8.85	8.37	6.95	3.25
Max	67	61.61	48.71	48.66	46.75	41.36	50.23
Group 3 n=30	Pre-op.	6 hours post-op.	2 days post-op.	4 days post-op.	5 days post-op.	7 days post-op.	14 days post op.
Mean	37.78	42.34	35.51	32.45	33.41	35.71	28.38
SD	19.50	16.73	18.91	15.49	14.69	14.36	16.74
Min	4.94	19.65	16.86	5.99	14.52	5.17	7.23
Max	75.17	73.25	72.49	54.34	55.53	56.1	56.12

Due to the peak of CRP in the plasma, which occurs on the 2nd and 4th day after the operative treatment, according to the Wilcoxon statistical analysis, highly significant statistical differences were obtained between the measurements in the pre-operative period and on the 2nd and 4th day after surgery ($p<0.01$) in all three groups (Table 3). A statistically significant difference also exists between the levels from the pre-operatively with the 5th, 7th and 14th day post-operatively in patients from the 3rd group ($p<0.5$), which explains the occurrence of a stronger immune system response (possible inflammation) in patients with open fractures.

Among the other significant highly significant statistical differences are between the levels on day 2 post-operatively with 4, 5, 7 and 14 days post-operatively in all three groups of patients ($p<0.01$). Due to the appearance of a CRP peak from the 2nd to the 4th day after surgery, there are highly significant statistical differences between the 4th day post-operatively with 5, 7 and 14 days post-operatively ($p<0.1$) in all three groups. On the 14th day after surgery, the level of CRP in the circulation drops and comes within normal limits, so the CRP plasma levels compared with the 7th day post-operatively gives the same highly significant difference ($p<0.01$) in 1st, 2nd and 3rd group.

According to the Kruskal Wallis test, there is a statistically highly significant correlation of CRP plasma levels between the three groups, in the following measurement points (p<0.01) 6 hours pre-operatively, 6 hours, 5th, 7th and 14th day post operatively.

With the Mann-Whitney test between-group analysis, a statistically highly significant difference was found between the 1st and 2nd group in the pre-operatively, 6-hour, 5, 7 and 14-day post-operative measurements ($p<0.0l$). There is also a statistically significant correlation between the 2nd and 3rd group, especially at the measurement point on the 7th day post-operatively ($p<0.5$) Statistically highly significant correlation also exists between the 1st and 3rd groups and that between the measurement point pre-operatively and 6 hours post-operatively ($p<0.01$) and between 5th and 14 days post-operatively, indicating a strong systemic response.

The results of IL-6 plasma levels in all measurement time points of the study and in all studied groups are shown in Table 2, where it can be noted that the plasma levels of IL-6 in all studied groups in the pre-operative period are markedly increased in relative to reference levels in healthy people.

As shown in Table 2, after the 6th hour of the operation, a marked increase in the levels of IL-6 was obtained in the 1st and 2nd groups of surgically treated patients, and therefore there is a significant, i.e. highly significant, significant difference with the preoperative levels of IL-6 in the patients ($p<0.05; p<0.01$). Due to the rapid decrease of IL-6 levels in the patients' plasma until the 14th day, there is a statistically significant, i.e. highly significant difference between the pre-operative period and the 14th day after the operative treatment in the 2nd and 3rd groups, respectively. ($p<0.05; p<0.01$). Also, in the obtained results from the patients' plasma, an increase (peak) in the level of IL-6 was observed, 6 hours after the operative intervention.

Table 3. Statistical analysis of CRP in plasma samples in the 1st, 2nd and 3rd group of patients at all measurements time point

CRP Group 1	6 hours post op.	2 days post op.	4 days post op.	5 days post op.	7 days post op.	14 days post op.
pre-operatively	r<0.01	r <0.01	r<0.01	r>0.05	r>0.05	r>0.05
6 hours post op.		r<0.01	r>0.05	r>0.05	r>0.05	r<0.01
2 days post op.			r<0.01	r<0.01	r<0.01	r<0.01
4 days post op.				r>0.05	r<0.01	r<0.01
5 days post op.					r<0.01	r<0.01
7 days post op.						r<0.01
CRP Group 2	6 hours post op.	2 days post op.	4 days post op.	5 days post op.	7 days post op.	14 days post op.
pre-operatively	r>0.05	r <0.01	r<0.01	r<0.05	r>0.05	r>0.05
6 hours post op.		r<0.01	r<0.01	r>0.05	r<0.05	r<0.01
2 days post op.			r<0.01	r<0.01	r<0.01	r<0.01
4 days post op.				r<0.01	r<0.01	r<0.01
5 days post op.					r<0.01	r<0.01
7 days post op.						r<0.01
CRP Group 3	6 hours post op.	2 days post op.	4 days post op.	5 days post op.	7 days post op.	14 days post op.
pre-operatively	r<0.01	r<0.01	r<0.01	r<0.05	r<0.01	r>0.05
6 hours post op.		r<0.01	r>0.05	r>0.05	r>0.05	r<0.01
2 days post op.			r<0.01	r<0.01	r>0.05	r<0.01
4 days post op.				r<0.01	r>0.05	r<0.01
5 days post op.					r>0.05	r<0.01
7 days post op.						r<0.01

Therefore, according to the Wilcoxon test of equivalent pairs, a statistically highly significant correlation was found in the 1st group between the 6th hour with the 5th (*p<0.05*) and the 14th day (*p<0.01*) post-operatively, in the 2nd group between the 6th hour post-operatively with 4th, 5th, 7th, 14th day post-operatively (*p<0.01*) and in the 3rd group between the 6th hour and the 4th and 14th day post-operatively (*p<0.01*). Highly significant statistical differences also exist between the 2nd day post-operatively with the 14th day post-operatively in all three groups (p<0.01) and between the 4th and 5th day post-operatively with the 14th day post-operatively in the 2nd group (*p<0.05, p<0.01*). Finally, a statistically highly significant correlation was found between the 7th day and the 14th day post-operatively in all three groups of patients. A statistically highly significant correlation of IL-6 in

plasma was determined between the three groups (Table 4), in all measurement time points (*p<0.01*). A statistically highly significant difference was found between the 1st and 2nd groups in all measurement points (*p<0.01*). There is also a statistically significant, i.e. highly significant correlation between the 2nd and 3rd groups, especially at the measurement time point pre-operatively (*p<0.05*) and on the 7th day post-operatively (*p<0.01*). A statistically significant correlation also exists between the 1st and 3rd groups on the 2nd and 4th day post-operatively (*p<0.05*). These statistically significant correlations confirm the fact that the systemic immune response of the body depends on the strength and type of injury.

Table 4. Statistical analysis of IL-6 in plasma samples in the 1st, 2nd and 3rd group group of patients at all measurements time point

IL-6 Group 1	6 hours post op.	2 days post op.	4 days post op.	5 days post op.	7 days post op.	14 days post op.
pre-operatively	r<0.05	r>0.05	r>0.05	r>0.05	r>0.05	r>0.05
6 hours post op.		r>0.05	r>0.05	r<0.05	r>0.05	r<0.01
2 days post op.			r>0.05	r>0.05	r>0.05	r<0.01
4 days post op.				r>0.05	r>0.05	r>0.05
5 days post op.					r>0.05	r>0.05
7 days post op.						r<0.01
IL-6 Group 2	6 hours post op.	2 days post op.	4 days post op.	5 days post op.	7 days post op.	14 days post op.
pre-operatively	r<0.01	r>0.05	r>0.05	r>0.05	r>0.05	r>0.05
6 hours post op.		r>0.05	r<0.01	r<0.01	r<0.01	r<0.01
2 days post op.			r>0.05	r>0.05	r<0.01	r<0.01
4 days post op.				r>0.05	r<0.05	r<0.05
5 days post op.					r>0.05	r<0.01
7 days post op.						r<0.01
IL-6 Group 3	6 hours post op.	2 days post op.	4 days post op.	5 days post op.	7 days post op.	14 days post op.
pre-operatively	r>0.05	r>0.05	r<0.05	r>0.05	r>0.05	r<0.01
6 hours post op.		r>0.05	r<0.01	r>0.05	r>0.05	r<0.01
2 days post op.			r>0.05	r>0.05	r>0.05	r<0.01
4 days post op.				r>0.05	r>0.05	r>0.05
5 days post op.					r>0.05	r>0.05
7 days post op.						r<0.01

During the examination in our study, several patients were excluded from the joint statistical processing of the data and were treated as a separate group, that is, it is a matter of several patients whose results are clearly different from the other subjects. These are two patients from group 3, two from group 1 and one patient from group 2, a total of 5 (5.55%), whose operative surgical wounds, due to the occurrence of inflammation, healed slowly, (sanatio per secundum intentionem s. per granulationem) that is partial healing of the operative wounds occurred. From the obtained values of the examined parameters in these 5 subjects, the occurrence of secondary peaks concentration was observed, especially for IL-6 on the 4th postoperative day and for CRP on the 5th postoperative day. In these patients, longer-term antibiotic therapy (according to the antibiogram) and more frequent dressings with antiseptic agents were carried out until the purposeful granulation of the operative wound (sanatio per secundum intentionem s. per granulationem) occurred.

Due to the elevated blood levels of IL-6 during acute injuries or stress, it is often used as an indicator of systemic inflammation and a predictor of pre-operative morbidity (Patric et al., 1996). After an injury, IL-6 levels in the circulation are detected after 60 minutes, with the appearance of a peak concentration between 4 and 6 hours and can persist for about 10 days in the blood circulation. In our clinical material, 6 hours post-operatively, an increase in IL-6 serum levels in the 1st and 2nd groups of surgically treated patients was obtained and there is a significant and highly significant difference with IL-6 levels in patients before the operative treatment. The relatively long half-life of existence provides the possibility of easy detection. The level of IL-6 is proportional to the degree of tissue damage during surgery, as opposed to the duration of the entire surgical procedure, therefore the systemic immune response is stronger during stronger tissue destruction.

From the obtained results, a statistically highly significant difference was found between the 1st and 3rd groups and that at all time points of measurement ($r<0.01$). There is also a statistically significant or highly significant correlation between the 1st and 2nd groups, especially with the pre-operatively measuring point ($r<0.05$) and the 7th day post-operatively ($r<0.01$).

A statistically significant correlation also exists between the 1st and 3rd groups in the 2nd and 4th day post-operatively ($r<0.05$) indicating that the height of the IL-6 parameter in the patients' plasma depends on the strength and type of injury (open fractures), therefore after strong tissue trauma, a higher concentration of IL-6 in the circulation and vice versa.

IL-1 and IL-6 acting synergistically are most responsible for the induction of CRP. Other cytokines and some endocrine factors are also involved in the response to CRP in the body (Otterness, 1994;). The rise in IL-6 precedes the rise in CRP, and the decline in plasma IL-6 begins before CRP reaches its peak concentration (Kragsbjerg et al., 1995). CRP synthesis is indicated rapidly after tissue damage, and plasma levels rise as early as 4 to 6 hours after injury, reaching peak values at 24 to 72 hours after the operation (Kilpatrick & Volanakis, 1991).

Due to the peak concentration of CRP in the plasma, which occurs on the 2nd and 4th day after the surgical treatment, highly significant statistical differences were obtained between the measurements in the pre-operative period and the 2nd and 4th day after surgery ($p<0.01$) in all three patients groups. A statistically significant difference also exists between the pre-operative period with the 5th, 7th and 14th day post-operatively in patients from the 3rd group ($p<0.05$), which explains the phenomenon that the level of CRP in subjects with open fractures (3rd group) persists longer. In these injuries, the systemic immune response is stronger, that is the probability for possible infection is higher in open fractures (Saiganesh et al., 2022).

Towards the 14th day after op. the level of CRP in the blood decreases and comes within the limits of normal, therefore the values of CRP compared with the 7th day post-operatively, also gives a highly significant difference ($p<0.01$) in all patients' groups, which is a sign of a good postoperative outcome of surgically repaired fractures, that is the repair of surgical wounds is primary (sanatio per primam intentionem). The level of CRP in plasma depends on the degree of tissue injury (Khreiss et al., 2004). The similar results are confirmed in our study.

In our study, a statistically significant difference also exists between the pre-operative period with the 5th, 7th and 14th day post-operatively in patients from the 3rd group ($p<0.05$), which explains the phenomenon that the level of CRP in the group of patients with open fractures persists longer. In these injuries, the systemic immune response is stronger, that is the probability of possible infection is higher in open fractures.

The level of CRP in the circulation of the patients depends as on the strength (high and low energy) as well as the type of injury (open fracture), that is because the systemic immune response in these injuries is stronger. Prolonged persistence of IL-6 is a sign of present immunosuppression and increased postoperative inflammatory morbidity, that is, high values of IL-6 cytokines 48 hours after operative treatment are a sign of a possible infectious complication (Tang et al., 1996).

Unlike cytokines, prolonged persistence of CRP in the blood on the 4th or 5th day is a sign of a possible infectious complication (Luster, 1998).

Conclusion

In our study, we determined the influence of the examined parameters CRP and IL-6 in plasma on the early detection of surgical postoperative inflammation in operatively treated fractures. With the obtained results of

our examined parameters, we can state that is provided a place for the routine procedure of CRP and IL-6 as predictors of possible postoperative inflammation.

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Резиме

Плазматски нивоа на Ц-реактивен протеин и интерлеукин-6 како маркери на воспаление кај пациенти со оперативно третирани фрактури

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Клучни зборови: Ц-реактивен протеин, Интерлеукин-6. Плазма, траума, воспаление

Условите кои влијаат на плазматските концентрации на протеините од акутната фаза вклучуваат инфекции, траума, хируршки третман, изгореници, ткивна исхемија (инфаркти), разни имунолошки воспалителни состојби и рак. Цитокинот Интерлеукин-6 (IL-6) е главниот стимулатор за производство на бројни протеини во акутна фаза. Утврдено е дека индукцијата на Ц-реактивен протеин (CRP) и производството на серумскиот амилоид А е предизвикана од цитокините IL-6 и IL-1 или TNF-алфа. Зголемените нивоа на IL-6 за време на акутни повреди или стрес често се користат како показатели за системско воспаление и се предиктори за предоперативниот морбидитет.

Ја спроведовме оваа проспективна рандомизирана студија кај 90 пациенти кои беа подложени на операција по траума со висока енергија, траума со ниска енергија и отворени фрактури за да ги дефинираме нивоата на IL-6 и CRP во плазмата во период од 2 недели. Ги презентиравме нашите резултати во седум временски точки, имено 6 часа пред операција и постоперативно во 2, 4, 5, 7 и 14 дена соодветно. Се обидовме да откриеме дали нивоата на IL-6 и CRP се враќаат на почетните вредности за времетраењето на нашата студија.

Во нашата студија го утврдивме влијанието на испитуваните параметри CRP и IL-6 во плазмата врз раното откривање на хируршкото постоперативно воспаление кај оперативно третираните фрактури. Со добиените резултати од нашите испитуавни параметри можеме да констатираме дека е обезбедено место за рутинска процедура на одредување на параметрите CRP и IL-6 како предиктори за можно постоперативно воспаление.