Kinetics of Changes in Serum Concentrations of Procalcitonin, Interleukin-6, and C- Reactive Protein after Elective Abdominal Surgery. Can it Be Used to Detect Postoperative Complications?

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Kinetics of Changes in Serum Concentrations of Procalcitonin, Interleukin-6, and C- Reactive Protein after Elective Abdominal Surgery. Can it Be Used to Detect Postoperative Complications?

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A B S T R A C T

Postoperative increase in inflammation biologic markers is associated with a nonspecific inflammatory response to a surgical injury. We investigated the kinetics of changes in serum concentrations of procalcitonin (PCT), C-reactive protein (CRP) and interleukin-6 (IL-6) after abdominal surgeries and we focused on the behaviour of those markers in the case of development of the systemic inflammatory response syndrome (SIRS). In the single centre we conducted a prospective observational study and we included patients admitted to the ICU after elective abdominal surgery. A total of 41 patients were included and 8 (19.5%) of them had clinical and laboratory signs of SIRS. Sepsis was confirmed in one of the patients, a 72-year old patient operated due to having an abdominal aortic aneurysm. Plasma concentrations of PCT, CRP and IL-6 were measured in all the patients before surgery and at the postoperative day 1 (POD1), postoperative day 2 (POD2) and postoperative day 3 (POD3). Systemic release of PCT, CRP and IL-6 was present in all the measured time points after the abdominal surgery. Median concentrations of IL-6 (100.4 pg/mL) and PCT (1, 17 pg/mL) production were measured highest at POD1 and the median of CRP (147 mg/L) was measured at highest POD2. A larger increase of all three measured markers was found in patients with SIRS compared to those without. IL-6 at POD1 and POD 2 was a good predictor of SIRS (areas under curves were 0.71 and 0.765, respectively), showing the highest accuracy among investigated markers at those time points. CRP at POD3 was a good predictor of SIRS (AUC was 0.76). A cut-off of 95 mg/mL in the level of CRP at POD3 yielded a sensitivity of 87.5% and specificity of 66.7% in detecting SIRS. IL-6 and CRP were the best in detecting postoperative SIRS after abdominal surgery with the highest area under ROC curve. This study is showing that PCT is not a good marker of SIRS caused only by surgical injury without sepsis.

***Key words**: C-reactive protein, procalcitonin, interleukin 6, systemic inflammatory response syndrome, postoperative complications, receiver operating characteristic curve*

Introduction

Surgical patients, especially those admitted to the intensive care units after having an abdominal surgery, represent a major diagnostic challenge in terms of identification of possible postoperative complications. Usually, these patients have been subjected to intaoperative procedures that may have induced various degrees of tissue destruction and cytokine production[1–3].

Since clinical symptoms and conventional laboratory markers are not always reliable signs for diagnosis of complications, several biomarkers such as procalcitonin

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(PCT), C-reactive protein (CRP) and interleukin-6 (IL-6) were used as diagnostic tool in these patients[4,5]. Non-specific inflammatory reaction triggered by an injury causes a smaller increase in concentrations of circulating PCT in comparison to the inflammation caused by infectious agents[6].

Surgical and traumatic injuries in different areas of the body induce PCT secretion of a varying degree, and an increase in its serum concentration depends primarily on the extension of the local tissue damage[7–15]. Patients who subsequently died had higher levels of PCT than the survivors[13,14]. The highest increase in PCT serum concentration was determined in patients undergoing abdominal surgery[10]. These conditions are associated with the risk of damaging the intestinal barrier and the possibility of bacterial contamination or translocation resulting in endotoxemia. The prevailing opinion is that the penetration of endotoxins and other microbial products into the bloodstream is responsible for the increased secretion of PCT under such circumstances[8,16–18]. CRP levels increase postoperatively in patients undergoing abdominal surgery especially in those who suffered an infective complication[4,5]. Levels of IL-6 also increase postoperatively and are probably related to the extents of tissue trauma[19]. The purpose of this study was to determine the kinetics of changes in serum concentrations of PCT, CRP and IL-6 after an abdominal surgery with the emphasis on the behaviour of these markers in the cases of development postoperative SIRS as a result of a surgical injury or sepsis.

Subjects and Methods

The prospective observational study included patients older than 18 years old, ASA status II-III, who underwent planned abdominal surgery due to malignant or non-malignant diseases of the digestive organs or obstruction of large blood vessels. Patients with clinically or microbiologically confirmed infection or suspected infection were not included, and the patients in whom the infection had been determined during surgery were excluded. Patients were followed for 4 postoperative days.

The preoperative care of the patients was at discretion of primary anesthesiologist and surgeon. All the patients received balanced general anaesthesia, and the usual preoperative antimicrobial prophylaxis. The replacement of fluid and intraoperative blood transfusions depended on the actual losses and the hemodynamic status of the patients, and were managed by anesthesiologist in charge of the case. Postoperatively, all patients were admitted to the intensive care unit, where they were kept from 24 to 72 hours, or longer in case of severe postoperative complications.

Postoperative complications were consisted if the patient developed surgical wound infection, SIRS, sepsis and multiple organ disfunction syndrome (MODS). The diagnosis of infection was based on Centers for Disease Control and Prevention (CDC)criteria, while the SIRS and sepsis were based on American College of Chest Physicians/Society of Critical Care Medicine (ACCP/SCCM) consensus[20,21]. SIRS was diagnosed if at least 2 of 4 SIRS criteria were present (tachycardia, tachypnea, hyperpyrexia, leukocytosis), and sepsis was diagnosed based on the presence of SIRS and clinically or microbiologically documented infection.

Methods of measuring PCT and IL-6

Samples of venous blood for determining the concentration of PCT, IL-6 and CRP were collected immediately before the surgery (0 time), and at the postoperative day 1 (POD1), postoperative day 2 (POD2) and postoperative day 3 (POD3). The CRP serum concentrations was determined daily as a part of routine laboratory measurements (immunoturbidimetric assay, Olympus). Blood samples for PCT and IL-6 determination were centrifuged, and serum was kept at –20 °C prior to measurement. PCT was measured with immunoluminometric assay, using 2 antigen-specific monoclonal antibodies (LUMItest PCT, B.R.A.H.M.S. Diagnostika, Berlin, Germany). Test sensitivity for detecting PCT levels was 0.1 ng/mL, while the threshold of the reference range was 0.5 ng/mL. IL-6 serum concentrations were determined using a commercial test from R & D Systems, Inc (Quantikine, Human IL-6 Immunoassay) based on the quantitative »sandwich« immunoenzyme technique with monoclonal antibodies specific for IL-6. The upper limit of reference range for IL-6 is 41 pg/mL.

Statistics

The measurement results are described in basic measures of mean and dispersion depending on the normality of distribution. Normally distributed variables are presented by arithmetic mean and standard deviation, and the variables not normally distributed by median and range. Nominal indicators are shown in the frequency distribution of the groups.

Friedman test was used to evaluate differences between more than two dependent samples for repeated measurements and variables that are not normally distributed, Mann-Whitney test was used for determining the difference between more than two independent samples, while Spearman (rho) test was used for determining the association between variables that are not normally distributed. To assess the significance of the results, the level of significance $\alpha = 0.01$ was chosen. Data were analyzed by statistical methods of examining the differences and correlations using SPSS 17.0 (SPSS Inc., Chicago, IL, USA). Receiver operating characteristic (ROC) curve analysis was performed using MedCalc 11.5.0.

Results

The study involved 41 patients, 27 (66%) men and 14 (34%) women, mean age 60.7 (+13.9) years. Over 80% of the patients underwent surgery for malignant diseases of the digestive organs. In 67.9% of the patients with digestive organ diseases inestinal resection was performed. Intraoperative complications, including hypotension (de-

fined as a blood pressure drop below 90/60 mmHg) with tachycardia (defined as a heart rate faster than 100 bpm) as a result of hypovolaemia, occurred in 49.08% of the patients. Within this group, 18 underwent surgery for resection of gastrointentinal tumors, and two were subjected to major vascular surgery (thrombectomy and resection of abdominal aortic aneurysm). Heavy blood loss was the reason for hemodynamic instability in 5 patients. Within this subgroup there were 2 patients (subjected to pancreatectomy due to pancreatic cancer) who had died the second day after the surgery as a result of a massive hemorrhage.

Clinical picture of SIRS, exhibited by tachycardia and leukocytosis, was developed in 8 of the patients, within 24 or 48 hours after the surgery. Sepsis was confirmed in a 72-year old patient after abdominal aortic aneurysm resection. The patient was hemodynamically unstable during and immediately after the surgery, and developed a clinical picture of SIRS 24 hours later, which then evolved into a severe sepsis and MODS within 72 hours. In the remaining 38 patients no clinical signs of infection were noted during the observation period.

Kinetics of changes in serum concentrations of PCT, IL-6 and CRP after elective abdominal surgery

The serum concentrations of PCT, IL-6 and CRP increased postoperatively. Before surgery, the concentration of PCT in all patients was within the reference range (<0.5 ng/mL), IL-6 concentrations (>41 pg/mL) were increased in four patients, and CRP (>5 mg/L) in 20 patients (Figure 1).

After the surgery, there was an increase in PCT, IL-6 and CRP concentrations in all subjects. The highest values of PCT and IL-6 (median 1.17 ng/mL and 100.4 pg/mL, respectively) were measured at POD1 while CRP levels peaked at POD2 (median 147 mg/L).

During the POD2 and POD3, the concentrations of PCT in the majority of the respondents displayed a decreasing trend, but the concentrations (median 0.71 and 0.63 ng/ml) remained higher than at baseline ($p<0.001$).

The serum IL-6 concentrations displayed a similar dynamic. During the POD2 and the POD3, IL-6 decreased in almost all subjects, but the values measured at these time-points (median, 25.5, IQR 17.5–71.7 and 14.6 pg/mL, IQR 8.5–27) were still higher than at baseline ($p<0.001$). During the POD3 most of the patients had a decrease in the concentration of CRP when compared to POD2 values (median 75.9 mg/L compared to135.2 mg/L, $p<0.001$). However, this value is still significantly higher than at baseline (median 75.9 mg/L compared to 6.8 mg/L, $p<0.001$).

A sudden increase in PCT was determined at POD3 in a 72-year-old patient, who underwent abdominal aortic reconstruction due to aneurysm. The baseline value of PCT was 0.09 ng/mL, POD2 and POD3 it read 0.85 and 0.84 ng/mL, and after 72 hours it was at 11.97 ng/mL. The concentration of CRP increased from the initial value of 3.1 mg/L to 137.2 mg/mL, and then to 210.6, i. e. 250.3 mg/L. The initial value of IL-6 was 10.5 pg/mL, after 24 hours it was 146.1 pg/mL, followed by 270.6 pg/mL after 24 hours, and finally 1219.5 pg/mL after 72 hours. Patient experienced intraoperative hemodynamic instability due to massive blood loss. After the surgery he developed a clinical picture of SIRS, which then progressed to severe (microbiologically confirmed) sepsis and MODS, resulting in patient's death within a week after the surgery.

Kinetics of CRP, IL6 and PCT levels and their significance in diagnosis of the SIRS after the elective abdominal surgery

The subjects who developed a clinical picture of SIRS had a higher concentration of PCT, IL-6 and CRP in each measurement time point, compared to the patients without any signs of SIRS. Still, the difference in PCT concentrations were not statistically different ($p=0.095$), IL-6 was significantly different at POD2 ($p=0.02$), and the CRP at POD3 ($p=0.018$) (Table 1).

When comparing the ROC curves, IL-6 at POD1 and POD2 was more accurate then CRP and PCT in the diagnosis of SIRS. However, ROC curve for CRP at POD3 was more accurate than IL-6 and PCT were in the diagnosis of SIRS (Figure 2). ROC curves for PCT in all the measurement points were not accurate in diagnosis of SIRS.

The areas under the curve to assess the accuracy of CRP, IL-6 and PCT in diagnosis of SIRS are shown in Ta-

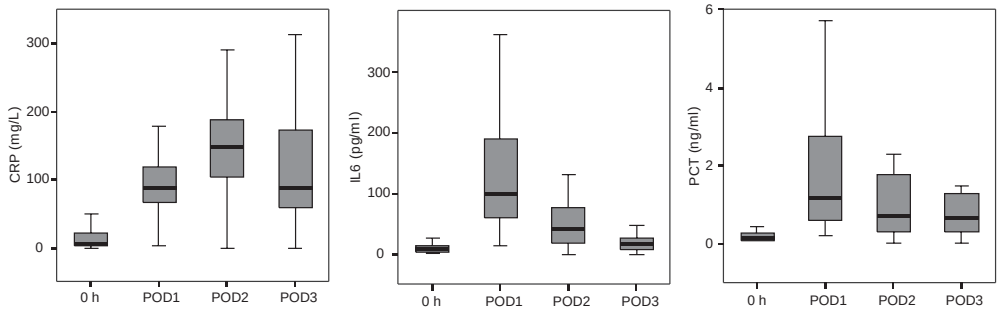

Fig. 1. Box-plot demonstrates changes in serum concentrations of PCT, IL-6 and CRP during (preoperative baseline »0 hours«) and after abdominal surgery (POD1, POD2 and POD3). Data are expressed as medians of measured values from four measurements in all subjects (between group comparisons, Friedman's test, $p<0.001$).

TABLE 1
CRP, IL6 AND PCT LEVELS AND THE SIRS OCCURRENCE

Measurement	CRP			IL-6			PCT		
	SIRS			SIRS			SIRS		
	Yes	No	p†	Yes	No	p†	Yes	No	p†
	M (25%–75%)*	M (25%–75%)		M (25%–75%)	M (25%–75%)		M (25%–75%)	M (25%–75%)	
0	6.1 (2.6–15.6)	6.8 (2.6–27.6)	0.999	10.2 (8.2–13.1)	9.3 (4.9–20.2)	0.885	0.1 (0.08–0.19)	0.2 (0.1–0.3)	0.467
POD1	106.7 (67.4–119.3)	86.1 (65.7–128.6)	0.681	238.9 (113.2–577.1)	98.3 (58–169.4)	0.062	1.8 (0.8–5.2)	1.2 (0.5–2.6)	0.391
POD2	187.3 (120.5–240.5)	135.2 (53.9–149.6)	0.128	71.3 (45.5–221.8)	25.5 (17.5–71.7)	0.020	1.5 (0.7–4.1)	0.7 (0.2–1.6)	0.128
POD3	188 (101.2–213.9)	75.9 (53.9–149.6)	0.018	23.4 (19.5–147.3)	14.6 (8.5–27)	0.084	1.3 (0.5–2.7)	0.5 (0.3–1.1)	0.095

*Median (interquartile range); †Mann Whitney test. Comparison of serum concentrations of C-reactive protein, interleukine-6 and procalcitonin in patients who underwent a major abdominal surgery. Measurement IV shows statistically significant relation between the levels of CRP and the occurrence of SIRS in operated patients (p=0.018). Another statistically significant relation is shown between the levels of IL6 and the occurrence of SIRS (Measurement III) (p=0.020), suggesting a possible predictive role of measuring the levels of CRP and IL6 while evaluating the possibility of SIRS development. (0: before surgery, POD1: postoperative day 1, POD2: postoperative day 2, POD3: postoperative day 3

ble 2. IL-6 is more accurate in detecting of SIRS than the CRP and PCT at POD1 and POD2. IL-6 higher than 100.4 pg/mL at POD1 is a cut-off for predicting SIRS with a sensitivity of 87.75% and specificity of 60.61%. Similarly, a cut-off of 30.7 pg/mL in the IL-6 concentration at POD2 yielded a sensitivity of 100% and a specificity of 54.55% in detecting SIRS. A cut-off of 95.4 mg/L in the CRP value at POD3 yielded sensitivity of 87.5% and specificity of 66.67% in detecting SIRS.

Discussion

We had observed that the IL-6 levels at POD1 and POD2 were significantly increased in patients who developed SIRS after the elective abdominal surgery. The ROC curve analysis confirmed those findings and the value of determining the levels of the IL-6 in diagnosis of SIRS at this early time points after surgery. Similar results were obtained for CRP at later time points after surgery (POD3). However, our results suggest that PCT is not a good biological marker for a sterile postoperative SIRS. A significant number of patients (19.5%) had both clinical and laboratory signs of postoperative SIRS. However, sepsis, SIRS and MOF were observed in a single patient who underwent abdominal aortic aneurysm repair.

Limitations of the study

First, a relatively small number of subjects were taken into consideration, which implies that considerable individual variations affected the ability for statistical comparison. Second, the follow-up time period was too short, leaving an opened possibility that some of the postoperative complications like sepsis, which could have occurred later, were not recorded. Third, individual characteristics of patients, such as comorbidity and their differences in immunoreactivity, as well as the drugs given in the perioperative period, such as antibiotics and immunosuppressants, may had affected the postoperative production of the biological markers tested in this study. Fourth, mode and duration of mechanical ventilation, which were not controlled, could have also affected the rise in pro-inflammatory cytokines. An elective abdominal

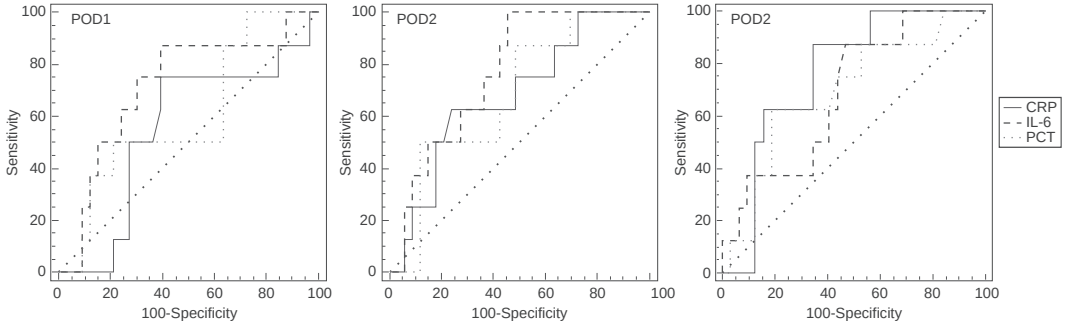

Fig. 2. Comparison of the receiver operating characteristic curves (ROC-curves) showing the relation between sensitivity (true positive) and 100-specificity (true negative) in determining the predictive value of PCT, IL-6 and CRP for the diagnosis of postoperative SIRS.

TABLE 2
COMPARISON OF AREAS UNDER THE RECEIVER OPERATING CHARACTERISTIC CURVE OF CRP, IL-6 AND PCT IN THE DIAGNOSIS OF POSTOPERATIVE SIRS

Measurement	AUC	95% CI	Sensitivity	Specificity	Cut-off
POD1					
CRP	0.547	0.385–0.703	75.0	60.61	>92.0
IL-6	0.716	0.554–0.845	87.5	60.61	>100.4
PCT	0.602	0.438–0.751	50.0	78.79	>2.73
POD2					
CRP	0.676	0.512–0.813	62.5	75.76	>176.8
IL-6	0.765	0.607–0.883	100.0	54.55	>30.7
PCT	0.678	0.514–0.815	87.5	51.52	>0.65
POD3					
CRP	0.762	0.601–0.882	87.5	66.67	>95.4
IL-6	0.689	0.524–0.826	87.5	54.55	>19.2
PCT	0.695	0.530–0.830	62.5	81.25	>1.15

surgery may be a trigger for activation of the inflammatory cascade, making the diagnosis of postoperative complications like SIRS and infection extremely important.

Abdominal surgical procedures are associated with the high risk of developing various perioperative complications. Hypovolemia is common due to the loss and redistribution of fluids, bleeding and damage to the intestinal barrier due to the mechanical injury or intestinal hypoperfusion during surgical manipulation. The latter contributes to the emergence of a bacterial contamination or translocation, and the penetration of the microorganisms and their products into the bloodstream is held responsible for the activation of the immune system and the development of the systemic inflammatory response[17,18]. Primarily, surgical trauma induces an acute phase response, which is capable of controlling tissue damage, killing infective organisms, and inducing repair processes in order to restore normal host function[22]. The serum IL-6 response to surgical injury has been extensively studied and described. In our study we have observed an early peak of IL-6 production after surgery. Similar observation about very early production of IL-6 after surgical trauma which markedly peaks at 4–48 h after surgery has already been reported[23]. The release of IL-6 has been shown to correlate with the type of abdominal surgery related to the extent of tissue trauma[24]. Moreover, the plasma IL-6 level may be a marker of the severity of the disease after the surgery (for example IL-6 level greater than 350 pg/mL was associated with poor prognosis after injury)[25].

CRP has been used for the diagnosis of intraabdominal surgical infection and as a general marker of an unfavourable postoperative course including surgical and nonsurgical complications[26]. Recently it has been shown that CRP may be a marker of abdominal anastomotic leak after a colorectal surgery[27]. Similarly, our data suggest that in critically ill patients, serial measurements of CRP concentrations may help to identify patients who would require more aggressive interventions in order to avoid complications. A transient increase in serum concentrations of PCT was noted in all patients, which is consistent with the observations of other authors[14].

Examining the dynamics of PCT in patients with burn injury, Carsin found that an increase in PCT concentration during the first hours after injury correlated with the percentage of burned skin surface[28]. Mimoz and colleagues found that an increase in PCT in patients with severe trauma is proportional to the extension of tissue injury and the severity of hypovolaemia (expressed by ISS score, serum concentration of LDH, and total volume of infusion solutions and blood applied to the correction of hypovolaemia). Thus mechanical tissue damage and hypovolemia are considered to be the most important incentives for initiating the immune response and secretion of PCT after a traumatic injury[7]. Meisner found a correlation between the initial increase in PCT and the amount of the transfused blood, and a weak correlation between the increase in PCT and the severity of trauma expressed by ISS score[15]. Increased secretion of PCT in a state of SIRS has been reported to indicate the extent and intensity of the inflammatory response[7,8]. However, in this study the observed difference in PCT increase between the patients with SIRS and the ones without any signs of it was not found to be statistically significant, probably due to the small number of subjects and large inter-individual variations. SIRS is expected to occur after severe trauma and extensive surgery with a complicated course, and in most cases it is a transient phenomenon which shows a tendency to a spontaneous recovery. In some patients SIRS can evolve into sepsis. The initial high value of PCT and the progressive or subsequent increase in its concentration, with clinical signs of SIRS, indicates the occurrence of surgical or septic postoperative complications[9,29]. The above described nature of PCT kinetics makes the determination of its serum con-

centration possibly useful in the diagnosis of postoperative septic complications. However, it should be noted that PCT is not a specific marker of an infection and cannot be a substitute for clinical assessment[29–33]. Since the individual non-infectious conditions can induce a significant increase in PCT, it is difficult to distinguish a non-specific SIRS from sepsis on the basis of PCT serum concentration values only[33,34]. Surgical injuries, depending on the location and on the type of the surgery, promote immune activity and secretion of PCT to a varying degree. Therefore, there is no single threshold concentration of PCT which could be used to distinguish a normal from a complicated postoperative course. Different groups of surgical patients correspond to different threshold values[15].

Examining the postoperative kinetics of PCT in cancer patients who underwent major gastrointestinal and gynaecological resection surgery, Mokart and colleagues found that an increase in PCT concentration over 1.1 ng/mL (with signs of SIRS, 24 hours after surgery with a probability of nearly 100%) indicates the occurrence of postoperative septic complications[35]. The results of several clinical studies suggest that the postoperative increase of PCT in the range of 1.5 to 2 ng/mL (from 1 to 3 days after surgery) can serve as an indicator of an increased risk for postoperative complications following intestinal, vascular, and cardiac surgery, while the PCT concentration values below 1.5 or 2 ng/mL makes the risk of complications less probable[11,15]. Our results are in accordance with the above quoted. Median PCT concentrations 24 hours after surgery in patients without SIRS was 1.2 (IQR 0.5 to 2.6) ng/mL, while in those with signs of SIRS the median was 1.8 (IQR 0.8 to 5.2) ng/mL.

Test results should always be interpreted together with clinical picture. Clinician should also take into account the nature and location of surgery, characteristics of patients (comorbidities), and medications administered in the perioperative period. The exact diagnosis of sepsis can only be established when increased PCT values and the presence of SIRS signs are supported by the clinical or microbiological evidence of infection[32].
We found unexpectedly high values of PCT in some patients, which had a normal postoperative course according to clinical assessment, and no signs of SIRS or sepsis.

It is plausible that the increased secretion of PCT in these patients was most likely triggered by a transient endotoxaemia as a consequence of a bacterial translocation or contamination, which was not accompanied by other clinical and laboratory changes. Patients were monitored in the intensive care unit the first 3 to 4 days, and it is possible that we may not have noticed some of the postoperative complications that could develop after that time. According to literature, early non-infectious complications (anastomotic insufficiency) usually occur within the first 3 days, and septic between the third and the fifth day after surgery[9,29].

The prevailing opinion is that endotoxemia associated with bacterial translocation or contamination is the most important inducer of postoperative SIRS and increased secretion of PCT after severe trauma and major surgery in the abdomen[13]. However, the results of clinical studies on the effect of endotoxaemia on the secretion of PCT are rather contradictory. Carsin failed to prove that the presence of endotoxins in the blood of the patients who suffered burns affects the secretion and release of PCT and IL-6, whereas the results of recent research support the hypothesis about the role of endotoxins and other microbial products in the activation of the immune response and induction of extrathyroid secretion of PCT[17,18,28].

As already mentioned, this research does have some apparent shortcomings (a small number of subjects, too short follow-up time) A research with a larger number of patients that would be observed over an extended period of time (at least for 7 to 14 days) should be conducted, which would allow a more accurate record of the possible postoperative complications.

Conclusion

IL-6 and CRP are markers of general inflammation. The increase in serum concentration of these markers correlates with the extent and the intensity of the inflammatory response. The largest increase in PCT occurs during invasive bacterial infections, while traumatic and surgical injuries cause a temporary increase of PCT within the acute-phase response. In our study the increase of PCT was not statistically significant, and cannot be used in differentiating patients with sepsis. Isolated mechanical injury and conditions associated with hypoxia, hypoperfusion, and massive blood loss with blood and blood product replacement may result in slight to moderate increase in serum PCT, while trauma and surgical procedures associated with the risk of endotoxemia will, regardless of the infection, contribute to a larger increase in the PCT.

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DINAMIKA I ZNAČAJ PROMJENA SERUMSKIH KONCENTRACIJA PROKALCITONINA, INTERLEUKINA-6 I C-REAKTIVNOG PROTEINA NAKON ABDOMINALNIH KIRURŠKIH OPERACIJA

S A Ž E T A K

Postoperativno povećanje serumskih koncentracija upalnih bioloških markera povezuje se s nespecifičnim upalnim odgovorom na kiruršku ozljedu. U našem istraživanju proučavali smo dinamiku promjena serumskih koncentracija prokalcitonina (PCT), C-reaktivnog proteina (CRP) i interleukina-6 (IL-6) nakon elektivnih abdominalnih operacija s naglaskom na ponašanje ovh markera u slučaju razvoja sindroma sistemskog upalnog odgovora (SIRS, od engl. Systemic inflammatory response syndrome). Prospektivna opservacijska studija provedena u našem kliničkom bolničkom centru uključivala je pacijente koji su nakon elektivnih abdominalnih operacija bili primljeni na jedinicu intenzivnog liječenja. Ukupno su razmotrena 41 bolesnika, od kojih je 8 (19,5%) pokazivalo znakove SIRS-a. Sepsa je utvrđena u samo jednog bolesnika, 72-godišnjaka hospitaliziranog nakon operacije abdominalne aortalne aneurizme. Serumske koncentracije PCT, CRP i IL-6 mjerene su u svih ispitanika prije operacije, te u tri navrata nakon operacije, i to tijekom prvog (POD1), drugog (POD2) i trećeg (POD3) postoperativnog dana. Tijekom svih mjerenja koja su uslijedila nakon abdominalne operacije zabilježeno je oslobađanje spomenutih markera u serum. Najveći medijani sekrecije za IL-6 (100,4 pg/mL) te za PCT (1,17pg/mL) zabilježeni su tijekom POD1 mjerenja, dok je za CRP najveći medijan izmjeren tijekom POD2 mjerenja (147 mg/mL). U pacijenata sa SIRS-om utvrđeno je veće povećanje u koncentraciji sva tri markera nego u onih bez sindroma sustavnog upalnog odgovora. IL-6 se tijekom POD1 i POD2 pokazao kao dobar predskazatelj mogućeg razvoja SIRS-a (područja ispod ROC-krivulje (AUC, prema engl. Area under curve) iznosila su 0,71 za POD1 te 0,765 za POD2), pokazujući najveću točnost među trima ispitanim markerima tijekom prva dva postoperativna dana. Mjerenje razina CRP-a tijekom POD3 također se pokazalo prediktivnima s obzirom na razvoj SIRS-a (AUC je iznosio 0,76). Prag od 95mg/ml za razine CRP-a tijekom POD3 polučio je osjetljivost od 87,5% te specifičnost od 66,7% pri otkrivanju SIRS-a. Razine IL-6 i CRP tijekom navedenih mjerenja pokazale su se kao dobri predskazatelji razvoja SIRS-a, za razliku od PCT-a, koji se tijekom ove studije nije pokazao kao dobar marker za otkrivanje SIRS-a uzrokovanog isključivo kirurškom ozljedom.