

Expression and prognostic relevance of CRP, PCT, and Il-15 in patients with postoperative infection due to spinal injury

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ABSTRACT

C-reactive protein (CRP), procalcitonin (PCT), interleukin-15 (Il-15) expression and prognostic relevance were analyzed in patients with postoperative infection due to spinal injury. For this purpose, a total of 169 cases of spinal injury patients who underwent surgical treatment from July 2021 to July 2022 were selected, and the patients were divided into the uninfected group (148 cases), infected group (21 cases) according to the presence or absence of infection after surgery. Looking at the site of infection in both groups, the levels of CRP, PCT, and Il-15 in the two groups were detected using an enzyme-linked immunosorbent assay, and the expression of the three in postoperative infection of spinal injury and the correlation with prognosis were analyzed. Results showed that compared with the uninfected group, the infected group had higher levels of CRP, PCT, and Il-15, which were different ($P < 0.05$). There were no significant differences in the CRP levels between the superficial infection of the incision and the deep infection of the incision as well as other systemic infection populations at 1 d after surgery ($P > 0.05$). CRP levels were higher in the group with deep infection of the incision as well as other systemic infections compared to the group with superficial infection at 3D and 7d after surgery ($P < 0.05$). There were no significant differences in the level of PCT between patients with superficial infection of the incision and those with deep infection of the incision as well as other systemic infections at 1 d after surgery ($P > 0.05$). The level of PCT was higher in the population with deep infection of incision as well as other systemic infections compared to the population with superficial infection at 3D and 7d after the operation ($P < 0.05$). There were no statistically significant differences in the levels of Il-15 between patients with superficial infection of the incision and those with deep infection of the incision as well as other systemic infections at 1 D postoperatively ($P > 0.05$). At 3D and 7d postoperatively, compared to the population with superficial incisions, the population with deep incisions as well as other systemic infections had higher levels of Il-15 with statistical significance ($P < 0.05$). CRP and PCT showed a positive correlation ($r = 7.192$, $P = 0.001$). CRP, Il-15 showed a positive correlation ($r = 5.231$, $P = 0.001$). PCT, Il-15 showed a positive correlation ($r = 9.029$, $P = 0.001$). CRP, PCT, Il-15 levels are closely related to postoperative infection in spinal injury. CRP, PCT, Il-15 showed high expression in postoperative infection of spinal injury and compared with the infection of the superficial part of the incision, the infection of the deep part of the incision, other systems have higher levels of CRP, PCT, Il-15. Moreover, CRP, PCT, and Il-15 were significantly associated with prognosis.

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Introduction

With the gradual increase in traffic and high fall accidents in recent years, there has been a rising trend of spinal injury disorders. The current clinical treatment of spinal injuries is surgical therapy, which has better clinical efficacy and more direct therapeutic effects, with a high clinical application rate (1,2). However, surgical treatment is often followed by various degrees of infection. When infections occur in the body, they can seriously affect the recovery and treatment outcome after surgery. Despite increasingly sophisticated perioperative prophylaxis in recent years, postoperative infections still sometimes occur (3). Some clinical scholars have noted in their studies that spinal infections are more devastating because of the proximity of spinal surgery to neurological structures. Therefore, early detection and analysis of infection are particularly impor-

tant. It is often difficult to diagnose post-spinal surgical infections and inflammatory factors are important serum indicators in their diagnosis of post-spinal infections (4). Some scholars have pointed out that serum inflammatory indicators such as CRP and PCT are easier to detect, but their clinical specificity is not high (5,6). The diagnostic value of the combined CRP, PCT, and IL-15 test for postoperative infection after the spinal injury has not been noted. Based on this, patients with postoperative infection after spinal injury were selected in this study to analyze the expression and prognosis of CRP, PCT, and IL-15 in postoperative infection after spinal injury.

Materials and Methods

Subjects: 169 patients with a spinal injury who underwent surgical treatment in our hospital from July 2021 to

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July 2022 were selected, and were divided into the uninfected group (148 cases) and the infected group (21 cases) according to the presence or absence of postoperative infection. The uninfected group included 86 males and 62 females, whose ages ranged from 35 to 71 years, with a mean of (53.1±14.3) years, and body mass index (BMI) varied from 21 to 26 kg/m², with a mean of (23.5±2.1) kg/m². The infected group included 13 males and 8 females, whose ages ranged from 36 to 70 years, with a mean of (53.1±13.4) years, and body mass (BMI) varied from 20 to 26 kg/m², with a mean of (23.6±2.0) kg/m². The comparison of baseline information between the two populations was comparable with no significant difference ($P > 0.05$).

Inclusion criteria: all enrolled populations were treated surgically in our hospital; the infected population all met the diagnostic criteria for postoperative infections in the Diagnostic Criteria for Hospital Infections (Trial) (7) and were confirmed by pathological diagnosis; the patients and their families were informed about this study and signed the informed notice.

Exclusion criteria: those with heart and lung organ insufficiency before surgery; those with combined autoimmune diseases; those with combined language impairment and poor compliance, unable to better cooperate with treatment and investigation.

Infection part detection

The postoperative infection sites were statistically analyzed by specialized medical staff, which mainly included superficial incisional patches, deep incisional areas, and other systemic parts of the infection.

Serum extraction

5 ml of fasting elbow venous blood was extracted from the enrolled population before, 3 d and 5 d after surgery. The supernatant was extracted after centrifugation at 3000 r/min for 15 min and stored at -40°C for use.

Analysis of indicators

Serum CRP, PCT, and IL-15 levels were measured using ELISA. After the sera were left at room temperature, the enzyme plates were labeled and then standards were made. Subsequently, the kit was selected and the

samples were diluted at one to two dilutions. The reaction wells were sequentially added with the diluted serum to be tested and standards 100 µl/well, followed by placing in a 37°C incubator for two hours of wet incubation, followed by using a special washing solution for the reaction plate, then adding antibody working solution (after 1:100 times dilution) 100 µl/well, placing in a 37°C constant temperature incubator for 45 min wet incubation, and finally adding termination solution 100 µl/well to terminate the reaction. The absorbance was measured at 450 nm. The color response was proportional to the levels of CRP, PCT and IL-15. The levels of CRP, PCT and IL-15 were calculated by plotting the standard curve.

Statistical processing

Data analysis was performed using SPSS 25.0. The measures were tested for chi-square by the Levene method, Shapiro-wilk test for normality, and expressed as mean ± standard deviation ($\bar{x} \pm s$). Independent samples t-test was compared between two groups at the same time point, and the F-group test was performed between multiple groups. The counts were expressed as rates (%) using the χ^2 test. Differences were considered statistically significant at $P < 0.05$.

Results

Analysis of CRP, PCT and IL-15 levels in the two groups

The levels of CRP, PCT, and IL-15 were higher in the infected group compared with the uninfected group, with statistical differences ($P < 0.05$), as shown in Table 1.

Analysis of CRP levels in different infection situations at different periods

There was no statistical difference in CRP levels at 1 d postoperatively compared to the superficial incisional infection, deep incisional infection, and other systemic infection populations ($P > 0.05$). The CRP levels were higher in the deep incisional infection as well as other systemic infection populations compared to the superficial incisional population at 3 d and 7 d postoperatively, with statistical differences ($P < 0.05$), as shown in Table 2.

Table 1. Analysis of CRP, PCT, and IL-15 levels in the two groups.

Group	Number of cases (n)	CRP (mg/L)	PCT (ng/ml)	IL-15 (ng/L)
Uninfected group	148	5.19±0.31	0.02±0.01	18.21±1.28
Infected group	21	35.10±2.36	0.29±0.03	53.29±3.10
t		18.291	9.103	11.182
P		0.001	0.001	0.001

Table 2. Analysis of CRP levels in different infection situations at different time periods [$(\bar{x} \pm s)$, (mg/L)].

Site of infection	Number of cases (n)	Postoperative 1d	Postoperative 3d	Postoperative 7d
Superficial incision	3	34.19±3.14	43.19±4.21	39.10±3.11
Deep incision	12	34.21±3.19	48.12±4.37	44.29±3.01
Other systems	6	34.15±3.21	53.19±5.92	47.20±3.15
F		0.912	10.281	10.124
P		0.318	0.001	0.001

Analysis of PCT levels in different infection situations at different periods

There was no statistical difference in PCT levels at 1 d postoperatively compared to the superficial incisional infection, deep incisional infection, and other systemic infection populations ($P > 0.05$); The PCT levels were higher in the deep incisional infection and other systemic infection populations at 3 d and 7 d postoperatively compared to the superficial incisional population, with statistical differences ($P < 0.05$), as shown in Table 3.

Analysis of IL-15 levels in different infection situations at different periods

There was no statistical difference in IL-15 levels at 1 d postoperatively compared to the superficial incisional infection, deep incisional infection, and other systemic infection populations ($P > 0.05$). The IL-15 levels were statistically different in the deep incision infection as well as the other systemic infections population at 3 d and 7 d postoperatively compared to the superficial incision population ($P < 0.05$), as shown in Table 4.

Correlation analysis of CRP, PCT, IL-15

CRP, PCT showed a positive correlation ($r=7.192$, $P=0.001$); CRP, IL-15 showed a positive correlation ($r=5.231$, $P=0.001$); PCT, IL-15 showed a positive correlation ($r=9.029$, $P=0.001$), as shown in Figure 1.

Analysis of the relationship between CRP, PCT, IL-15 and prognosis

CRP, PCT, and IL-15 levels were strongly correlated with the prognosis of postoperative infection after spinal injury, as shown in Table 5.

Discussion

Infection after spinal injury surgery often leads to a

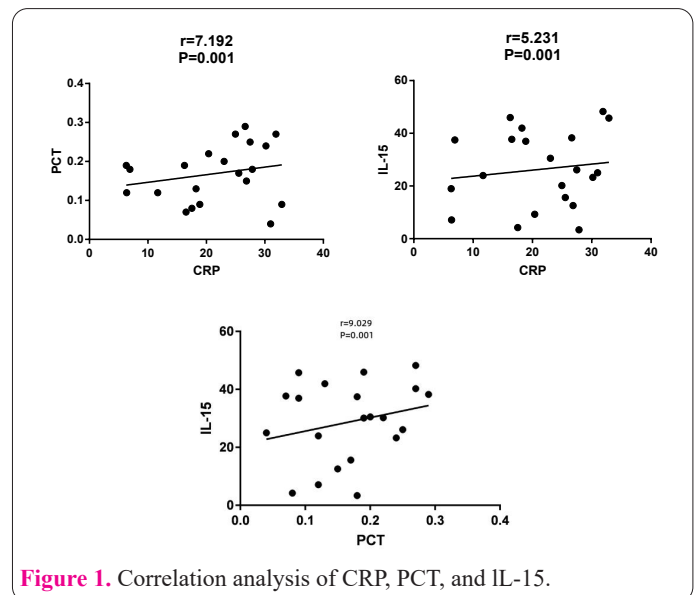


Figure 1. Correlation analysis of CRP, PCT, and IL-15.

series of complications that prolong the patient's hospital stay and hospitalization costs, as well as reduce the patient's quality of life and cause psychological and physical damage to the patient and family. Clinical investigations have shown that there are various factors associated with the development of infection after spinal injury surgery, such as age, obesity, smoking, and surgical access (8). It is currently stated that the use of prophylactic antibiotics during lumbar spine surgery can reduce the rate of postoperative infection in patients, but the appropriate duration of this prophylactic antibiotic use is still a matter of debate (9).

It has been noted in clinical studies that laboratory parameters, such as CRP levels, have been used in the assessment of postoperative occurrence, but the prediction of postoperative infection in patients remains somewhat controversial (10,11). In normal human serum,

Table 3. Analysis of PCT levels in different infection situations at different periods [$(\bar{x} \pm s)$, (ng/ml)].

Site of infection	Number of cases (n)	Postoperative 1d	Postoperative 3d	Postoperative 7d
Superficial incision	3	0.35±0.03	0.53±0.04	0.43±0.03
Deep incision	12	0.33±0.03	0.59±0.07	0.47±0.05
Other systems	6	0.35±0.02	0.65±0.07	0.54±0.06
F		0.016	9.128	7.193
P		0.059	0.001	0.001

Table 4. Analysis of PCT levels in different infection situations at different periods [$(\bar{x} \pm s)$, (ng/ml)].

Site of infection	Number of cases (n)	Postoperative 1d	Postoperative 3d	Postoperative 7d
Superficial incision	3	49.10±4.39	57.10±5.02	50.10±5.24
Deep incision	12	49.12±4.34	65.28±5.10	55.12±5.92
Other systems	6	49.09±4.41	71.23±5.19	62.19±5.29
t		0.029	6.219	9.012
P		0.061	0.001	0.001

Table 5. Analysis of the relationship between CRP, PCT, IL-15 and prognosis.

Item	Risk Coefficient	95%CI	P
CRP	1.231	1.021~2.104	0.001
PCT	1.284	1.034~2.315	0.001
IL-15	1.195	1.016~2.129	0.001

the concentration of CRP is usually at 1 mg/dL, which increases slightly with age. However, CRP tends to rise abnormally after tissue damage, surgery or infection (12). Clinical investigations have revealed that the possibility of wound infection in the body should be considered if there is a sustained or secondary increase in CRP levels about 1 week after surgery (13,14). In this study, we found that serum CRP levels increased abnormally in patients with spinal injuries when they developed infections after surgery. Moreover, the CRP levels were higher in deep incisional infections and other systemic infections compared to superficial incisional infections.

PCT is present in the C cells of the thyroid gland which is closely associated with the human host response to bacterial infection. Clinical investigations have shown that PCT is aberrantly expressed in sepsis as well as in bacterial infections, where it is present in the endotoxin response. Some pro-inflammatory mediators as well as concentrations show a linear relationship with the degree of damage (15,16). In previous studies, PCT was considered to be selectively responsive to systemic bacterial, fungal, and parasitic infections, with a high specificity and sensitivity to systemic infections (17,18). Based on this, PCT was selected for testing in this paper. It was found that PCT showed an abnormal increase in the serum of patients who developed the infection after spinal injury surgery. Moreover, the CRP levels were higher in deep incisional infections and other systemic infections compared to superficial incisional infections.

IL-15, which has a molecular mass of 14.4ku after maturation, belongs to a family of helical cytokines with a four-level helix structure. The human IL-15 gene is approximately 34 kb in length and is located on chromosome 4q31, with nine exons. Clinical studies have demonstrated that IL-15 combined with cytokines derived from other monocytes/macrophages can effectively enhance the toxic activity of NK cells, which play an important role in the early defense of the host against viral infection and malignant transformation, suggesting that IL-15 can efficiently enhance the immunity of the host (19,20). It has been noted in studies that IL-15 is closely associated with intracellular infection in human herpesvirus infection, EBV, and cells, suggesting that IL-15 is closely associated with infection in the organism (21,22). In this paper, we found that IL-15 showed an abnormal increase in the serum of patients who developed infections after spinal injury surgery. In addition, IL-15 levels were higher in deep incisional infections and other systemic infections compared to superficial incisional infections. Moreover, CRP, PCT, and IL-15 were closely related to the prognosis of infection after spinal injury surgery.

In summary, CRP, PCT, and IL-15 showed high expression in postoperative infections after spinal injury. In addition, the levels of CRP, PCT, and IL-15 were higher in deep incisional infections and other systemic infections in the organism compared with superficial incisional infections. Moreover, CRP, PCT, and IL-15 were closely correlated with prognostic correlation.

Acknowledgments

Not applicable.

Interest conflict

The authors declare that they have no conflict of interest.

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