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## ORIGINAL ARTICLE

# Diagnostic Value of Serum Procalcitonin in Early Infection after Internal Fixation for Traumatic Fracture

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**SUMMARY**

***Background:*** **This study aimed to observe the changes of serum procalcitonin (PCT) and C-reactive protein (CRP) concentrations after internal fixation for traumatic fracture and to discuss the diagnostic value of these two indicators in early infection after internal fixation for traumatic fracture.**
***Methods:*** **Patients who received internal fixation for traumatic fracture at our hospital from June 2014 to December 2016 were included. They were divided into infection group (12 cases) and non-infection group (166 cases), depending on whether infection occurred. Venous blood samples were collected from cases in both groups on day 1, day 4, and day 9 after surgery. Changes in PCT and CRP levels were detected at different time points.**
***Results:*** **As compared with the non-infection group, PCT and CRP levels were significantly increased at each time point after surgery in the infection group. The sensitivity of PCT combined with CRP in the detection of early infection after surgery was higher than that of either used alone.**
***Conclusions:*** **The serum PCT level can be used as an early diagnostic indicator of infection after internal fixation for traumatic fracture. The combined use of PCR and CRP levels can increase the sensitivity of detection.**
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**KEY WORDS**

traumatic fracture, infection, procalcitonin, C-reactive protein

## INTRODUCTION

Infection is a common and severe complication after internal fixation for traumatic fracture. Mild infection may lead to delayed fracture healing, malunion or osteomyelitis; some severe cases may require amputation or develop toxemia and septicemia that are life threatening. Internal fixture as a foreign body does not respond to systemic use of antibiotics following infection. If the infection is not properly controlled, it may be necessary to remove the internal fixture with clearance of focal lesions. This will be followed by secondary surgery once the infection is under control. Treatments are very complex for infection after internal fixation for traumatic fracture and bring a huge economic and psychological burden to the patients. More importantly, outcomes of secondary surgery are usually less satisfactory compar-

ed to the primary surgery. Therefore, early discovery and diagnosis of infection after internal fixation for traumatic fracture are hotspots of research.

A search for easy and feasible infection evaluation indicators is of high diagnostic and prognostic value for early infection after internal fixation for traumatic fracture. At present, the major indicators include body temperature, routine blood test, C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR). However, these indicators have poor specificity and sensitivity. Their increase is not only observed after bacterial infection, but also after surgery, in viral infection, and other non-infection conditions. These indicators usually remain at a high level even several days after the infection is under control, so they cannot reflect the severity and prognosis of infection [1].

Procalcitonin (PCT), a precursor of calcitonin, remains at a very low level in the serum under normal conditions. However, the serum PCT level will increase considerably in bacterial infection, especially severe bacterial infection and sepsis. Its level is closely related to severity of the disease. However, serum PCT levels will not increase or only increase mildly in viral infection or infection caused by other pathogens [2]. Many reports on PCT have been published recently, and serum PCT levels are considered to be highly valuable in diagnosis of bacterial infection [3]. Serum PCT levels can also facilitate determination of the severity of the disease and prognostic prediction. The higher the serum PCT level, the more severe the disease is; a sustained increase of PCT levels usually predicts a poor prognosis [4,5]. An obvious reduction in the serum PCT level indicates the effectiveness of the treatment [6]. The serum PCT level will increase in bacterial infection; it is detectable at an early stage of infection, with a long half-life and high stability. PCT detection is now widely used in clinical practice. We studied the patients who received internal fixation for traumatic fracture from June 2014 to December 2016 and discussed the diagnostic value of PCT and CRP levels in early infection after internal fixation for traumatic fracture.

## MATERIALS AND METHODS

### Subjects

Patients who received internal fixation for traumatic fracture at our hospital from June 2014 to December 2016 were included. They were divided into infection group (12 cases) and non-infection group (166 cases), depending on whether infection occurred. The two groups were comparable in gender distribution and age.

### PCT level detection

Serum PCT levels were detected using a chemiluminescence method, and the normal range was set to 0 - 0.5 ng/mL. Bacterial infection was indicated when PCT $\geq$ 0.5 ng/mL, and bacterial infection was negative when PCT < 0.5 ng/mL.

### CRP level detection

CRP levels were determined using an immunoturbidimetric assay, with normal range set to 0 - 8 mg/L. CRP $\geq$ 8 mg/L indicated bacterial infection, and CRP < 8 mg/L indicated no bacterial infection.

### Observation indicators

Changes in PCT and CRP levels were detected at day 1, day 4, and day 9 after surgery. The sensitivity and specificity of the two indicators were compared in the two groups. The diagnostic value of PCT and CRP levels in early infection after internal fixation for traumatic fracture was discussed.

### Statistical analysis

SPSS 17.0 software was used for statistical analysis. $P < 0.05$ indicated a significant difference.

## RESULTS

### Comparison of serum PCT and CRP levels after surgery between the two groups

As compared with day 1 after surgery, PCT and CRP levels increased considerably at day 4 and day 9 after surgery in the infection group ($p < 0.05$). See Table 1.

### Sensitivity and specificity of serum PCT levels or CRP levels used alone or in combination at day 4 after surgery

The sensitivity of serum PCT and CRP levels used alone was 84.6% and 76.0%, respectively. The sensitivity of the two indicators used in combination was 82.3%. The sensitivity of the combined use of two indicators increased considerably as compared with that of either indicator used alone. The specificity of the two indicators used alone was 95.3% and 89.4%, respectively. The specificity of the two indicators used in combination was 98.2%. Thus, the specificity of the two indicators used in combination increased significantly as compared with that of either indicator used alone (Table 2).

## DISCUSSION

Infection is a common and severe complication after internal fixation for bone fracture. Mild cases of infection may suffer from delayed fracture healing and prolonged hospital stay. This not only increases the economic burden for patients, but also brings about the risk of disability. Perioperative antibiotics as preventive measures can reduce the incidence of infection; but the preventive use of antibiotics may conceal early symptoms and increase the difficulty in diagnosis of infection. Once the infection occurs, it is necessary to remove the internal fixture, which may be hardly acceptable for patients. Early detection and severity evaluation of bacterial infection are long-standing problems. A laboratory test is

**Table 1. Comparison of serum levels of PCT and CRP between infection group and non-infection group.**

| | Time (day) | PCT (μg/L) | CRP (mg/L) |
|---|---|---|---|
| Infection group | 1 | 1.32 ± 0.72 | 85.25 ± 28.40 |
| | 4 | 3.26 ± 1.25 | 124.50 ± 30.32 |
| | 9 | 2.34 ± 0.98 | 91.00 ± 32.85 |
| Non-infection group | 1 | 0.85 ± 0.56 | 43.18 ± 17.08 |
| | 4 | 0.62 ± 0.43 | 29.36 ± 15.21 |
| | 9 | 0.35 ± 0.23 | 18.01 ± 9.87 |

**Table 2. The sensitivity (%) and specificity (%) of separate and combined diagnosis of PCT and CRP in the diagnosis of infection after internal fixation of traumatic fracture.**

| | Sensitivity (%) | Specificity (%) |
|---|---|---|
| PCT | 84.6 | 95.3 |
| CRP | 76.9 | 89.4 |
| PCT + CRP | 92.3 | 98.2 |

most commonly used for the diagnosis of infection after internal fixation for traumatic fracture, based on white blood cell count (WBC), interleukin-1 (IL-1), IL-6, and IL-8 [7]. WBC is the most commonly used inflammatory markers. Considered the first defense against infection by pathogenic microorganisms, WBC plays a very important role in non-specific immunity. Its increase is usually used to determine the onset of infectious diseases and it may indicate bacterial infection, but no viral infection. However, WBC is affected by many factors, including treatments, physiological stress, and immune factors. WBC does not reflect the status of the disease. In some severe cases of bacterial infection, WBC decreases rather than increases. In other words, the specificity and sensitivity of WBC are limited [8].

C-reactive protein (CRP) is part of the non-specific immune system. It is an acute phase protein synthesized in the liver due to stress. The increase in CRP levels generally indicates infection and inflammation [9,10], and it occurs in specific and non-specific infection, surgery, viral infection, local bacterial infection, and non-infectious conditions. The degree of increase varies from one individual to another, and CRP levels may remain high even several days after the infection is under control [11]. Although CRP is a diagnostic indicator of infection, it cannot reflect the severity of infection, and, therefore, it has limited prognostic value. CRP levels may increase under the following conditions as well: severe viral infections, mycoplasma infections, acute rejection, cardiovascular diseases, autoimmune rheumatic diseases, acute trauma, surgery, or advanced cancer. Therefore, CRP levels alone also have limitations in the diagnosis of bacterial infection [12].

PCT levels will increase dramatically in bacterial infections, but not in viral infections. This feature can be used for the diagnosis and differential diagnosis of bacterial infection [13]. PCT level detection is widely applied at present, and PCT levels remain very low under normal conditions. PCT will be produced in large quantities in different issues and organs and released into blood circulation under the joint action of bacterial toxins and pro-inflammatory cytokines in bacterial infection. Its increase will be detected in blood 2 - 3 hours after early infection, with the peak at 6 - 12 hours and lasting for 24 - 28 hours. The half-life is 25 - 30 hours. However, PCT levels will not increase in viral infection and chronic non-specific infectious diseases, or only increase mildly. The PCT level is directly proportional to the severity of inflammation, and it decreases as inflammation is alleviated or under control [14]. Thus, the PCT level is considered a reliable indicator of the severity, prognosis, and outcomes of bacterial infection [15]. PCT can be rapidly detected at an early stage of infection; it is stable *in vivo* and has a long half-life and is closely connected to the severity of infection. Because of these features, PCT exhibits great advantages in the differential diagnosis of bacterial infection compared to other conventional inflammatory markers such as CRP and WBC [16].

Our study shows that compared with day 1 after surgery, serum PCT and CRP levels increased considerably on day 4 and day 9 after surgery in the infection group. As compared with the non-infection group, PCT and CRP levels on day 4 and day 9 after surgery both increased dramatically ($p < 0.05$). The sensitivity and specificity of PCT levels were superior to those of CRP.

The sensitivity and specificity of the two indicators used in combination were obviously higher than those of either indicator used alone, consistent with other reports [17,18]. We believe that the serum PCT level can be used as an early diagnostic indicator of infection after internal fixation for traumatic fracture. The combined use of the two indicators can increase the sensitivity of detection. However, our sample size was small, and the findings need to be verified by studies with a larger sample size.

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**Declaration of Interest:**
The authors report no potential conflict of interests.

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