C-REACTIVE PROTEIN IN TIBIAL FRACTURES

NATURAL RESPONSE TO THE INJURY
AND OPERATIVE TREATMENT

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Serial serum C-reactive protein (CRP) measurements were made, for three weeks, in 42 consecutive patients with solitary tibial fractures. The CRP response was related to the treatment: lower values were observed in 27 patients treated conservatively than in 15 operated patients. Open reduction and plating resulted in a greater response than closed intramedullary nailing. The timing of the CRP response was related to the timing of the treatment: the highest values were usually recorded two days after admission or operation. The timing of the operation did not affect the degree of CRP response. Neither the site, nor the type of fracture, nor the age of the patient played any role. Awareness of these natural CRP responses after fractures may help in the diagnosis of early post-traumatic and postoperative complications, especially infections.

The tests usually used to diagnose early infections in patients with fractures and osteosyntheses are erythrocyte sedimentation rate (ESR), white blood cell count, body temperature and pulse rate. As all these are influenced by the initial trauma and operation, they are rather nonspecific. Serum C-reactive protein (CRP) estimation was introduced by Pepys (1981) for the early diagnosis of bacterial infections, including septic arthritis and osteomyelitis (Peltola and Jaakkola 1988). CRP is one of the normal constituents of plasma (Tillett and Francis 1930) and it is one of the acute phase proteins synthesised by hepatocytes. The primary signal for this protein synthesis is interleukin-1, produced by the macrophages at sites of tissue injury (Stahl 1987). Normally, the CRP level is less than 10 mg/l in 99% of healthy individuals (Shine, de Beer and Pepys 1981) but it may increase up to 3000 times in a number of diseases.

Trauma causes a CRP response and may make the assessment of infections difficult in injured patients. We wanted to define the degree and timing of the natural CRP response associated with tibial fractures.

<table>
<thead>
<tr>
<th>Mode of treatment and number</th>
<th>Timing of operative treatment (days)</th>
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<tr>
<td></td>
<td>0 to 1</td>
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<tr>
<td>Conservative 27</td>
<td></td>
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<tr>
<td>IMN* 10</td>
<td>4</td>
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<tr>
<td>ASIF* 5</td>
<td>4</td>
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<tr>
<td>Total 42</td>
<td>8</td>
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<td>* IMN, closed intramedullary nailing; ASIF, open internal fixation (with AO/ASIF plates)</td>
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PATIENTS AND METHODS

There were 53 consecutive patients with recent tibial fractures, unsuitable for ambulatory treatment, admitted to our clinic between September 1986 to November 1987. Only patients with solitary fractures were studied. Eleven patients were excluded from the final analysis because of insufficient laboratory data (8) or clinically detected infections such as pneumonia or urinary tract infection (3). There were 26 men and 16 women. Their mean age was 46 years (range 18 to 82). Some details of the remaining 42 patients are given in Table I.

The CRP value was measured at 340 nm immuno-
turbidimetrically by a Hitchhike 704 analyser using CRP antiserum (Kallestad Diagnostics, USA) and CRP-buffer Cat. No. D-179 and CRP-standards Cat. No. D-274 (Orion Diagnostica, Finland). The measurements were performed on the patients' admission to hospital and then daily for one week. Further measurements were performed on the 10th, 14th and 21st days. The upper limit of the normal CRP value in our laboratory is 10 mg/l.

The highest CRP values were usually observed on the second day after the initial trauma or operative treatment, irrespective of the operative method used. In uncomplicated cases, the values usually slowly decreased thereafter and were normal after two or three weeks (Fig. 1). The mean CRP in patients treated operatively was 24.4 mg/l immediately before operation and 51.5, 78.5 and 45.2 mg/l on the following three days. If the operation was performed on admission or during the first two days after the initial trauma, the responses to the fracture and to the operation interfered (Fig. 2). If the operation was performed later, a biphasic curve was usually observed. However, the amplitude of CRP response was not influenced by the timing of the operation.

The type of initial fracture had no effect on the degree of CRP response. The mean maximal CRP value was the same (p > 0.05) for diaphyseal (51.9), distal (49.2) and proximal metaphyseal (66.8) fractures. It was the same (p > 0.05) for comminuted (62.1), oblique (49.0) and transverse fractures (56.8). The mean CRP was 58.4 for open and 54.7 mg/l for closed fractures (p > 0.05).

### RESULTS

When the patients were admitted their mean CRP was 8.7 mg/l (range 2 to 55). A significant rise was observed during the first days after the skeletal trauma (Fig. 1), irrespective of the mode of treatment. The degree and timing of the CRP response depended on the therapeutic method and especially upon the timing of operative treatment. The mean maximal CRP was the same in all the 10-year age groups and for both sexes (p > 0.05).

The response was highest in patients treated by open reduction and internal fixation with plates (Fig. 1 and Table II). The differences between the mean maximal CRP values for the three modes of treatment are significant (p < 0.01).

### DISCUSSION

CRP estimation was introduced into clinical practice as an early indicator of infection. Though superior to the ESR in respect of its faster dynamics, CRP is still not ideal due to its low specificity in patients who have sustained accidental or surgical trauma. The tissue necrosis of a myocardial infarct (Pepys 1981; Pietilä et al 1986) can elevate the CRP level as can a cerebral infarct, peripheral arterial disease or an acute compartment syndrome. Many other infective and inflammatory conditions can cause a raised CRP level. Urinary tract
infections (Mustard et al 1987), acute pancreatitis (Mayer et al 1984) and reactions to blood products (Gozzard, Lui Yin and Delamore 1986) are all conditions not uncommonly associated with traumatic fractures. The moderately elevated CRP values observed in rheumatoid arthritis and related conditions (Dixon et al 1984) should also be considered.

In our patients the degree of CRP response was related to the method of treatment and may be an indicator of the additional tissue trauma caused by the operation (Stahl 1987). Perhaps the CRP level may have clinical use in the search for less invasive operative methods.

Our results show that in the assessment of postoperative deep wound infections after injury a single CRP value is an unreliable criterion. A trend seen in serial CRP measurements is more useful. Extremely high values one week after the trauma or its operative treatment, abnormal values persisting for more than three weeks, or a late secondary rise in serial CRP values may all indicate one of the many complications mentioned. Knowledge of the trauma-related natural CRP response helps in the assessment of post-traumatic and postoperative complications.

No benefits in any form have been received or will be received from a commercial party related directly or indirectly to the subject of this article.

REFERENCES


