

C-reactive protein as a parameter of surgical trauma

CRP response after different types of surgery in 349 hip fractures

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Background Postoperative C-reactive protein (CRP) levels in serum appear to reflect surgical trauma. We examined CRP levels after different types of surgery in hip fractures.

Methods We studied the CRP response after 349 operative procedures in proximal femur fractures with a normal postoperative course. 5 different operative techniques were used: 3–4 percutaneous cancellous screws, dynamic hip screw (DHS), proximal femur nail (PFN), hemiarthroplasty (HA), and total hip arthroplasty (THA).

Results Peak CRP levels were reached on the second postoperative day in each group (medians: screws 8.7, DHS 12, PFN 14, HA 16, THA 16 mg/dL). Significant differences were found between screws and all others, and between DHS and arthroplasties.

Interpretation CRP levels following surgical trauma can be used to quantify the degree of tissue damage and invasiveness of a procedure and reflect the perioperative stress experienced by the patient.

C-reactive protein, an acute-phase protein, is an acknowledged marker of infections and has been linked to the development of systemic inflammatory response syndrome. The plasma concentration of CRP can increase several hundredfold within 24–48 h after tissue injury from a normal resting state concentration of 0.5 mg/dL (Foglar and Lindsey 1998). A rapid rise in CRP can be observed after orthopedic surgery, reaching the maximum value on the second day after surgery. CRP levels

of about 10–16 mg/dL can be seen after total hip or knee arthroplasty (Aalto et al. 1984, Niskanen et al. 1996, Okafor and Maclellan 1998, White et al. 1998). In fracture treatment of the tibial shaft, CRP levels reach values of 7 mg/dL (Lindström et al. 1997), and 5 mg/dL in malleolar fracture treatment (Buttenschoen et al. 2000). CRP values appear to depend on region (femur versus ankle) and may also reflect the extent of surgical trauma (Scherer et al. 2001). Studies from abdominal surgery have shown that CRP levels after laparoscopic approach for fundoplication or cholecystectomy are significantly lower than after conventional operation (Kristiansson et al. 1999, Sietses et al. 1999). Thus, we examined CRP levels after different operative procedures in the same region (the hip).

Patients and methods

- 580 patients with traumatic proximal femur fractures were admitted to our department from 1998 through 2002. 82 patients who had clinical signs of infection, neoplasia, hepatic cirrhosis, CRP levels greater than 5 mg/dL preoperatively, or who had had any operative procedures within 3 months before admission were excluded from the study—as were 90 patients who developed an operative or postoperative complication. Less than 1 preoperative measurement and less than 3 postoperative CRP measurements in the first 10 days after operation were used as another exclusion criterion (involving 59 patients). This left 349

Table 1. Patient data

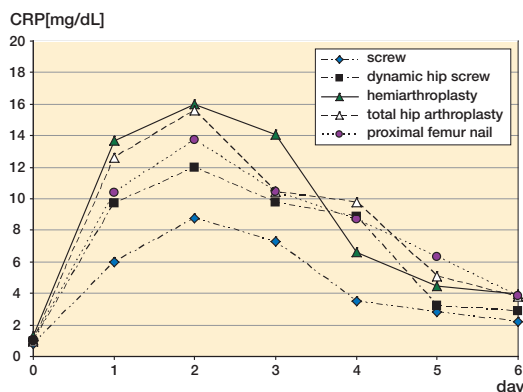
	n	Age (range)	Mean length of hospital stay (days)
Screws	44	66 (28–95)	13
Dynamic hip screw	66	69 (21–94)	12
Proximal femur nail	100	79 (33–100)	13
Hemiarthroplasty	52	84 (57–97)	15
Total hip arthroplasty	87	77 (43–97)	15
Total	349	76 (21–100)	13

Table 2. Peak CRP levels on the second postoperative day (mg/dL)

	Mean	95% CI	Inter-quartil	Median
Screws	8.7	5.6–13	6.2	5.7
Dynamic hip screw	12	9.3–15	12	9.8
Proximal femur nail	14	12–15	6.8	14
Hemiarthroplasty	16	14–18	7.0	17
Total hip arthroplasty	16	14–17	9.1	15

“uncomplicated” patients who underwent surgery for hip fractures (medial and lateral fractures of the femoral neck, intra- and subtrochanteric fractures). The following standard procedures were used: 3–4 percutaneous cancellous screws (AO), dynamic hip screw, proximal femur nail, hemiarthroplasty, and total hip arthroplasty. Patient data are given in Table 1.

Analysis of CRP was done using an immunoturbidometric technique on a Hitachi 912 autoanalyzer (Hitachi Europe Ltd., Frankfurt, Germany). Blood samples were obtained on admission, and at least 3 measurements were obtained postoperatively (days 1, 2, 3, 4, 5, 6 and 10).



CRP response after different fracture treatments for proximal femur fractures.

Statistics

We used SPSS for Windows. Data are presented as mean (SEM). The Mann-Whitney U-test was used for comparison between two independent variables at the same time. The level of significance was set at $p < 0.05$ using a two-tailed test.

Results

Before operation, CRP levels were similar in the 5 groups. Different CRP levels evolved on the first postoperative day (Figure). For each group, the peak level of CRP was reached on the second day after surgery (Table 2), after which it decreased. We found significant differences between single screws and all other techniques, as well as between dynamic hip screws and total hip arthroplasties or hemiarthroplasties (Table 3). Comparing osteosynthesis and arthroplasties, significant differences on postoperative days 1, 2 and 3 were found. The mean CRP values for osteosynthesis

Table 3. P-values, second postoperative day

	Total hip arthroplasty	Hemiarthroplasty	Proximal femur nail	Dynamic hip screw
Screws	< 0.001	< 0.001	< 0.001	0.01
Dynamic hip screw	0.01	0.03	0.1	
Proximal femur nail	0.2	0.1		
Hemiarthroplasty	0.8			

were 8.8 mg/dL, 11 mg/dL and 9.3 mg/dL, respectively, as compared to 12 mg/dL, 16 mg/dL and 13 mg/dL in arthroplasties.

Discussion

Previous studies (Ellitsgaard et al. 1991, Choudhry et al. 1992, Kraggsbjerg et al. 1995) have reported that CRP levels depend on the region of trauma, with the maximum levels on the second postoperative day. Reliable data exist for hip fractures (Okafor and Maclellan 1998) and arthroplasty of the hip (Niskanen et al. 1996, White et al. 1998), reaching values of about 10–16 mg/dL for standard procedures, using a posterolateral or anterolateral approach. These values were reproduced in our series. On the contrary, treating a hip fracture with percutaneous screws led to considerably lower peak levels (8.7 mg/dL), indicating less soft tissue injury (minimally invasive). Comparing single percutaneously-inserted screws and dynamic hip screws, we found significantly higher values with dynamic hip screws, again paralleling soft tissue damage. The degree of bone and bone marrow injury produced during an operation may be important in determining the extent of the CRP response (Larsson et al. 1992). Higher levels in arthroplasties than with dynamic hip screws but not than with proximal femur nails suggest that trauma to the bone marrow is crucial for the CRP response. Opening the femoral canal, extruding bone marrow from the medullary cavity and (possibly) loading the lungs with bone marrow and fat during stem preparation, and often inserting an endoprosthetic shaft or a femoral nail similarly results in high CRP levels.

CRP can be used to quantify surgical trauma and to assess the surgical trauma experienced by individual patients. High CRP values on the second postoperative day indicate a major inflammatory response to the operative procedure, and reflect perioperative tissue damage and antigen load.

Contributions of authors

MN: data collection, data processing, statistics, writing of manuscript. GM: data collection, advisor. MAS: writing of manuscript, supervisor.

No competing interests declared.

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