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Postoperative Kinetics of C-Reactive Protein and Erythrocyte Sediment Rate in One-, Two-, and Multilevel Posterior Spinal Decompressions and Instrumentations

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Abstract

Study design: Prospective study.

Objective: To characterize the normal pattern of kinetics of postoperative C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) after decompression, spinal instrumentation, and posterolateral fusion in 1, 2, and more than 2 levels.

Methods: Blood specimens were obtained from patients who underwent posterior decompression, instrumentation with pedicular screws, and posterolateral fusion from June 2009 to January 2011. CRP and ESR levels were measured on the day before surgery and on postoperative days 1, 3, 7, 11, 14, 28, and 42.

Results: Mean CRP levels peaked on the third day postoperatively in all groups. By day 7 postoperatively, it had dropped rapidly. At the 14th and 28th postoperative days, decreases to normal CRP levels were found in 16% and 80% of all patients, respectively. The pattern of decline in CRP was similar among groups. Values of ESR increased and peaked between the third and seventh postoperative days. ESR values gradually decreased. At the 42 day postoperatively, ESR level still remain above normal values in all groups.

Conclusions: We compared conventional operation groups of 1-, 2-, and more than 2-level posterior instrumentation and found no statistically significant differences in the peak of CRP level, the ESR value, and the pattern of decline. CRP levels of 80% of the patients returned to normal within 4 weeks.

Keywords

C-reactive protein, erythrocyte sedimentation rate, spinal surgery, infection

Introduction

C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR) are valuable indicators for postoperative infection. Abnormalities of their postoperative kinetics should raise suspicion of a postoperative infection. The postoperative changes in CRP and ESR in spinal surgery patients without postoperative infection have been studied. Chung et al showed that CRP levels peaked on the third day postoperatively and gradually decreased thereafter in noninfected cervical and lumbar spinal surgery patients.[1] The same study also reported that cervical spine operation and spinal instrumentation were associated with significantly higher CRP levels.[1] Mun et al also studied postoperative CRP and ESR in noninfected spinal surgery patients. They reported that CRP level peaked on the third day

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postoperatively in spinal decompression patients while CRP level peaked on the fifth day postoperatively in patients with instrumentation.[2] In the same study, ESR peaked on the 1st and 10th postoperative days in the simple decompression group and the spinal instrumentation group, respectively.[2] Thus, previous studies appear to provide a reference for postoperative changes in CRP and ESR in uncomplicated spinal surgery. This may be used to make comparisons with cases complicated by postoperative infection.

The peak CRP level differs between minimal invasive, simple, and instrumentation spinal surgery. A study of 4 types of uncomplicated spinal surgery found that the peak CRP level in the microdiscectomy group was lower than that of the conventional discectomy, anterior lumbar fusion, and posterolateral intercorporal fusion with internal fixation groups.[3] The first-day postoperative CRP was higher in the open laminectomy group compared with the microdiscectomy and microendoscopic discectomy groups.[4] Kraft et al demonstrated a higher maximum CRP level in the fusion group (360° posterior lumbar interlaminar fusion with transpedicular screws and 2 polyetheretherketone spinal implants) compared with the minimally invasive endoscopically assisted group; however, a rapid fall within 4 to 6 days was observed in both groups.[5] From the findings of many studies, higher CRP levels are seen in more extensive spine operations.

Few studies have compared these inflammatory markers in multilevel operation. Houten and Tandon compared peak CRP between 1-level and 2-level bilateral pedicular screw instrumentation, laminectomy, and traditional posterolateral intertransverse fusion. They found that peak CRP was lower in the 1-level group, and the fall of CRP level was prolonged in the 2-level group.[6] However, their study did not include cases with more than 2-level instrumentations. To date, the literature lacks data about the normal kinetics of CRP and ESR in multilevel lumbar spine operations. This may limit the use of these acute-phase proteins as markers of postoperative infection. The aim of this study is to characterize the normal pattern of kinetics of postoperative CRP and ESR after decompression, instrumentation, and posterolateral fusion in 1, 2, and more than 2 levels.

Materials and Methods

The data was collected prospectively from all patients who underwent posterior decompression, instrumentations with pedicular screws (1, 2, and more than 2 levels), and posterolateral fusion by the principal investigator, Sombat Kunakornsawat, from June 2009 to January 2011 at Lerdsin Hospital. Indications for surgery were lumbar stenosis and spondylolisthesis. Exclusion criteria were history of rheumatoid arthritis, autoimmune diseases, chronic infection, immunosuppressive treatment, malignancy, connective tissue disease, trauma, sepsis, staged procedures, and any operative procedure within the previous 3 months. The patients were categorized into 3 groups depending on the number of levels of instrumentation (group 1: 1 level; group 2: 2 levels; and group 3: more than 2 levels). The institutional review board of Lerdsin Hospital approved this study.

Table 1. Characteristics of the Patients.

	Group 1: 1 Level	Group 2: 2 Levels	Group 3: >2 Levels
N	12	14	34
Age (years), mean ± SD	59 ± 15	61 ± 12	61 ± 9
Gender, n (%)			
Female	10 (83)	12 (86)	20 (59)
Male	2 (17)	2 (14)	14 (41)
Operative time (minutes), mean ± SD	130 ± 30	148 ± 40	169 ± 37
Blood loss (mL), mean ± SD	270 ± 175	442 ± 234	757 ± 342

All cases received the following: midline incision, laminectomy, and pedicular screws instrumentation, followed by posterolateral intertransverse process fusion with local graft mixed with bone substitute (MASTERGRAFT Resorbable Ceramic Granules; Medtronic Sofamor Danek, Memphis, TN). Vigorous irrigation with 3 liters of normal saline without antibiotic was done. Traumatized muscle was debrided before skin closing. A subfascial redivac drain was placed, and then it was removed on the second postoperative day. Antibiotic prophylaxis of cefazolin 1 g was given intravenously within 1 hour of skin incision, and every 6 hours for 72 hours after surgery. It was redosed every 4 hours or because of more than 1500 mL of blood loss during operation. Cases with penicillin or cephalosporin allergy were given clindamycin instead.

Blood specimens were obtained on the day before surgery and postoperative days 1, 3, 7, 11, 14, 28, and 42 to evaluate CRP and ESR. CRP was quantified by using the latex agglutination method, and ESR was quantified by the Westergren technique.

The statistical analysis was performed using SPSS 22.0 (SPSS Inc, Chicago, IL). ANOVA testing was used to compare the means of the 3 groups. Statistical significance was set as a P value of less than .05.

Results

Sixty patients were enrolled in this study. The mean age of each group was 60 years. There were high proportion of female in group 1 (83%) and group 2 (86%). Operative time was longest in group 3 ($P = .007$). Blood loss was also significantly higher in group 3 compared with both groups 1 and 2 ($P = .0001$; Table 1).

After operation, values of ESR increased and peaked between the third and seventh postoperative days. Values of ESR decreased after the third postoperative day in both groups 2 and 3 as well as after the seventh postoperative day in group 1. The mean ESR on the third postoperative day in groups 1, 2, and 3 were 91 ± 29, 93 ± 23, and 82 ± 20 mm/h, respectively. The mean ESR on the seventh postoperative day in groups 1, 2, and 3 were 106 ± 15, 79 ± 30, and

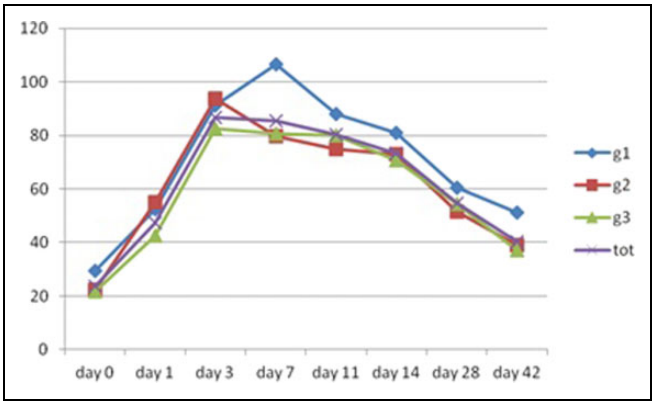

Figure 1. Postoperative mean ESR for all 3 groups with no statistically significant differences of mean ESR between groups (tot = all groups).

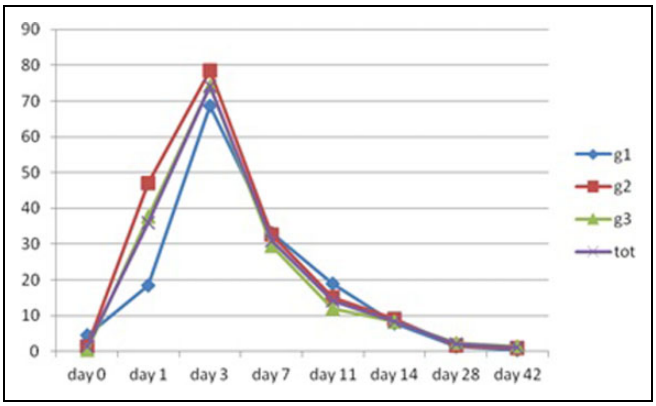

Figure 2. Postoperative mean CRP for all 3 groups with no statistically significant differences in mean of CRP between groups (tot = all groups).

80 ± 23 mm/h, respectively. Up to the last day of follow-up at day 42 postoperatively, the values of ESR gradually decreased and remained above normal values in all groups (Figure 1). No statistically significant differences in the values of ESR among the 3 groups were seen.

Preoperative CRP levels were high in 9 patients. Mean CRP levels peaked on the third day postoperatively in all groups. Maximum mean CRP in groups 1, 2, and 3 were 68.7 ± 32, 78.5 ± 48, and 72.3 ± 49 mg/L, respectively. By day 7 postoperatively, it had dropped rapidly in groups 1, 2, and 3 to 33 ± 32, 32.6 ± 30, and 29.6 ± 22 mg/L, respectively. At the 14th and 28th postoperative days, decreases to normal CRP levels were found in 16% and 80% of all patients, respectively. The pattern of decline in CRP was similar among groups (Figure 2). No statistically significant differences in mean CRP between groups were found during the study.

Discussion

CRP and ESR are important tests of acute-phase proteins. Conditions that cause inflammatory processes such as infection, tissue injury, trauma, or immunological reactions increase plasma CRP levels or ESR values. After operation, CRP and ESR values increase rapidly and decrease gradually. The deviation of normal kinetic of CRP or ESR may indicate postoperative infection.[7-9] Mok et al reported peak CRP and ESR values around the third and fourth postoperative days. They propose that a second rise of the CRP level or a lack of decrease suggest postoperative infection. However, approximately 22% of their patients have no peak CRP level.[8] In Kang et al's study, CRP reached peak level between the first and third postoperative days and gradually decreased. CRP level returned to normal in 40% of the patients on the fifth day. They have used abnormal CRP responses as an indicator for resuming intravenous antibiotic.[9]

The peak CRP in minimally invasive surgery is lower than in open surgery. However, the pattern of decline in both groups is similar.[6] The reduction of tissue destruction–mediated inflammation is the cause of the lower peak CRP in the minimally invasive surgery group. The peak CRP level is also higher in the instrumentation group.[1,3,10] Many articles have reported the kinetics of CRP and ESR in spinal surgery.[1,2,6,10] However, very few studies have characterized the normal kinetics of CRP and ESR in multilevel instrumentation. From our study, we found that the kinetics of CRP were similar among groups of 1, 2, and more than 2 levels. Mean CRP reached maximum level on the third day postoperatively in posterior decompression, posterior instrumentation, and posterolateral fusion. There were no statistically significant differences in the maximum mean CRP level of all the groups. CRP level gradually decreased to normal (less than 6 mg/L) at the 28th day postoperatively. The peak CRP was found in all our patients. In contrast to Mok et al's study, peak CRP was observed in 78% of their patients.[8] It may be explained by the use of spinal instrumentation, the use of bone substitute, and the blood sample collection regimens. All of our patients had spinal instrumentations, compared with 83% of Mok et al's study. In our study, blood samples were obtained on the day before surgery and on postoperative days 1, 3, 7, 11, 14, 28, and 42. In their studies, blood sample were collected daily until the patients were discharged. For the use of bone substitute, in this study MASTERGRAFT Resorbable Ceramic Granules were used in all patients. There was no information about bone substitute used in the study by Mok et al.

At the 14th day postoperatively, Aono et al reported that 52% of the patients with single-level posterior instrumentations had normal CRP level.[11] In contrast to this study, only 16% had normal CRP level. Eighty percent of our patients had normal CRP level at the 28th day. The inflammatory reaction from posterolateral fusion may be the answer to the prolonged high CRP level in our study. The peak and kinetics of CRP in our study are similar in all 3 groups, and this may indicate that the difference of the degree of soft tissue injury and the difference of the immunological reaction from the spinal instrumentations among the 3 groups are not significant. We found that the kinetics of ESR in our study were not as consistent as CRP. The peak ESR level in group 1 was higher than those of groups 2 and 3. The ESR level gradually decreased until the 42nd postoperative day. However, the ESR level still had not

returned to the same level as the preoperative level at the sixth week postoperatively. The reasons why the kinetics of ESR are not as consistent as that of CRP may be various factors effecting the level of ESR such as gender, age, smoking, level of plasma protein, and medication.[6]

The present study has certain strengths and limitations. The first strength of this study is its prospective design. Also, the longitudinal observation period of blood specimens was relatively long, which continued until the 42nd postoperative day. However, the weakness of our study was the small number of cases in groups 1 and 2. Regarding limitation of the study, there were no infected cases to determine kinetics of ESR and CRP compared with the noninfected cases. For clinical use, in patients who had posterior spinal instrumentation, CRP level measurement may not be useful for the first 3 to 4 days postoperatively because it may be the normal peak CRP level. However, if the infection is suspected in the patients after the fourth to fifth days postoperatively, we recommend to measure CRP level twice. It should be measured first when clinical symptoms are suggestive of infection (axial pain, fever), and 2 to 3 days after the first measurement. Normally, CRP level should decrease. If CRP level of the second measurement is higher, it is highly suspicious of infection.

In conclusion, we compared conventional operation groups of 1-, 2-, and more than 2-level posterior instrumentation and found no statistically significant differences in the peak of CRP level, the ESR value, and the pattern of decline. CRP levels of 80% of the patients returned to normal within 4 weeks.

Authors' Note

The institutional review board of Lerdsin Hospital approved this study.

Declaration of Conflicting Interests

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