CLINICAL ARTICLE

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Diagnostic Value of Early Inflammatory Reaction in Postoperative Infection of the Lumbar Spine

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Objective : Our aim is to evaluate the early changes of biologic markers such as white blood cell(WBC) count, erythrocyte sedimentation rate(ESR) and C-reactive protein(CRP) in early diagnosis of postoperative infection and to differentiate infection from inflammatory reaction in lumbar spine surgery.

Methods : We reviewed 330patients who had undergone spinal operations between May 1999 and October 2001. For this study, the patients were classified into two groups, which include a group that underwent spinal decompressive surgery *without instrumentation(SD), and the other group that underwent fusion surgery with spinal instrumentation(SI). And each* group was also subdivided into two groups respectively, one with infection and the other without infection. We retrospectively analyzed the WBC count, ESR and CRP preoperatively and postoperatively, according to their operation type and postoperative infection history.

Results : Inflammatory indices were physiologically affected by instrumentation itself. But ESR and CRP elevations were more prolonged and sustained under infection. In SD patients without infection, ESR and CRP were stabilized 5 days after surgery. In SI patients without infection, CRP was stabilized about 7days after surgery, but ESR showed sustained and variously elevated. In both SD and SI groups, the stabilization of CRP was the most reliable behavior of surgery without infection.

Conclusion : C-reactive protein is most sensitive parameter for postoperative spine infection. The knowledge of the inflammatory indices and their relatively uniform patterns with or without infection offers surgeons the ability to infer the state of surgical wound.

KEY WORDS : C-reactive protein · Erythrocyte sedimentation rate · Spinal surgery · Infection · Inflammation.

Introduction

The operations of the lumbar spine, which are the largest portion of the spinal surgery, have infection rate ranging from 1 to 6%. Although this is not very high compared to some other types of operation, considering the sufferings of the patients and difficulties in the proper treatment of the infection, it is very important to detect early and treat appropriately[3,11,13,16]. Even though it is important to look for common symptoms of postoperative infection such as fever, radiological changes and the recurrence of pain, these are limited in their diagnostic potential during the early stages of infection. Thus, the basic and objective way to diagnosis infection early are to utilize the blood indices for the screening of postoperative infection[16,18]. However, this blood indices varies depending on the type and stage of spinal operation. For example, when a instrument is inserted during spinal operation, the inflammatory reaction is increased as a foreign body reaction[6,15,16] Thus, in various spinal operations, proper understanding and interpretation of postoperative changes in the blood indices will be very important for early diagnosis of spinal postoperative infection. In this study, we investigated the inflammatory response as tracked by the values of erythrocyte sedimentation rate(ESR), C-reactive protein(CRP), and white blood cells (WBC) taken from blood tests over time following typical surgical treatment of the lumbar spine. The general changes and patterns were traced and then compared and analyzed with the cases where postoperative infections developed so that we could pursue the clinical meaning of blood inflammatory reactions for the early diagnosis of surgical wound infection.

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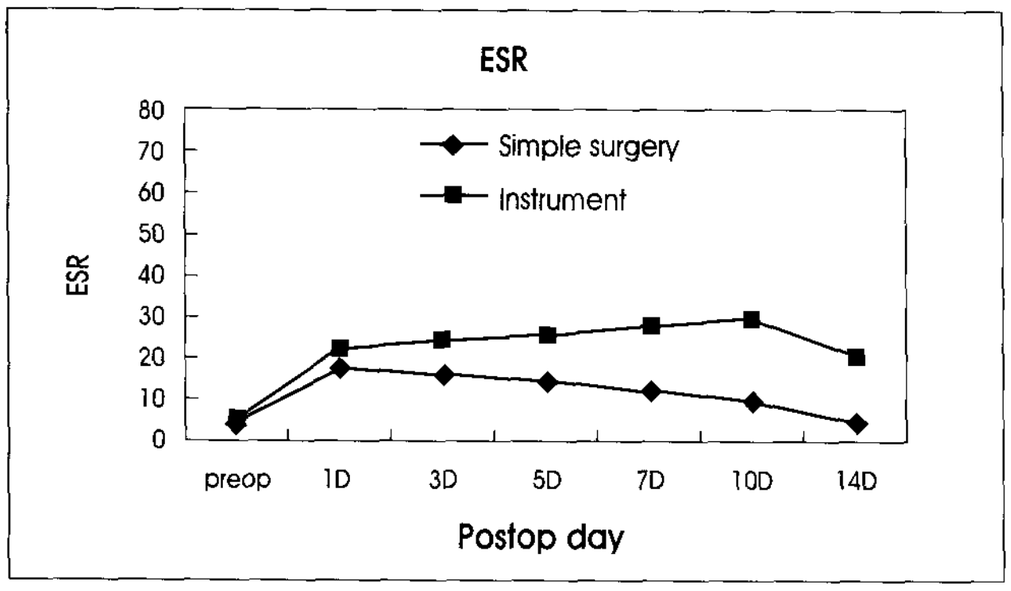

Fig. 1. The mean erythrocyte sedimentation rate (0~10mm/h) for the non-infection group.

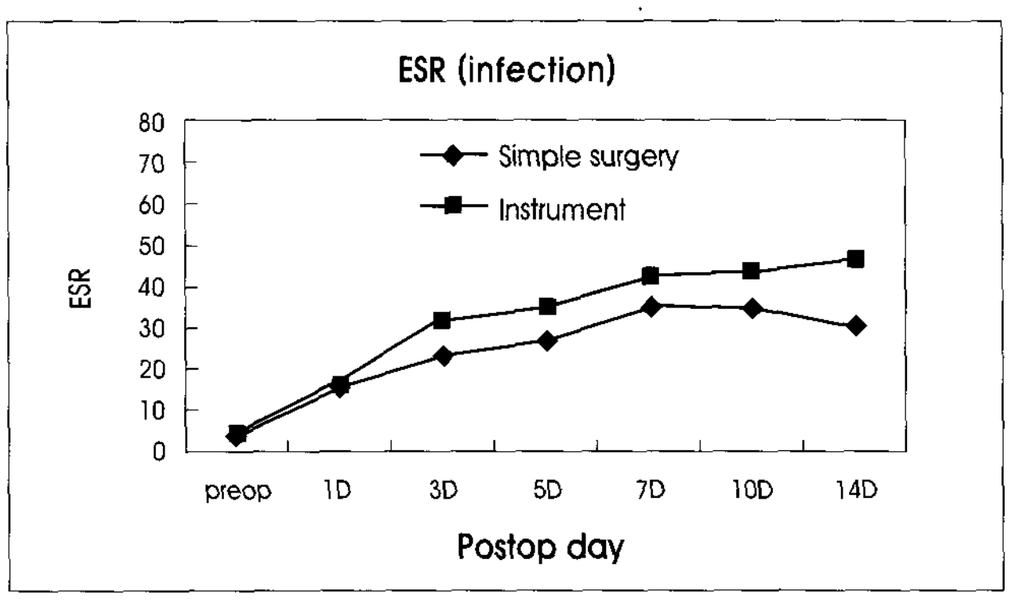

Fig. 2. The mean erythrocyte sedimentation rate (0~10mm/h) for the infection group.

Materials and Methods

In the author's practice, 334patients who received surgical treatment for lumbar spinal disease under general anesthesia in this hospital between May, 1999 and October, 2001, were included. The patients consisted of 138 males and 196 females. The age distribution was from 17 to 79 with an average age of 52.8. First, patients were classified into two groups according to the type of operation. The first group included 165cases of simple decompression(SD). This group underwent surgery without instrumentation, such as microdiscectomy and microfenestration. The second group consisted of 160patients that underwent fusion surgery with spinal instrumentation(SI). These two groups were then divided into two subgroups depending on the presence of postoperative infection. Thus, a total of 4 groups were analyzed. Among the SD groups, there were 159cases with no infection and 6cases with infection. In the cases of infection of the SD groups, 5 patients had undergone microdiscectomy and 1 had received microfenestration.

In SD with no infection, the average age was 52 and the women patients' rate was 45% (72patients), and in SD with infection, the average age was 48 and the women patients' rate was 50% (3patients). In SI patients, most of the patients underwent posterior lumbar interbody fusion or posterolateral fusion and the patients who underwent screw fixation in one or more segments : 158cases without infection and 11cases with infection (6.5%, 11/169). In SI patients without infection, the average age was 52 and the women patients' rate was 45% (5patients) and in SI with infection the average age was 54 and the women's rate was 45% (5patients). Overall, in the spinal instrumentation group, which is the more extensive surgery, the women patients' rate was higher than in the SD group and the mean age difference between each group was not significant. The mean surgical time was 136minutes (range 54~190minutes) for the SD group and 268minutes (range 198~390minutes) for the SI group. Microscopes were used in all cases of SI and SD groups. The spinal instrumentation consisted of pedicle screws and rods with or without interbody cages. Patients who had a general disease which could have had an effect on the blood inflammatory level were excluded. From each group's blood test, the ESR, CRP, and WBC were checked from the preoperative day to 1, 3, 5, 7, 10 days and two weeks after the surgery and analyzed retrospectively. In each period, the average value was compared with different groups, and these statistical analyses saw $p<0.05$ as a significant difference using Student's t test.

Results

SD without infection (Fig. 1, 3, 5)

ESR (normal 0~10mm/h) reached the maximum (average 18.1) on post-op day 1 and maintained until post-op day 3 (average 17) and then from post-op day 5 its level was reduced to normal gradually. CRP (quantitation, normal <5mg/L) started to increase from post-op day 1 (average 8.4) and peaked on day 3 (average 13.9), then after day 5 its level tended to decrease. In the case of WBC (normal 4000~10,000/L), its count peaked (average 13,200) at post-op day 1 and decreased at day 3~5 (average 11,800) and after day 7 it showed a pattern returning to normal.

SD with infection (Fig. 2, 4, 6)

ESR increased 3days after the surgery (average 22.5) and in contrast to the cases without infection, its level remained elevated at post-op days 5~7 ($p<0.05$). Similar to ESR, CRP also continued to increase on day 3 after the surgery and by days 5~7 there were clear differences ($p<0.005$). The WBC count had a peak on day 5 after the surgery (average 14,600) and then reduced gradually but it didn't reach to the normal level before it was diagnosed as infection.

SI without infection (Fig. 1, 3, 5)

ESR showed a pattern that increased from post-op day 1

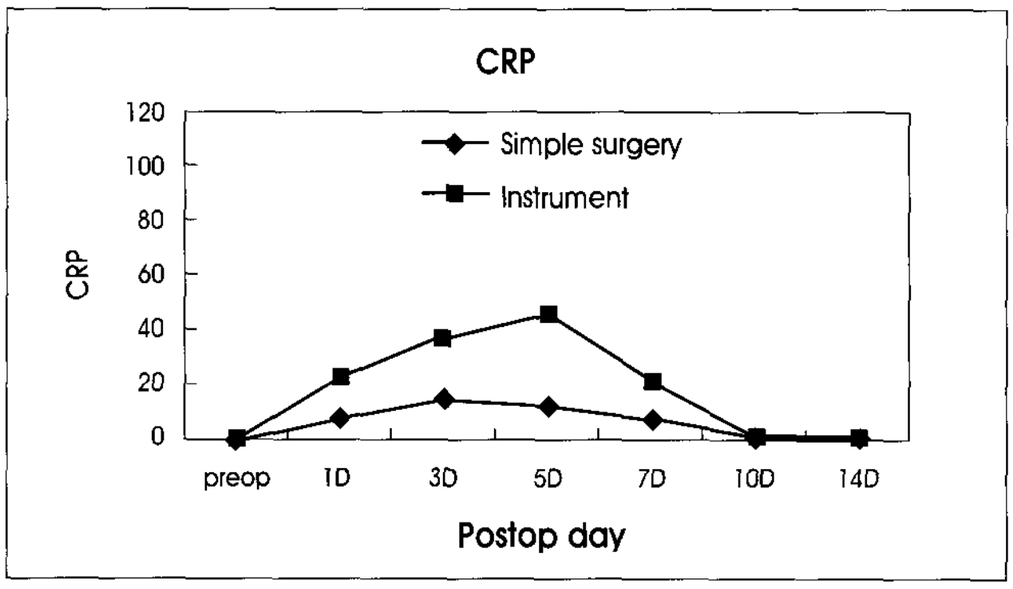

Fig. 3. The mean C-reactive protein (quantitation, 5mg/L) in the non-infection group.

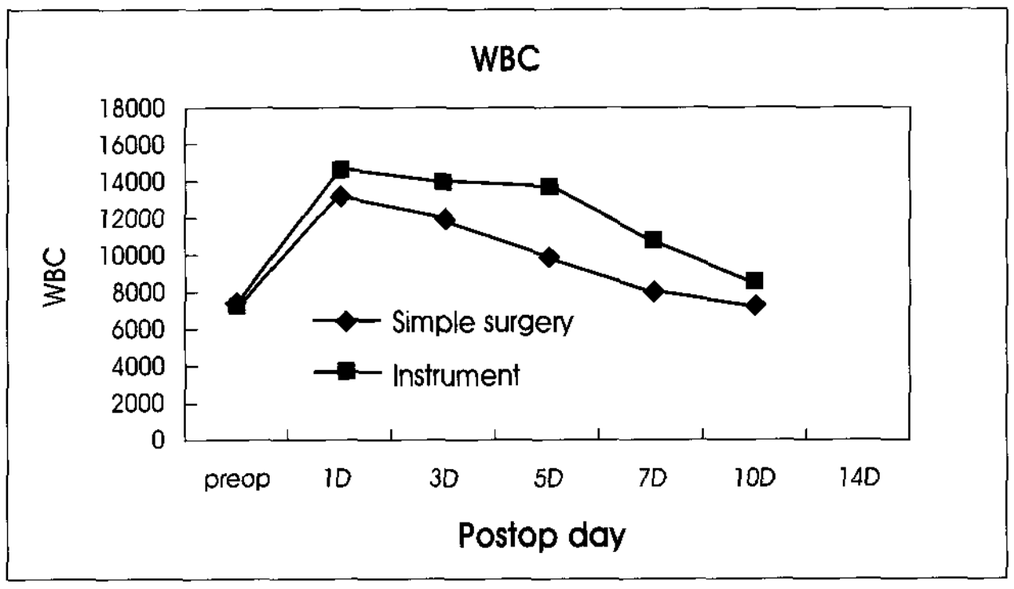

Fig. 5. The white blood cell counts in the non-infection group.

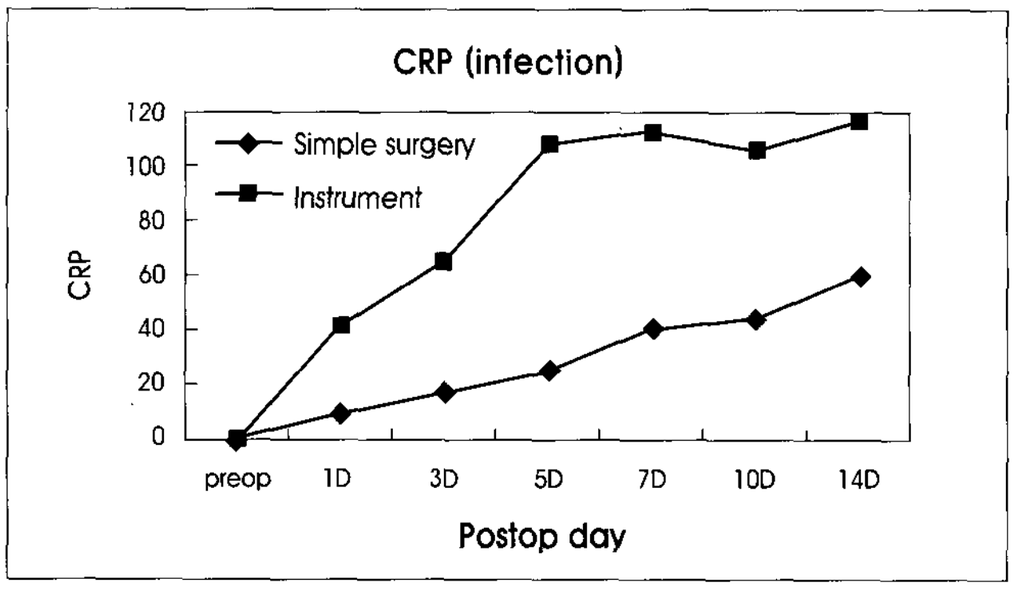

Fig. 4. The mean C-reactive protein (quantitation, 5mg/L) in the infection group.

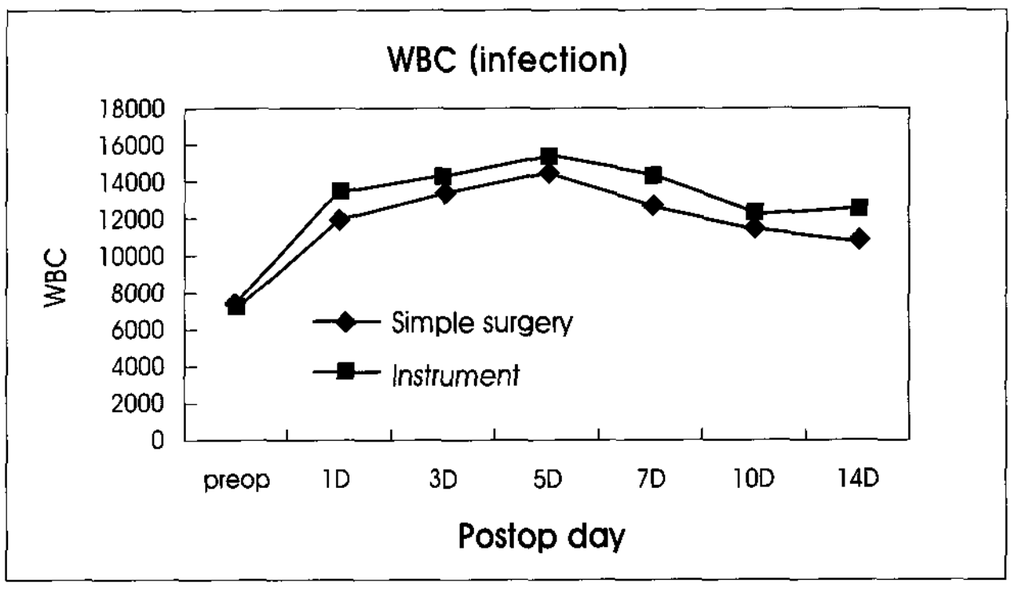

Fig. 6. The white blood cell counts in the infection group.

(average 21.4), increased more on day 3 (average 27), and on day 10 it reached its peak (average 29.4) after which its level decreased gradually. In the case of CRP, its level increased from post-day 1 (average 22.59) and peaked at day 5 (average 44.2). As with SD after day 5 its value showed a rapid decrease and after day 10, it dropped to the normal level. In the case of WBC, its peak was on day 1 (average 14,500) and continued to day 5 (average 13,840). It started to reduce after day 7 (average 10,680) and by day 10 it reached the normal value.

SI with infection (Fig. 2, 4, 6)

ESR increased from day 1 (average 16). From day 5 (average 35) to day 10 (average 43.3) it maintained a higher level than the cases without infection, but the distribution of its values showed a big individual difference. CRP levels increased on day 1 (average 40.13), day 5 (average 108.17) and day 10 (average 105.05), showing higher levels of CRP than the cases with no infection. After day 7 when its values dropped rapidly in cases with no infection, the difference between infection and no infection became apparent (CRP days 7 $p<0.005$). WBC had its peak on day 5 (average 15,300) and continued to day 7 (average 14,050) and then reduced gradually.

The microorganisms were identified in 4cases of SD group : 2cases of coagulase negative staphylococcus(CNS) and 2cases of S. aureus. Based on radiologic findings such as MRI, needle biopsy was done. In the case of SI culture identified 10cases. The microorganisms grew on culture of drainage tip in most cases except 2cases, which needed needle biopsy : 6cases of coagulase negative staphylococcus(CNS) and 4 cases of S. aureus and 1case of culture negative. Among S. aureus, methicillin-resistant staphylococcus aureus(MRSA) appeared in 1case of SD and 2cases of SI.

Discussion

Wound infection after lumbar spine surgery is caused by direct microbial contamination of the intervertebral disc, vertebral body or soft tissue during surgery. In spite of general sterilization, draping and strict hand washing, it remains a possible complication. As in any other surgery, it can be affected by several factors such as the exposure of surgical draping, perforation of surgical glove, infection transfer by surgical microscope, etc. However, since microorganisms which cause the infection during surgery are relatively limited and uniformed surgical methods are usually used, the clinical pattern and laboratory results can be used as parameters for predicting postoperative infection. In other words, if we know the changing pattern of actively used WBC, ESR and CRP blood

test results in general postoperative state and infection state following wound infection after lumbar spine surgery, it will be helpful to diagnose the infection early and plan treatment. ESR is the precipitation speed of red blood cells(RBC) while maintaining the fluid status after mixing the blood with anticoagulant. Thus the precipitation occurs slowly in the normal patient but its speeds increase in various pathological conditions. And, in some cases, its speed increases in proportion to the degree of the disease. The ESR measurement is helpful to diagnose the occult disease or to follow the progress of the manifested disease. In cases of multiple myeloma, leukemia, severe anemia and collagen disease, it shows a high rate of increase. In cases of acute local infection, recurrence of chronic infection, rheumatic arthritis, myocardiac infarction or tuberculosis it shows a medium rate of increase. In cases of degenerative arthritis, early appendicitis or cirrhosis, it shows a normal level. But, because there can be many factors which changes the values, it will be more helpful to observe the progress.[7)]

CRP is a substance in the serum of acute patients and it plays a role in initiating opsonic action, phagocytosis or lysis against invading cells. Usually within 24~48hours the CRP value can increase up to 2,000times, but it is also important to compare with previous changes in the value. The CRP is especially useful for tracing inflammatory disease activity, detecting systemic lupus erythematosus, inter-current infection in leukemia or rejection by the recipient in kidney transplantation[8)]. In surgical patients, the CRP increase is caused by tissue damage and it can have individual differences in the degree of increase. The degree of increase can also be determined by the degree of tissue damage and type of damaged tissue. While after discectomy, which is a typical case of SD, the ESR change is a useful marker to diagnose postoperative septic discitis, in surgery like SI, which is a larger surgery with using instruments for fixation, ESR has limitations for detecting postoperative infection[9,10)] When SI is compared to the inflammatory reaction of SD, certain basically different conditions of SI should be considered. For example, with the inflammatory reaction of the body against the instrument as well as factors like the increased operation period, an extensive wound exposure for instrumentation, and wide surface of the instrument itself, SI shows an inflammatory reaction which has larger intervals and more persistence than SD, which is more related to the frequency of complications such as infections[16,17,20)]. According to the results of this study, similar to that of other authors[15,16)], the extent of rise in ESR and CRP were more apparent in SI than SD and the infection percentage of SI was higher than SD. Compared with non-infection population, there were no specific predisposing factors for patients with infection.

To summarize the characteristics of each surgery ; For the cases without infection, in SD, after small increase of ESR, CRP and WBC, they were declined on. In SI, both the ESR and CRP markers elevated rapidly, but there was no big difference in WBC observed. Instrumentation itself affected two parameters. These differences, especially in CRP, were thought to be a direct result of tissue injury inflicted by extensive tissue damage during the PLIF or PLF procedures. But apparent decline of CRP on a week after surgery can be observed on both SD and SI without infection. For the cases with infection, in SD the ESR was elevated elastically from day 3~4 after the surgery and had a difference with the cases without infection, and CRP showed a specific pattern without apparent decline for about a week. Thus both markers were helpful in diagnosis. But In SI, the increase width and persistence of ESR did not have significant difference with the cases without infection, thus it was considered to be difficult to diagnose the infection from the ESR increase before checking the persistence of increased CRP. For the cases with infection, the WBC showed a prolonged rise representing the possibility of infection, and had an irregular decline.

As reported by other authors[16,18)], the results of this study showed that due to the non-specific nature of ESR compared to CRP, the diagnostic value of ESR for the early diagnosis of infection was reduced. This variability of ESR was more serious in SI. Comparing two markers, ESR and CRP, CRP in case without infection showed a rapid descending curve that stabilized after 6days, but ESR showed a gradual elevation that remained for 1~2weeks. Particularly in the case of instrumentation, ESR sustained a large rising curve and had various sustained periods which could be overlapped with ESR reaction with infection, which could cause the physician to fall into confusion. Although it is widely used for postoperative infection diagnosis, ESR was unclear as an early detection marker for its variation[4,10,13,14)]. Kapp and Sybers suggested ESR as only a marker for questioning early infection of simple surgery without instrumentation.[9)]

The reason why ESR's diagnostic dependency is reduced is because there are many parametric factors such as red blood cell size and number, and the density of serum which can control ESR. These parameters can be affected by any type of surgery[5)]. Also effects on ESR by instrumentation itself can increase the non-specificity of ESR. Therefore, if the diagnosis of postoperative infection is only based on the data of ESR, one has to know whether ESR has increased or not preoperatively and make sure that judgments about the existence of infection should be based on the information from continuous ESR changes instead of absolute values[4,9,10,14)]. In addition, ESR changes can be used for checking the patient's reaction to treatment after diagnosis of infection[3)].

Even though there are some problems with CRP as a basic

screening test because CRP is also related with several parameters, CRP can be suggested to be a reliable infection marker due to the specificity with which normal value is reached more uniformly after surgery without infection than ESR[12,14,18]. In our study, although changes of CRP level with instrumentation were similar to that of ESR level, the stabilization curve of CRP which declined rapidly in the case without infection was apparent. Therefore, CRP was proved to be a most sensitive marker for early detection of postoperative infection on about 7days after surgery.

WBC was considered as reference marker because it showed various irregular declines with infection even though it has a characteristic early decline without infection.

ESR is an important marker for suspecting infection after spinal surgery, but CRP is more specific marker for diagnosing infection in spinal surgery. So, with the careful observation of serial ESR and WBC value on the basis of knowledge of the CRP, surgeon can make an early diagnosis of postoperative wound infection.

However, because it is possible to have delayed infection besides the immediate wound infection after the surgery, continuous attention should be paid to clinical symptoms of patients who complain about like backache as well as clinical findings like fever and muscle tenderness[11,19].

Conclusion

Since ESR, CRP and WBC from the blood test after lumbar spine surgical treatment increase in different patterns according to the surgical types respectively and normalized, it is necessary to understand the change pattern of inflammatory parameters in the early postoperative phase and to have fast diagnosis base on these information. Each marker can help in the diagnosis of infection, but CRP is the most sensitive marker and if there is persistent elevation or second rise around a week after the surgery, the wound infection should be considered.

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