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Comparison of erythrocyte sedimentation rate and C-reactive protein in patients with distal radius fractures according to the prophylactic antibiotic period: 1 day versus 1 week

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Purpose: Surgical site infection is a serious postoperative complication. Most surgical site infections after distal radius fracture (DRF) surgery are superficial and early-onset, and they can be prevented by prophylactic antibiotics. The erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) are representative inflammatory markers. The aim of this study was to compare serial serum ESR and CRP levels in DRF patients according to the period of prophylactic antibiotic use.

Methods: A retrospective study was conducted on 46 patients with DRF treated with internal fixation. Twenty-two patients treated between September 2019 and March 2020 were in group A and 24 patients who underwent treatment from September 2020 to March 2021 comprised group B. The patients in group A were administered the first-generation cephalosporin for 1 week, as was customary. Group B received 1-day antibiotic prophylaxis. Surgery was performed by a single surgeon using volar locking plates. The surgical wounds and serum ESR and CRP levels were examined before surgery, 2 days after surgery, and 1 week after surgery and compared between the two groups.

Results: The CRP level, but not the ESR, changed significantly over time within each group. However, no statistically significant difference was observed between the two groups, and there were no surgical site infections.

Conclusion: The use of prophylactic antibiotics for 1 week had no significant effect on reducing ESR and CRP compared to 1-day prophylactic antibiotics in patients with DRFs.

Keywords: Radius fractures, Surgical wound infection, Antibiotic prophylaxis

Introduction

Surgical site infection (SSI) is one of the serious postoperative complications. SSIs not only increase morbidity but also have an economic burden on patients and society. If prophylactic antibiotics are administered appropriately, the incidence rate can be reduced by 35% [1]. Antibiotic prophylaxis is widely used and it has been shown to lower infection rates in closed fracture surgery and arthroplasty [2,3]. The first-generation cephalosporin, such as cefazolin, is used as a prophylactic antibiotic.

The SSI of distal radius fractures (DRFs) is known to be 4.25% among patients who were treated with volar plate fixation [4]. A widely used classification system for SSI after fracture fixation is based on the time of onset after surgery: early (< 2 weeks), delayed (2–10 weeks), and late (> 10 weeks) [5,6]. Early-onset SSIs are

mostly caused by the high-virulence pathogen *Staphylococcus aureus*, followed by infectious symptoms such as pain, swelling, redness, and so on. Most SSIs after DRF surgery are superficial, early-onset, and could be treated with proper antibiotics [7,8].

The use of antibiotic prophylaxis is recommended within 24 hours after wound closure. Use longer than 24 hours may not only be beneficial but also contribute to antibiotic resistance. However, domestic studies evaluating the appropriateness of preventive antibiotic use have shown poor compliance [9,10]. We used preventive antibiotics for 1 week before the antibiotic adequacy evaluation in 2020, but prophylactic antibiotics have been administered only for 1 day after the evaluation. We sought to identify differences between 1-day and 1-week use of prophylactic antibiotics in DRFs by checking serial surgical wound, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) level, which help to detect early-onset SSIs.

Methods

Ethics statement: The study was approved by the Institutional Review Board of the Soonchunhyang University Gumi Hospital (No. 2021-04) and informed consent was waived due to the retrospective nature of this study.

We used prophylactic antibiotics for 1 week before the antibiotic adequacy evaluation as usual, but prophylactic antibiotics have been administered only for 1 day from one month before the evaluation. The ninth antibiotic adequacy evaluation in 2020 was performed from October 2020 to December 2020. Therefore, we set study periods such as September 2020 to March 2021 and September 2019 to March 2020.

Patients were included if they were over 20 years old with one side DRF, not both sides. Also, they were excluded if they had cancer, liver cirrhosis, other hematologic illness, or multiple fractures that required surgery.

Group A patients were administered the first-generation cephalosporin (cephazedone sodium 1 g, twice a day) for 1 week. We have used 1-day antibiotic prophylaxis (before incision and 12 hours after surgery) in group B since September 2020, when the antibiotic adequacy evaluation was performed.

The operations were performed by a single surgeon. The modified Henry approach was used, and then volar locking plates were applied. ESR and CRP levels were examined before surgery, day 2 after surgery, and week 1 after surgery, including complete blood count with differential count, chemistry. Surgical wounds were dressed every other day and checked by grade according to a surgical wound classification system [11]. If SSI symptoms such as swelling, redness, heating sense or discharge, etc. occurred in a surgical wound and ESR or CRP was elevated, antibiotics should be used until the wound was clear and ESR or CRP was normal.

The IBM SPSS Statistics ver. 25.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis of clinical results. The p-values were calculated using the Student t-test, Mann-Whitney U-test, Pearson chi-square test, and Fisher exact test. The statistical significance was assumed at $p < 0.05$. To compare repetitive values of ESR and CRP, log transformations were performed on non-normative variables and then compared by repeated measures analysis of variance.

Results

The study included a total of 49 patients who underwent open reduction and internal fixation due to DRFs, 25 patients (group A) from September 2019 to March 2020 and 24 patients (group B) from September 2020 to March 2021. Three patients were excluded from group A because one patient had metastatic cancer and two patients had liver cirrhosis. Finally, 22 patients in group A and 24 patients in group B were involved in the study (Table 1). The mean age of patients was 62.5±12.4 years in group A and 64.7±11.7 years in group B. The proportion of female patients was 72.7% in group A and 79.2% in group B. The mean body mass index (BMI) was 23.3±2.3 kg/

Table 1. Demographic profile of the patients

Characteristic	Group A	Group B	p-value
No. of patients	22	24	
Age (yr)	64.7±11.7	62.5±12.4	0.541
Sex			0.609
Male	6	5	
Female	16	19	
Fracture site			>0.999
Right	11	12	
Left	11	12	
Body mass index (kg/m^2)	24.0±3.3	23.3±2.3	0.408
Operation time (min)	36.4±9.6	33.5±5.5	0.342
Time to surgery (day)	8.0±4.0	6.3±2.6	0.154
AO classification			0.866
Type A	7	7	
Type B	3	4	
Type C	12	13	

Values are presented as number only or mean±standard deviation.
Group A, the group administered antibiotic prophylaxis for 1 week; group B, the group administered antibiotic prophylaxis for 1 day.

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m^2 in group A and 24.0±3.3 kg/m^2 in group B. According to the AO classification, there were seven cases of type A, three cases of type B, and 12 cases of type C. Group B had seven cases of type A, four cases of type B, and 13 cases of type C; and there was no statistically significant difference between the two groups.

The surgery was performed on the right wrist in 23 patients and on the left wrist in 23 patients in both groups. The median operation time was 34.9 minutes (range, 23–57 minutes). The median time to surgery was 7.1 days (range, 1–17 days). Patient demographics for each group are summarized in Table 1. There was no statistically significant difference in patient demographics between the two groups ($p>0.05$).

In all cases in group B and 21 cases in group A, surgical wounds were clean. Only one case in group A, surgical wound was clean-contaminated 2 days after surgery. However, antibiotics were used until the first week of surgery in group A, and the surgical wound was clean after the first week of surgery.

The mean ESR levels on the day before surgery, day 2 after surgery, and week 1 after surgery were 22.3±15.9 mm/hr, 20.2±17.0 mm/hr, and 18.9±13.5 mm/hr in group A and 12.8±8.9 mm/hr, 11.6±7.0 mm/hr, and 13.3±9.8 mm/hr in group B (Fig. 1). There was no significant difference in the change of ESR over time ($p=0.393$).

The mean CRP levels on the day before surgery, day 2 after surgery, and week 1 after surgery were 0.3±0.2 mg/dL, 1.9±1.4 mg/dL, and 0.5±0.7 mg/dL in group A and 0.5±0.7 mg/dL, 3.3±3.3 mg/dL, and 0.6±0.8 mg/dL in group B (Fig. 2). There was a statistically significant difference in CRP changes over time ($p<0.001$); however, there was no statistically significant difference between the two groups ($p=0.076$).

Discussion

One of the complications in DRF surgery is infection. According to the multicenter retrospective study, 4.25% in total were almost superficial infections and then required antibiotic treatment for more than 7 days [4]. A nationwide cohort study revealed that about 5% of patients treated with plate fixation were SSIs [12].

A meta-analysis revealed that prophylactic antibiotics reduced SSIs after hip fracture surgery [13]. Also, antibiotic prophylaxis has been effective for reducing SSIs related to internal fixation of other closed fractures [14]. This antibiotic prophylaxis after surgery is administered not to sterilize the tissues but to modulate intraoperative contamination of the surgical wound to a level that will not overwhelm the host defenses [15]. Continuing prophylactic antibiotics longer than 1 day after wound closure has not proven beneficial [16]. There was also the first study on the duration of prophylactic antibiotics in DRF, and the use of prophylactic antibiotics for more than 24 hours was of little benefit in reducing the infection rate compared to those used more than that [17].

A study on antibiotic prophylaxis before Kirschner wire (K-wire) fixation for DRFs showed that the use of preventive antibiotics did not affect the rate of infection [18]. However, infection rate of DRF patients treated with external fixation was much higher than that of DRF patients treated with internal fixation [19,20]. Persistent pin exposure could be an infection source, so prophylactic antibiotics might be useless. Some stud-

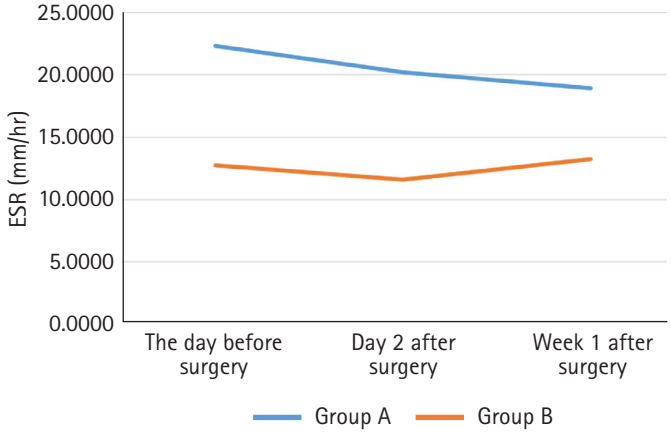

Fig. 1. Erythrocyte sedimentation rate (ESR) values over Group A, the group administered antibiotic prophylaxis for 1 week; group B, the group administered antibiotic prophylaxis for 1 day.

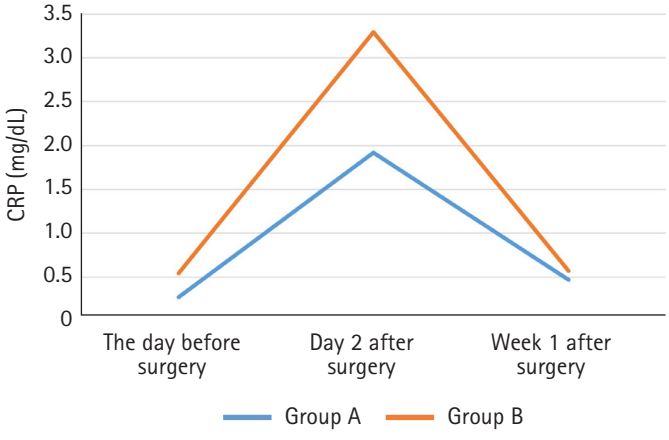

Fig. 2. C-reactive protein (CRP) values over Group A, the group administered antibiotic prophylaxis for 1 week; group B, the group administered antibiotic prophylaxis for 1 day.

ies recommend that all pins and K-wire be buried under the skin to prevent infection [8,21].

ESR and CRP are representative inflammatory markers. CRP is an acute-phase protein synthesized by hepatocytes and it is a sensitive laboratory parameter for bacterial infection [22,23]. A continuous or new increase in CRP level after the initial peak could be a signal of an infectious complication [24]. Therefore, CRP screening is a simple and reliable test for the detection of early infectious complications after spinal surgery [25]. On the other hand, the ESR peak occurs on approximately the 5th postoperative day and decreases more slowly and with a more irregular pattern than CRP. ESR has limitations in detecting early wound infection [26]. These trends are also seen in this study. CRP is a good and reliable marker for detecting early SSIs for DRFs.

For the proper use of prophylactic antibiotics, there is a guideline that (1) antibiotic prophylaxis is used 30 to 60 minutes prior to incision, (2) first-generation cephalosporin is used, (3) prophylactic antibiotic administration period is limited to 1 day after surgery, (4) the dosage should be increased in obese patients, and (5) the administration should be redosed during surgery if the surgery time is longer or the blood loss exceeds 1,500 mL during surgery [15,27-29]. However, in the evaluation of the adequacy of preventive antibiotics, it was clearly revealed that surgery that was not subject to evaluation did not use properly according to the preventive antibiotic guidelines [30]. Therefore, it is necessary to follow the guidelines for preventive antibiotics as much as possible in surgery that usually requires the use of prophylactic antibiotics.

There are several limitations to our studies. First, it is a retrospective study, not a prospective. Second, the number of patients included in this study was not large. In the future, we will conduct research on preventive antibiotics for many DRF patients.

There was no difference in CRP levels between 1-day and 1-week antibiotic prophylaxis in DRFs. Herein, 1-day the first-generation cephalosporin usage could be sufficient for prophylactic antibiotic.

Conclusion

The use of antibiotics for more than 1 day after DRF surgery is not very effective in reducing ESR and CRP or lowering the infection rate compared to the use of antibiotics for only 1 day.

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Conflicts of Interest

The authors have nothing to disclose.

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