Effective prevention of surgical site infection using a Centers for Disease Control and Prevention guideline–based antimicrobial prophylaxis in lumbar spine surgery

Masahiro Kanayama, M.D., Tomoyuki Hashimoto, M.D., Keiichi Shigenobu, M.D., Fumihiro Oha, M.D., and Daisuke Togawa, M.D.

Spine Center, Hakodate Central General Hospital, Hakodate, Hokkaido, Japan

Object. Antimicrobial prophylaxis (AMP) reduces the rate of surgical site infection (SSI) in lumbar spine surgery, but a great deal of variation exists regarding the timing and duration of AMP. The authors had previously used prophylactic antibiotics for 5 to 7 postoperative days. Based on the Centers for Disease Control and Prevention (CDC) guideline, the AMP period was changed to the day of surgery only. In the current study, the authors compared the rate of SSI in lumbar spine surgeries between two different protocols of AMP.

Methods. Data from 1597 consecutive uninfected patients who had undergone lumbar spine surgery between January 1999 and September 2004 were reviewed. The pathophysiology among these patients included disc herniation in 686, degenerative spondylolisthesis in 340, spinal stenosis in 259, failed lumbar surgeries in 73, degenerative scoliosis in 52, isthmic spondylolisthesis in 48, spinal trauma in 34, foraminal stenosis in 27, spinal tumor in 27, and miscellaneous in 51 patients. The rate of SSI was compared between the two AMP groups.

There were 1133 patients in the multiple-dose group, and 464 patients in the single-dose group. The rate of instrumentation surgery was not statistically different between the multiple-dose group (43%) and the single-dose group (39%). The overall rate of SSI was 0.7%. The SSI rate was 0.8% in the multiple-dose group and 0.4% in the single-dose group; the difference between the two was not significant. Regarding the organisms of SSI, resistant strains of bacteria were cultured in five (83.3%) of six patients in the multiple-dose group, whereas none was cultured in the single-dose group.

Conclusions. Data in the current study did not demonstrate a difference in the rate of SSI between the two different AMP protocols. Based on the CDC guideline, a single dose of AMP was proven to be efficacious for the prevention of SSI in lumbar spine surgeries. A shorter duration of first-generation cephalosporin use may effectively prevent the emergence of antibiotic-resistant bacterial infection.

Key Words: • surgical site infection • lumbar spine surgery • antibiotic prophylaxis • Centers for Disease Control and Prevention

Surgical site infection is a devastating complication in spine surgeries, and appropriate prevention is a key to successful lumbar surgeries. The incidence of postoperative spinal infection increases with the complexity of the procedure and is reported as less than 1% in discectomy and as high as 10% in instrumentation surgery. The use of prophylactic antibiotics has been documented to reduce the rate of SSI. For example, the rate of SSI in lumbar spine surgery has been reported as 1 to 4% with prophylactic antibiotics and 6 to 13% without them. Note, however, that a great deal of variation exists regarding the optimal timing and duration of prophylactic antibiotics for lumbar spine surgeries. In 1999, the CDC proposed a guideline for the prevention of SSI. The guideline recommends timing the infusion of the initial dose of antibiotics so that a bactericidal concentration is established in serum and tissues by the time of skin incision and maintaining the therapeutic level of the drug in both serum and tissues throughout the operation and until, at most, a few hours after wound closure.

In the current study we compared the rate of SSI in lumbar spine surgeries between the different protocols of AMP.

Clinical Material and Methods

Until December 2002, we administered prophylactic antibiotics intravenously for 5 to 7 days after lumbar spine surgeries. In January 2003, based on the CDC guideline, we revised the protocol for AMP. In the revised protocol, antibiotics were given only on the day of surgery. A first-generation cephalosporin was administered unless the patient had a history of a significant allergy such as anaphylactic shock, systemic skin eruption, or toxic liver dysfunction.

Surgery was performed in a laminar airflow operating facility. The surgical site was routinely irrigated using first-generation cephalosporins every hour during surgery. Suction drains were routinely left in posterior spinal wounds where fusions had been performed and were removed 2 to 3 days after the procedure. The preoperative AMP protocol was not changed; that is, antibiotics were given 30 minutes before skin incision. An additional dose was administered every 3
hours to maintain therapeutic levels throughout surgery.

During a 5-year period (between January 1999 and September 2004), 1597 consecutive uninfected patients underwent lumbar spine surgery. The present study was based on a retrospective analysis of the prospective database, which included patient age and sex, diagnosis, type of surgery, use of instrumentation, revision surgery for postoperative complications, and so forth. There were 912 male and 685 female patients with a mean age of 55.4 years. A wide variety of diagnoses were treated among these patients. The pathophysiology included 686 cases of lumbar disc herniation, 340 of degenerative spondylolisthesis, 259 of lumbar spinal stenosis, 73 of failed lumbar surgeries, 52 of degenerative scoliosis, 48 of isthmic spondylolisthesis, 27 of foraminal stenosis, 27 of spinal tumor, 18 of spinal trauma, 16 patients with osteoporotic vertebral collapse, and 51 of various others.

The patients were divided into two groups based on the AMP protocol. Multiple-dose group patients received antibiotics for 5 to 7 days after surgery. Single-dose group patients received antibiotics only on the day of surgery. First-generation cephalosporins were routinely used in both AMP protocols. Of the 1597 patients, 1133 composed the multiple-dose group; 464, the single-dose group. The proportion of patients who underwent instrumentation surgery was 43% (483 of 1133 patients) in the multiple-dose group and 39% (182 of 464 patients) in the single-dose group.

Infection was detected by a positive wound culture and/or typical infectious signs including a purulent exudate, surrounding erythema, and wound fluctuate. Laboratory studies were also referenced, such as prolonged elevation in the C-reactive protein value. Infected patients were treated based on the severity of the infection. The rate of SSI was determined according to the number of wound infections requiring additional surgical interventions. Late infections—those occurring more than 6 months after the initial surgery—were not included in this study. No patients were lost to the follow-up evaluation period. The rate of SSI was compared between the single-dose group and multiple-dose group. The effect of instrumentation was also evaluated.

Results

Eleven of 1597 patients incurred an SSI requiring additional surgeries; thus, the overall rate of SSI was 0.7%. There were three infections (0.3%) out of 932 posterior decompression procedures, and eight infections (1.2%) out of 665 instrumentation surgeries. The rate of SSI appeared to be higher in patients who had undergone instrumentation surgery, but the difference was not significant. Four of the 11 infected patients were treated successfully with a single procedure of wound drainage and debridement. The remaining seven patients underwent multiple surgeries including a closed irrigation-suction procedure. To cure the infections spinal implants were removed in most of the patients who had received instrumentation. Parenteral antibiotics were administered for several weeks.

Infection occurred in nine (0.8%) of the 1133 patients in the multiple-dose group and in two (0.4%) of the 464 patients in the single-dose group; the difference was not significant. In the cases in which spinal instrumentation was placed, the rate of SSI was 1.4% (seven of 483 patients) in the multiple-dose group and 0.5% (one of 182 patients) in the single-dose group. The rate of SSI in patients who had undergone posterior decompression surgeries was 0.3% (two of 650 patients) in the multiple-dose group and 0.4% (one of 282 patients) in the single-dose group. Regardless of whether spinal instrumentation was used, a single dose of AMP did not increase the rate of SSI.

Of nine SSIs in the multiple-dose group, seven were deep wound infections and two were superficial. Coagulase-negative staphylococci were cultured from three patients, methicillin-resistant *Staphylococcus aureus* in two, and gram-positive bacillus in one. Despite apparent signs of infection, no organisms were cultured in three patients. There was one *Staphylococcus aureus* and one *Enterococcus faecalis* infection in the single-dose group, which were not resistant strains of bacteria. Both of these SSIs were deep wound infections.

Thus, regarding the cultured organisms in SSI, resistant strains of bacteria were detected in five (83.3%) of six patients in the multiple-dose group, but none in the single-dose group.

Discussion

Surgical site infection is a devastating complication in spine surgeries that prolongs the duration of the hospital stay, increases medical expenditures, and worsens the quality of life.\(^5,16,18\) Since the study by Horwitz and Curtin in 1975,\(^6\) prophylactic antibiotics have been the standard of care for patients undergoing lumbar spine surgery to prevent postoperative infection.\(^5,11,13,14\) Rubinstein and colleagues\(^15\) investigated the efficacy of a single dose of 1 g of cefazolin in reducing postoperative infection in uninfected patients undergoing surgery on the lumbar spine. In their double-blind randomized trial, there were nine wound infections (12.7%) in the 71 patients who had received placebo and three (4.3%) in the 70 patients who had received cefazolin. Barker\(^1\) also performed a systematic review of a randomized controlled study and showed that infection rates were 2.2% (10 of 451 patients) with antibiotics and 5.9% (23 of 392 patients) without antibiotics.

In 2001, the Japan Spine Research Society performed a nationwide survey on complications of the spine, enrolling 16,157 patients who had undergone spine surgery at 196 institutes. Spinal instrumentation was used in 5497 patients (34.0%). They reported an overall SSI rate of 0.9%.\(^5\) Note, however, that each hospital obviously had a different AMP protocol, and therefore the study data could not reveal the optimal timing and duration of AMP for lumbar spine surgeries. The proper duration of prophylactic antibiotic use has long been an issue of debate.\(^5,19\)

Wimmer and colleagues\(^10\) examined 850 spinal procedures to determine the risk factors for SSI, and they recommended the extended use of prophylactics in posterior instrumentation. However, Dobzyniak and associates\(^7\) reviewed data from 635 patients who had undergone lumbar discectomy and reported that a single preoperative dose of antibiotics did not increase the risk of SSI after lumbar disc surgery.

In the current study we evaluated a larger number of patients and different types of lumbar surgeries and found that a single dose of AMP effectively prevented SSI in lumbar spine surgeries, even in cases involving the use of spinal instrumentation. These results supported the findings report-
Antibiotic prophylaxis in lumbar spine surgery

ed by Dobzyniak et al. Moreover, in the current study, antibiotic-resistant strains of bacteria were detected in 83.3% of the cultured organisms in the multiple-dose group but in none in the single-dose group. This finding suggested that unwarranted or prolonged use of antibiotics might increase the likelihood of incurring an infection with an emergence of antibiotic-resistant microbial pathogens.

The choice of prophylactic antibiotic is another important factor in preventing SSI. Authors of many trials in which cefazolin was compared with second- and third-generation cephalosporins have failed to show any difference in efficacy. Cefazolin should be the first-line agent for prophylaxis. Broad-spectrum third-generation agents should be reserved for therapeutic purposes. Results in the current study also showed that 83.3% of infectious organisms in the multiple-dose group were resistant strains of bacteria, whereas none in the single-dose group were resistant. A shorter duration of first-generation cephalosporin use might effectively prevent the emergence of antibiotic-resistant bacterial infection.

The current study had several limitations that must be addressed. One criticism is related to the definition of SSI. We defined SSI as a postoperative wound infection requiring additional surgical interventions. Given that most SSIs were superficial and could be managed with antibiotics and local wound care, the rate of SSI might be underestimated in the current study. However, we aimed to compare the rate of SSI between the two different AMP protocols, not to compare the SSI rate in the current study with that published in the literature. From this standpoint, the definition of SSI must be consistent between the two groups. If nonsurgically treated superficial wound infections had been included, the definition of SSI might be obscured and have potential bias.

The retrospective nature of the study might also be a relative weakness. However, previous prospective randomized trials of antibiotic prophylaxis in spine surgeries have been underpowered, thus raising the possibility that a type II error was introduced. A large number of samples is required to detect the difference in SSI rates between the different protocols of antibiotic prophylaxis. As Dimick and colleagues pointed out, for baseline wound infection rates of 10, 5, and 2%, it would be necessary to enroll 474, 988, and 2518 patients, respectively, in each treatment group. Clearly, the magnitude of this number indicates that a clinical trial is unlikely to occur. Considering the low incidence of infection in lumbar surgeries, a retrospective investigation of a large number of patients is more reasonable. In the current study we evaluated the data from 1597 lumbar spine surgeries, which represents one of the biggest retrospective investigations. We believe this study provides informative data to surgeons managing lumbar spine disorders.

Conclusions

A review of 1597 consecutive uninfected patients who underwent lumbar spine surgery revealed that SSIs developed in 0.7% of cases. No statistical difference was observed between the different AMP protocols. The CDC guideline-based AMP (perioperative and postoperative single dose of first-generation cephalosporin) effectively prevented SSI in lumbar spine surgeries and the emergence of resistant-strain bacterial infections.

References