

Is Postoperative Antimicrobial Prophylaxis Needed for the Management of Surgical Site Infection after Spinal Instrumentation Surgery?

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Abstract

Background: It is widely accepted that postoperative Antimicrobial Prophylaxis (AMP) is effective in reducing the risk of surgical site infections (SSI) following spinal surgery. After publication of the Guideline for Prevention of Surgical Site Infection by the Centers for Disease Control and Prevention in 1999, a large number of studies confirmed the effectiveness of AMP. Due to the possible emergence of AMP resistant bacteria or appearance of side-effects, we have treated and managed patients who underwent spinal surgery without post operative antimicrobial agents since 2003.

Purpose: To investigate the incidence of SSI in patients without administration of antibiotics after spinal instrumentation surgery.

Subjects: A consecutive 468 patients (230 males and 238 females) were adopted in this study from November 2003 to June 2010. Mean age at the time of operation was 52.1 years. We defined this group as the non-postoperative dose group. There were 121 patients (25.9%) who underwent instrumentation surgery. On the other hand, we defined patients who were administered postoperative multiple doses of AMP between January 2000 and October 2003 as the postoperative dose group. There were 340 cases, consisting of 198 males and 142 females in this group. Average age at the time of operation was 51.3 years. There were 146 patients (42.9%) who underwent spinal instrumentation surgery.

Methods: All patients were administered 1 g of cefazolin within 30 minutes of skin incision, and the same dose of antimicrobial agent was added every four hours during surgery in the non-postoperative dose group. We administered AMP before and for 7 days after surgery in the postoperative dose group.

Results: The postoperative infection rate was 1.92% (9 cases), of which 7 cases were superficial infections and 2 cases were deep infections in the non-post operative dose group. In the post operative dose group, there were 9 confirmed post operative wound infections in the 340 patients for an overall SSI rate of 2.65%. There was no significant difference between the two groups. The incidence of SSI in patients who underwent spinal instrumentation surgery was 0.83% (one of 121 patients) in the non-postoperative dose group and 2.04% (three of 147 patients) in the postoperative dose group. There was no significant difference between the two groups even with the use of spinal implants.

Conclusions: The duration of antimicrobial prophylaxis was not related to the SSI rate at our institution. Postoperative administration of antibiotics appears to be unnecessary for spinal surgery even with spinal implants when perioperative management was achieved for the patient condition and surroundings as recommended in the CDC guidelines.

Introduction

Postoperative surgical site infection (SSI) is a significant complication in spine surgery because it may require a reoperation to control local infection and to prevent septic condition. The incidence of SSI is reported to be from less than 1% in decompressive surgery to 10% in instrumentation surgery [1-5]. The American Centers for Disease Control and Prevention (CDC) proposed a guideline for the prevention of SSI in 1999 [6]. In the guideline, there were many factors that were recommended to prevent SSI in the perioperative management. For example, the care for the condition of the patient [7], the surgical site, the operator [8] and the operating room [9] are all important factors in preoperative and intraoperative management. Also, drainage [10] and surgical site care [11] are also important as postoperative management. Moreover, the use of anti microbial prophylaxis (AMP) has been documented to play a significant role in reducing the rate of SSI. There were many topic points about antibiotic prophylaxis in spine surgery included in the North American Spine Society evidenced-based clinical guidelines in 2007 [12]. They included efficacy, protocol, redosing, discontinuation, wound drains, body habitus, and comorbidities. It was pointed out that there was poor evidence as to whether AMP results in decreased infection rate as compared to patients who do not

receive prophylaxis according to the guideline. After the publication of the NASS guidelines, Kanayama et al. [13] reported the rate of SSI was not different between single day dose administration based on the CDC guidelines and multiple day doses of AMP in lumbar spine surgery with or without implants. However, nowhere in the current literature are there consistent recommendations regarding the duration of administration of postoperative antibiotics in spine

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surgery with spinal implants. We should accumulate more data about the efficacy of postoperative AMP for spine surgery with or without implants. The purpose of this study was to investigate the incidence of SSI prospectively in patients without administration of antibiotics after spinal surgery, and to elucidate the efficacy of AMP in patients with or without instrumentation surgery if perioperative management was performed according to the CDC guidelines. It was hypothesized that no increased infection rate would be identified in patients with spinal surgery with implants receiving only preoperative and intraoperative antibiotics.

Methods

Until October 2003, we administered prophylactic antibiotics (*cephalosodium* 2000 mg/day in adults and 40 mg/kg/day in children) intravenously for between 5 and 7 days after spine surgeries. We did not use it in the preoperative and intraoperative periods at that time. From November 2003, we administered prophylactic antibiotics via intravenous drip infusion only in the preoperative and intraoperative periods in all consecutive spinesurgeries as a prospective study. Patients with preoperative pyogenic spondylitis and septic wound condition were excluded in this study. A first generation cephalosporin was administered as the first choice unless the patient had a history of a significant allergy such as anaphylactic shock, systemic skin eruption, or toxic liver dys function. In our protocol for preventing SSI, preoperative antibiotics were administered within 30 minutes before skin incision, and then the surface of the surgical site was cleanly washed using chlorhexidine in the preoperative period. Intraoperatively, an additional dose of antibiotics was given every four hours. If the operation was completed within 4 hours, no additional antimicrobial agent was given in our protocol. The surgical site was irrigated using only saline solution as often as possible during the surgery, and finally a large amount of saline solution was used before closing the surgical site. In the postoperative period, the surgical site was managed with continuous negative pressure suction drainage that was removed 48 hours after surgery. From November 2003 to March 2010, a total of 468 patients, consisting of 230 males and 238 females were included in this study. We defined this group as the non-postoperative dose group. Average age at the time of operation was 52.1 ± 21.6 years, and the age distribution is shown in Table 1. Average operation time was 179.3 ± 100.7 minutes and average blood loss was 207.2 ± 359.6 ml. Pathophysiologies included degenerative disorder in 275 cases (58.8%), intradural tumor in 79 cases (16.9%), trauma in 47 cases (10.0%), scoliosis in 44 cases (9.4%), and spinal tumors, which includes primary and metastatic bone tumors of the spinal column in 23 cases (4.9%). The main surgical region was cervical in 185 cases (39.5%), lumbar and sacral in 177 cases (37.8%), and thoracic in 106 cases (22.7%). There were 121 patients who underwent spinal instrumentation surgery. The percent of those needing instrumentation was 25.9% (Table 1). On the other hand, we defined patients who were administered postoperative multiple doses of AMP between January 2000 and October 2003 as the postoperative dose group. There were 340 cases, consisting of 198 males and 142 females in this group. Average age at the time of operation was 51.3 ± 20.7 years, and the age distribution is shown in Table 1. Average operation time was 231.9 ± 136.4 minutes and average blood loss was 393.8 ± 547.7 ml. Pathophysiologies included degenerative disorder in 184 cases (54.1%), intradural tumor in 54 cases (15.9%), trauma in 49 cases (14.4%), scoliosis in 28 cases (8.2%), and spinal tumor in 25 cases (7.4%). The main surgical region was cervical in 142 cases (41.8%), thoracic in 101 cases (29.7%), and lumbar and sacral in 97 cases (28.5%). There were 146 patients (42.9%) who underwent spinal instrumentation surgery (Table 2). The identification of SSI involves interpretation of clinical and laboratory findings. Clinical signs include

a purulent exudate, surrounding erythema, and wound fluctuance. Laboratory data was referenced prolonged elevation in the value of white blood cells, C-reactive protein and erythrocytose dimentation. Superficial SSI involves only skin or sub cutaneous tissue of the incision. Deep SSI involves fascia and muscle layers of the incision. SSI is defined as infection occurring within 30 days after the operation if no implant is left in place or within 1 year if the implant is in place and the infection appears to be related to the operation [6,14]. All subjects could be assessed as to whether SSIs had occurred within one year in both the non-postoperative dose group and the postoperative dose group. We analyzed the incidence of SSI in the non-postoperative dose group compared with the postoperative dose group. We also investigated the incidence of SSI in patients who underwent instrumentation surgery in both groups.

Statistical Analysis

Data input and calculation were performed with StatView, version 5.0 software (Windows XP version, Abacus Concepts, Berkeley, CA). Comparison of age, duration of surgery and blood loss at the time

Age strata (years)	Postoperative dose group (%)	Non-postoperative dose group (%)
<20	42 (12.4)	70 (14.8)
20-29	23 (6.8)	27 (5.8)
30-39	16 (4.7)	30 (6.4)
40-49	47 (13.8)	46 (9.8)
50-59	70 (20.6)	76 (16.2)
60-69	78 (22.9)	101 (21.6)
70-79	56 (16.4)	99 (21.2)
>80	8 (2.4)	19 (4.1)
Total	340 (100)	468 (100)

Table 1: Age distribution in the postoperative dose group and non-postoperative dose group.

	Postoperative dose group (n=340)	Non-postoperative dose group (n=468)	P value
Age (years)	51.3 ± 20.7	52.1 ± 21.6	P=0.603
Duration of Operation (min)	231.9 ± 136.4	179.3 ± 100.7	P<0.001
Blood loss (ml)	393.8 ± 547.7	207.2 ± 359.6	P<0.001
	n (%)	n (%)	
Sex			
Men	198 (58.2%)	230 (49.1%)	
Women	142 (41.8%)	238 (50.9%)	
Pathophysiology			
Degenerative disorder	184 (54.1%)	275 (58.8%)	
Intradural tumor	54 (15.9%)	79 (16.9%)	
Trauma	49 (14.4%)	47 (10.0%)	
Scoliosis	28 (8.2%)	44 (9.4%)	
Spinal tumor*	25 (7.4%)	23 (4.9%)	
Surgical region**			
Cervical	142 (41.8%)	185 (39.5%)	
Thoracic	101 (29.7%)	106 (22.7%)	
Lumbar and Sacral	97 (28.5%)	177 (37.8%)	
Instrumentation surgery	147 (43.2%)	121 (25.9%)	

*Includes primary and metastatic tumors of the spinal column **Indicates the main region of surgery including those requiring multiple level surgery

Table 2: Summary of patient characteristics in the postoperative dose group and non-postoperative dose group.

of operation between the postoperative dose group and the non-postoperative dose group were performed using the Mann-Whitney U test. The Fischer exact test was used for comparisons for incidence of SSI between the two groups. P values less than 5% were considered to be statistically significant.

Results

There were 9 confirmed postoperative wound infections, which included superficial SSI in 7 and deep SSI in 2, of the 468 patients in the non-postoperative dose group. Overall incidence of SSI was 1.92%. In the postoperative dose group, there were 9 confirmed postoperative wound infections, which included superficial SSI in 4 and deep SSI in 5, of the 340 patients for an overall SSI rate of 2.65%. There was no significant difference between the two groups. The incidence of SSI in patients who underwent spinal instrumentation surgery was 0.83% (one of 121 patients) in the non-postoperative dose group and 2.04% (three of 147 patients) in the postoperative dose group. There was no significant difference between the two groups even with the use of spinal implants (Table 3).

Six (66.7%) of 9 cases with SSI had comorbidities in the non-postoperative group. There were diabetes mellitus in 4 and allergy conditions in 2. Two cases received reoperation, and one who had drug allergy received instrumentation surgery. There was no remarkable data with the time of operation and blood loss. Causative bacteria were methicillin-sensitive *staphylococcus aureus* in 2 cases, and coagulase-negative *staphylococci* in 7 cases in the non-postoperative dose group. There were no antimicrobial resistant bacteria detected. All 9 patients with SSI underwent no surgeries for the wound infection, but they were treated and cured by sensitive antimicrobial agents (Table 4).

On the other hand, 2 (22.2%) of 9 cases with SSI had comorbidities in the postoperative group. Both of these cases had diabetes mellitus. Four cases received spinal reoperation for multiple operative back. There were 4 cases whose time of operation exceeded 4 hours, and 2 cases whose intraoperative blood loss were over 1000 ml. Causative bacteria were coagulase-negative *staphylococci* in 4 cases, *pseudomonas aeruginosa* in one case and methicillin-resistant *staphylococcus aureus* in 2 cases in the postoperative dose group. No bacteria were cultured in 2 cases in this group when clinical signs appeared. All three cases with deep SSI were treated by surgical intervention (Table 5). Thus, regarding the cultured organisms in SSI, resistant strains of bacteria were detected in 2 (22.2%) of 9 patients in the postoperative dose group, but none were detected in the non-postoperative dose group.

Discussion

SSI is a devastating complication in spine surgeries that prolongs the duration of the hospital stay, increases medical expenditures, and worsens the quality of life [15,16]. AMP has been the standard management in lumbar spine surgery to prevent SSI since the report of Horwitz and Curtin in 1975 [2]. There have been many reports that the use of prophylactic antibiotics was effective to prevent SSI even in other spine surgeries [17-24]. Although perioperative use of antibiotics has been accepted as a general concept in surgical management, there were actually few studies that demonstrated evidence of the efficacy, protocol, redosing and discontinuation of AMP. In 2007, the North American Spine Society (NASS) proposed evidence-based clinical guidelines which included recommendations concerning the use of AMP in spine surgery [12]. In these guidelines, there was enough evidence of the efficacy of AMP to recommend intervention, including one meta-analysis of a prospective randomized trial [25] and two randomized controlled trials [26,27]. According to the 1999 CDC

guidelines, an antimicrobial agent was recommended to be initiated before skin incision and the therapeutic level of the drug maintained in both serum and tissues throughout the operation and until, at most, a few hours after wound closure [6]. Kakimaru, et al. [28] reported that the incidence of SSI in patients without postoperative doses of AMP was not significantly different from that in patients with postoperative use of AMP. They concluded that postoperative administration of AMP appeared to be unnecessary for spinalde compression surgery without instrumentation. Kanayama et al. [29] reported that the CDC guideline-based AMP protocol which was defined as perioperative and postoperative single doses of first-generation *cephalosporin* effectively had prevented SSI in lumbar spine surgeries. They indicated that postoperative multiple doses of AMP were not needed and were ineffective to prevent SSI in lumbar spine surgery with or without spinal implants, and might increase resistant-strain bacterial infections. In the current study with over 6 years of follow-up, we prospectively investigated whether postoperative administration of AMP was effective or not for consecutive cases in all spine surgeries regardless of the use of spinal implants. Our results demonstrated that SSI rate including superficial infection was 1.92% (9 of 468 cases) in any spinal surgeries without pyogenic condition when perioperative management was achieved for the patient condition or environment and surroundings as recommended in the CDC guidelines. This rate was similar with the data of a paper reported by Kakimaru, et al. [28]. Concerning the duration of AMP in spinal instrumentation surgery, Wimmer et al. [30] examined 850 spinal procedures to determine the risk factors for SSI, and they recommended the extended use of prophylactics in posterior instrumentation. On the other hand, Kanayama, et al. [29] reported the rate of SSI was 0.5% (one of 182 cases) in lumbar spine surgery with implants with the use of AMP only on the operative day. Mastronardi et al. [21] reported that the incidence of SSI was 0.9% (9 of 972 cases) in any spinal instrumentation surgeries with their preoperative and intraoperative use of AMP protocol (redosing every two hours). The NASS clinical guideline indicated that there were not any high quality studies about postoperative redosing in the instrumentation surgery [4,24,31]. However, these studies demonstrated that the shortening of antibiotic administration was safe and efficacious even if they had the limitations of being retrospective. In our study, the incidence of SSI in patients with instrumentation surgery was only 0.83% (1 of 121 cases) in the non-postoperative dose group. This SSI ratio was similar with the data of the previous two papers. There was no significant difference in the incidence of SSI between patients who had received postoperative AMP and patients who had not received antibiotics after surgery with or without instrumentation. This study was not strong evidence but demonstrated that redosing may not be useful in preventing postoperative infections.

There were overall 4 cases who suffered from SSI after spinal surgery with implants in both groups, and three cases (75%) received reoperation for multiple operated back. Moreover, their operations were longer times and they had more blood loss which may affect the higher prevalence of SSI. Although comorbidities are often discussed as a risk factor of SSI, there was higher prevalence in cases with SSI in the

	Postoperative dose group	Non-postoperative dose group	P value
Overall	2.65% (9/340)	1.92%(9/468)	P=0.6303
Superficial	1.18% (4/340)	1.50% (7/468)	P=0.7683
Deep	1.47% (5/340)	0.43% (2/468)	P=0.1382
Without instrumentation	3.11% (6/193)	2.31% (8/347)	P=0.5814
With instrumentation	2.04% (3/147)	0.83% (1/121)	P=0.6293
*Includes decompression surgery and fusion without implant surgery.			

Table 3: Incidence of surgical site infections of the two groups.

Case No	Age(y)/Sex	Pathophysiologies	Surgical Method	Instrumentation	Operation Time (m)	Blood Loss (ml)	Comorbidities	Type of SSI	Causative Bacteria
1	15/M	Tumor	C3 Osteoid osteoma excision	-	143	100	Skin allergy	Superficial	MSSA
2	27/F	DD	L5/S1 MED	-	80	10	DM	Deep	CNS
3	45/F	DD	L4/5 Herniectomy	-	130	70	None	Superficial	CNS
4	49/M	DD	C3-7 Laminoplasty	-	237	300	DM	Superficial	CNS
5	54/M	DD	C3-7 Laminoplasty	-	148	70	None	Superficial	CNS
6	56/M	DD	C3-7 Laminoplasty	-	187	120	DM	Superficial	CNS
7	60/M	DD	L2/3 TLIF (Reoperation)	+	189	176	Drug allergy	Deep	CNS
8	61/M	DD	C3-7 Laminoplasty	-	165	80	DM	Superficial	MSSA
9	61/M	Trauma	C1/2 PF (Reoperation)	-	260	80	None	Superficial	CNS

DD: Degenerative Disorder; MED: Micro Endoscopic Discectomy; TLIF: Transforaminal Lumbar Interbody Fusion; PF: Posterior Fusion; DM: Diabetes Mellitus; MSSA: Methicillin-Sensitive *Staphylococcus aureus*; CNS: Coagulase-Negative *Staphylococci*

Table 4: Summary of the demographic data of the patients with SSI in the non-postoperative dose group.

Case No	Age(y)/Sex	Pathophysiologies	Surgical Method	Instrumentation	Operation Time (m)	Blood Loss (ml)	Comorbidities	Type of SSI	Causative Bacteria
1	41/F	DD	L3-S1 PLF (Reoperation)	+	506	1143	None	Deep	CNS
2	49/F	DD	L4/5 Herniectomy	-	144	280	None	Superficial	ND
3	49/F	Tumor	L2-4 Intradural tumor resection	-	360	327	DM	Superficial	CNS
4	51/F	DD	C3-7 Laminoplasty	-	180	70	None	Superficial	ND
5	53/F	Scoliosis	T2-S1 PSS	+	760	1175	None	Deep	MRSA
6	63/F	DD	L4/5 PLF L5/S1 PLIF (Reoperation)	+	392	800	None	Deep	CNS
7	63/M	DD	C3-7 Laminoplasty	-	255	323	None	Superficial	CNS
8	66/F	DD	C3-7 Laminoplasty (Reoperation)	-	155	100	DM	Deep	MRSA
9	66/F	DD	SD+ C3-7 Laminoplasty (Reoperation)	-	351	711	None	Deep	P. Aeruginosa

DD: Degenerative Disorder; PLF: Posterolateral Fusion; PSS: Posterior Scoliosis Surgery; PLIF: Posterior Lumbar Interbody Fusion; SD: Suboccipital Decompression; DM: Diabetes Mellitus; MRSA: Methicillin-Resistant *Staphylococcus aureus*; CNS: Coagulase-Negative *Staphylococci*; P. aeruginosa: *Pseudomonas aeruginosa*; ND: Not Detected

Table 5: Summary of the demographic data of the patients with SSI in the postoperative dose group.

current study. There were 6 (66.7%) of 9 cases who had comorbidities with SSI compared with 98 (21.4%) of 459 cases without SSI in the non-postoperative dose group (data not shown).

As a cause of SSI in the perioperative management, many factors were reported such as the care for the condition of the patient, the surgical site care, the operator, the operating room and so on. We believe that it is more important to manage the general status of the patient and perioperative environment than to administer antibiotic prophylaxis. Because our research was a comparative study for the duration of AMP, it may not refer to the efficacy of AMP for spinal surgeries. However, we suggest that there may be at least poor effectiveness of antibiotic administration after spinal operation. Our prospective research demonstrated that postoperative administration of antibiotics might not be effective for spinal surgeries even with spinal implants. The current study had several limitations that must be addressed. One criticism is related to statistical analysis. Previous prospective studies of AMP in spine surgeries have been under powered because of their small number of samples. If the prevalence in one sample is 1%, and the prevalence in a second sample is 2%, over 2000 cases are needed for a statistically significant difference if the 95% confidence intervals of the two prevalence do not overlap [12]. Clearly, the magnitude of this number indicates that a clinical trial is unlikely to occur. In the current study, we evaluated the data from 468 patients, which represents one of the biggest prospective investigations. We believe this study provides informative data to surgeons managing spinal disorders.

Conclusions

The duration of antimicrobial prophylaxis was not related to the

SSI rate at our institution. Postoperative administration of antibiotics appears to be unnecessary for spinal surgery even with spinal implants.

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