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Original article

Evaluation of antimicrobial prophylaxis against postoperative infection after spine surgery: Limit of the first generation cephem

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ABSTRACT

In our department, first-generation cephem (CEZ) are generally administered for 2 days as antimicrobial prophylaxis (AMP) for spinal surgery. However, the incidence of surgical site infection (SSI) has recently increased, particularly cases involving coagulase-negative Staphylococci (CNS) as an etiologic agent.

The objective was to elucidate the problems with the current AMP and the risk factors of SSI through a retrospective investigation of affected cases.

The subjects were patients who underwent spine surgery at our department between August 2007 and June 2013. The subjects were divided into those who developed SSI (S group) and who did not develop SSI (non-SSI (N) group), patients who developed CNS infection in the S group was subdivided as C group, and the risk factors were investigated. The significance of each factor was analyzed using cross tabulation, and multivariate logistic regression analyses were performed with 22 of the investigation factors as explanatory variables.

The incidence of SSI was 2.55%, and the etiologic agent was CNS in 17 patients. Upon comparison between the S and N groups, the presence of 3 or more underlying diseases and blood loss were extracted as significant risk factors. Upon comparison between the C and N groups, emergency surgery and intra- and postoperative steroid administration were extracted as significant risk factors, in addition to the presence of 3 or more underlying diseases and blood loss.

The effect of the current AMP using first generation cephem is limited, and reconsideration of the protocol may be necessary.

1. Introduction

Regarding antimicrobial Prophylaxis (AMP) for spinal surgery, the Centers for Disease Control and Prevention (CDC) published guidelines for the prevention of Surgical Site Infection (SSI) in 1999 [13], and guidelines for the prevention of postoperative bone and joint infections were prepared in Japan in 2006. With reference to these guidelines, the Toho University spine group prepared an AMP protocol comprised of Cefazolin (CEZ) administration for 2 days including the day of operation and has applied it since 2007.

Our countermeasures against SSI for spinal surgery were: shortening of preoperative hospital stay, abolition of shaving, cleaning of the surgical field with povidone iodine before surgery, initial administration of 1 g of CEZ at the time of introduction of anesthesia, additional administration every 2–3 h during surgery, cleaning of the surgical field with saline every hour during surgery, disinfection of the hands and changing gloves every 3 h during a long surgery, and additional CEZ administration every 6–8 h after surgery for a maximum of 2 days including the day of operation.

However, the incidence of SSI after the introduction of these countermeasures in 2007 was 2.55%, which is not low. The time between surgery and on set SSI was 2–143 days, average of 13.5 days. The most frequent etiologic agent was *Staphylococcus epidermidis*, and coagulase-negative Staphylococci (CNS) including *S. epidermidis* accounted for more than half of the cases 58.6%.

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The objective of this study was to retrospectively investigate SSI cases following spinal surgery at our hospital and to assess the current AMP and its problems and limitations.

2. Patient and methods

Of 1180 patients who underwent spinal surgery performed by the Toho University spine group between August 2007 and June 2013, 1137 patients, excluding those with spinal infection and those underwent percutaneous surgery, were selected as the subjects. There were 638 male and 499 female patients, and the mean age was 61.3 (7–91) years old.

SSI was determined according to the Center for Disease Control and Prevention (CDC) definition [13]. The subjects were divided into those who developed SSI (S group) and who did not develop SSI (non-SSI (N) group) SSI, and patients who developed CNS infection in the S group were further divided into the CNS infection group (C group).

Risk factors of SSI were analyzed by comparison between the S and N groups and between the C and N groups.

The investigation factors were: advanced age, gender, presence or absence of DM and collagen disease, multiple spine surgeries, history of cigarette smoking, excess alcohol consumption, BMI, malnutrition, 3 or more underlying diseases, trauma, bladder and rectal disturbance, serious paralysis (Frankel > C), duration of preoperative hospital stay (>7 or ≤7 days), emergency surgery, operative time (min), blood loss (ml), multilevel spinal surgery, anterior surgery, presence or absence of instrumentation, drainage volume (ml), use of steroid, blood transfusion, and admission to ICU(Table 1). BMI (22>; 0, ≥22–25>; 1, ≥25–30>; 2, ≥30; 3), operative time (120 min>; 0, ≥120–300>; 1, ≥300; 2), blood loss (100 ml>; 0, ≥100–300>; 1, ≥300–1000>; 2, ≥1000; 3), and drainage volume (100 ml>; 0, ≥100–300>; 1, ≥300–1000>; 2, ≥1000; 3) were converted to data staged at each cut-point. The significance of each factor was analyzed employing cross tabulation, and multivariate logistic regression analyses were performed. In the analysis, firstly, forced input analysis with all items was performed, followed by extraction of significant risk factors using the stepwise method. Specifically, the forward selection method and backward elimination method were applied, and the p-value, odds ratio, and its 95% confidence interval of each factor were determined. For statistical analysis software, IBM SPSS Statistics, Version 19 (IBM Co. Ltd., USA) was used.

This study was approved by the ethics committee of Toho University School of Medicine (approval number: 27077).

3. Results

On comparison between the S and N groups, significant differences were noted on cross tabulation for the presence of 3 or more underlying diseases ($p = 0.001$), operative time ($p < 0.001$), blood loss ($p < 0.001$), number of surgically treated intervertebral segments ($p = 0.012$), anterior surgery ($p = 0.031$), instrumentation ($p = 0.004$), drainage volume ($p = 0.001$), use of steroid ($p = 0.033$), blood transfusion ($p = 0.021$), and admission to ICU ($p < 0.001$) (Table 2). In the analysis using forced input of all variables, the presence of 3 or more underlying diseases (OR: 3.93; CI: 1.65–9.37; $p = 0.002$) and blood loss (OR: 1.90; CI: 1.00–3.60; $p = 0.050$) were extracted. In the analysis using the forward selection method, significant differences were noted for the presence of 3 or more underlying diseases (OR: 4.12; CI: 1.88–9.04; $p < 0.001$) and blood loss (OR: 2.42; CI: 1.59–3.68; $p < 0.001$), and a tendency toward significance was noted for the anterior surgery ($p = 0.080$). When the analysis was conducted using the backward elimination method, significant differences were noted for the presence of 3 or more underlying diseases (OR: 3.94; CI: 1.80–8.61; $p = 0.001$) and blood loss (OR: 2.40; CI: 1.58–3.65; $p < 0.001$), and a trend toward significance was noted for the use of steroid ($p = 0.075$) (Table 3). In comparison between the C and N groups, significant differences were noted on cross tabulation for the presence of 3 or more underlying diseases ($p = 0.012$), emergency surgery ($p = 0.017$), operative time ($p < 0.001$), blood loss ($p < 0.001$), number of surgically-treated intervertebral segments ($p = 0.048$), instrumentation ($p = 0.041$), drainage volume ($p = 0.019$), and use of steroid ($p = 0.010$) (Table 4). In the analysis using forced input of all variables, advanced age (OR: 4.95; CI: 1.14–21.56; $p = 0.033$) and

Table 1
Patient characteristics.

	N-group	S-group	C-group
Number	1108	29	17
Advanced age (range)	61.3 (7–91)	61.5 (15–81)	64.1 (15–81)
Gender (male/female)	622/486	16/13	9/8
DM (%)	182 (16.4)	2 (6.9)	1 (5.9)
Collagen disease (%)	72 (6.5)	3 (10.3)	2 (11.8)
Multiple spinal surgeries (%)	149 (13.5)	7 (24.1)	5 (29.4)
History of cigarette smoking (%)	320 (31.2)	8 (27.6)	5 (29.4)
Excessive alcohol consumption (%)	48 (4.7)	2 (6.9)	1 (5.9)
BMI (range)	24 (13.7–43.7)	24.8 (18.2–34)	26.1 (19.1–34)
Malnutrition (%)	103 (9.3)	2 (6.9)	2 (11.8)
3 or more underlying diseases (%)	225 (20.4)	14 (48.3)	8 (47.1)
Trauma (%)	21 (1.9)	1 (3.4)	1 (5.9)
Bladder and rectal disturbance (%)	29 (2.6)	0	0
Serious paralysis (%)	72 (6.5)	2 (6.9)	2 (11.8)
Duration of preoperative hospital stay (range)	4.2 (0–196)	5.7 (0–49)	7.4 (0–49)
Emergency surgery (%)	96 (8.7)	4 (13.8)	4 (23.5)
Operative time (range)	167 (20–663)	284 (80–586)	290 (102–586)
Blood loss (range)	298 (0–8160)	1130 (0–6710)	1163 (0–6710)
Multilevel spinal surgery (range)	2.2 (1–14)	4.2 (1–13)	3.7 (1–13)
Anterior surgery (%)	56 (5.1)	2 (6.9)	0
Instrument (%)	483 (43.6)	21 (72.4)	12 (70.6)
Drainage volume (range)	321 (0–2946)	571 (0–1630)	499 (35–1440)
Use of steroid (%)	346 (31.4)	14 (48.3)	10 (58.8)
Blood transfusion (%)	329 (29.8)	15 (51.7)	8 (47.1)
Admission to ICU (%)	40 (3.6)	5 (17.2)	2 (11.7)