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Original Article

Risk factors for surgical site infection following spinal instrumentation surgery

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A B S T R A C T

Background: In spinal instrumentation surgeries, surgical site infection (SSI) is one of the complications to be avoided. However, spinal instrumentation surgeries have a higher rate of SSI than other clean orthopedic surgeries. The purpose of this study was to investigate the risk factors for SSI following spinal instrumentation surgeries and contribute to the prevention of SSIs by identifying high-risk patients.

Methods: Records of 431 patients who underwent spinal instrumentation surgeries from 2011 to 2014 with a minimum follow-up period of 90 days were retrospectively reviewed. Associations of SSI with various preoperative, operative, and postoperative factors were statistically analyzed with univariate and stepwise multivariate logistic regression analysis.

Results: Deep or superficial SSIs were observed in 15 patients (3.5%). Univariate analysis revealed significant association of SSI with diabetes mellitus (odds ratio [OR] 4.7, 95% confidence interval [CI] 1.5−14.4; $p = 0.012$) and serum albumin $\leq$3.5 g/dl (OR 3.35, 95% CI 1.1−10.38, $p = 0.012$). The number of regular medications prescribed in patients with SSI (8.2 $\pm$ 5.4) was significantly more than that in patients without SSI (3.8 $\pm$ 4.4) ($p = 0.001$), and the cut-off value of the number of medications was 7, as derived from receiver operating characteristics analysis. Multivariate analysis revealed that the number of regular medications $\geq$7 was an independent risk factor significantly associated with SSIs (OR 7.3, 95% CI 2.3−24.0, $p = 0.001$).

Conclusions: Our study demonstrated that an important risk factor for SSI after spinal instrumentation surgery was number of regular medications $\geq$7. Number of regular medications is a simple and valuable risk index for SSI, which reflects the influence of medications and comorbidities.

1. Introduction

Surgical site infections (SSIs) after general surgeries are likely to result in a lower quality of life, longer hospital stay, and higher medical costs, and SSIs following orthopedic surgeries are also similar [1,2]. Particularly, spinal instrumentation surgeries have a higher infection rate than other orthopedic implant surgeries. The rate was reported in major articles as follows: 2.3% in 74114 cases of spine surgeries with implants [3], 0.51% in 30491 cases of total hip replacement [4], and 0.72% in 56216 cases of total knee replacement [5]. Joint arthroplasty, which is the representative procedure of clean orthopedic surgeries, is usually an elective surgery. On the other hand, spine surgeries are often needed to be performed as soon as possible, without enough time to evaluate and control the preoperative statuses of patients due to progressive neurological symptoms or instability due to trauma, tumor, and others. Sometimes, the neurological symptoms might be so severe that spine surgery is unavoidable even if the patients have higher risks of infection. It is crucial to stratify the patients undergoing such a spine surgery according to the risk of infection and to take more careful preventive measures. Therefore, the identification of risk factors for SSI is important in the prevention of infection after spinal instrumentation surgeries.

Although SSI risk factors are generally classified into preoperative, operative, and postoperative factors, SSI risk factors of spine surgeries in previous systematic reviews were mainly preoperative factors such as diabetes mellitus, obesity, smoking, and previous SSI

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[6–9]. On the other hand, surgical stress of spinal instrumentation surgery has a wide range (for example, from three columns osteotomy with long fusion to single segmental fusion) compared with that of joint arthroplasty. Postoperatively, it is not uncommon to use a drain for a longer time due to leakage of the cerebrospinal fluid or apprehension of extradural hematoma. Since the variations in the operative and postoperative factors are greater in spinal instrumentation surgery, it is suspected that these factors, in addition to preoperative factors, are associated with SSIs in these surgeries.

Diabetes mellitus has been a common comorbid risk factor in most previous studies [10–18], whereas other comorbidities resulting in an immunocompromised state, such as end stage renal disease and liver cirrhosis, were rarely found. These comorbidities might be difficult to be detected as risk factors of SSI by statistical analysis, probably because of their low prevalence. A combination of various comorbidities resulting in an immunocompromised state might be recognized as a risk factor. It is thought that patients with more comorbidities have a higher risk of SSIs; however, there is no conclusive evidence or specific risk index for SSI, that integrates the risks of multiple comorbidities. Therefore, scales that were developed to assess risks excluding infections are adopted for the evaluation of risk of infection. It was previously reported that American Society of Anesthesiologists' Physical Status classification (ASA-PS), which is used to evaluate the risks of anesthesia, and Charlson Comorbidity Index (CCI), which assesses patient mortality, were associated with SSI in spine surgeries [11,18–20]. ASA-PS is controversial due to interobserver inconsistency [21], and the weighted score in the CCI is slightly complicated and discordant with the risk of infection. Thus, a simple and appropriate index reflecting the risk of SSI of various underlying diseases is required.

We conducted a retrospective case–control study at our university hospital, wherein spine surgeries for high-risk patients or high-risk spine surgeries are frequently performed. The purpose of this study was to investigate the risk factors of SSIs following spinal instrumentation surgeries. By identifying patients at a high-risk of SSIs, we can pursue the prevention of SSIs.

2. Materials and methods

This retrospective study was approved by the institutional review board of Niigata University [certification number: 2002]. Records of all 434 patients who underwent spinal instrumentation surgery except for infectious disease from 2011 to 2014 were reviewed, and those of 431 patients that were followed-up for at least 90 days were included. SSI was defined according to the 2015 surveillance definition by Center for Disease Control and Prevention/The National Healthcare Safety Network (CDC/NHSN) [22], based on the 1999 CDC guideline [1]. Superficial SSI included the infections that occurred within 30 days after spinal instrumentation surgery and involved only skin and subcutaneous tissue. Deep SSI included the infection that occurred within 90 days after the surgery and involved subfascial soft tissues. Deep SSI patients have at least one of the following: purulent drainage; culture positive specimen from deep layer and inflammatory physical findings; an abscess or other evidence of infection that is detected on gross anatomical or histopathologic exam, or imaging test.

2.1. General prevention strategy

Antibiotic drugs (usually cefazolin with dose modification) were administered 30 min before skin incision for prophylaxis and were repeated every 3 h during the surgeries. The duration of postoperative prophylactic antibiotics was 2 days, in principle, and the duration was modified as decided by the treating physician. All patients were screened for diabetes mellitus based on plasma glucose and HbA1c before surgery. Blood glucose in diabetic patients was corrected to <200 mg/dl by using a sliding scale of insulin use.

2.2. Investigating factors and definitions

Preoperative patient-related variables were age, sex, indication of spinal surgery, comorbidities, laboratory data (serum albumin and hemoglobin), body mass index (BMI), ASA-PS score, CCI score, number of regular medications the patient was consuming, and post-irradiation, which indicated that the spinal surgical site was exposed to radiation therapy in the past. Indication of spinal surgery was categorized as degenerative disease, deformity, trauma, tumor, and others. Comorbidities included diabetes mellitus, prediabetes [23], hypertension, hyperlipidemia, hyperuricemia, chronic kidney disease (estimated glomerular filtration rate < 60 ml/h/1.73 m^2), end stage renal disease (undergoing hemodialysis), liver cirrhosis, chronic lung disease, rheumatic disease, and malignancies (diagnosed within the last 5 years). Regular medications were totally reviewed, and steroids and other immunosuppressant drugs were especially analyzed. The number of medications included all regular oral drugs and self-injectable drugs such as insulin, but did not include the medications that were taken as needed or as supplements. Operative and postoperative variables were surgical procedure, site of surgery (cervical, thoracic, or lumbar), status of surgery (emergent or elective, revision or primary), number of fused vertebrae, operative time, intraoperative blood loss, allogeneic blood transfusion, postoperative hyperglycemia (over 200 mg/dl, within postoperative 48 h), duration of drain placement, and duration of antimicrobial prophylaxis (AMP). Surgical procedure included posterior spinal fusion, posterior interbody fusion, osteotomy (pedicular subtraction osteotomy, posterior vertebral column resection, and total en bloc spondylectomy), anterior fusion, and combined anteroposterior fusion.

2.3. Statistical analysis

All statistical analyses were performed using Statistical Packages for Social Sciences v22.0 (SPSS, Chicago, IL, USA). Continuous variables were compared using the Mann–Whitney U-test, and categorical variables were compared using Fisher's exact test. Significance was set at $p < 0.05$. Univariate analyses of factors associated with SSI were performed. Numerical data were divided into 2 groups based on cut-off values according to the guidelines or previous reports and were analyzed as not only continuous variables but also categorical variables. Continuous variables with significant changes in univariate analyses were converted to binaries using the receiver operating characteristics (ROC) analysis. Variables with a p value of <0.20 in univariate analyses were analyzed by forward stepwise multivariate logistic regression.

3. Results

A total of 431 patients who underwent spinal instrumentation surgery and followed over 90 days were reviewed and analyzed. The mean age of the patients was 44.5 ± 26.6 years (mean ± SD), and 53% of these patients were females. Indication of spine surgery (some overlapping) were as follow: degenerative disease, 110 patients (26%); deformity, 194 patients (45%); trauma, 65 patients (15%); tumor, 45 patients (metastatic 42, primary 3) (10%); and