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Clinical Study

Risk factors for surgical site infection in elective routine degenerative lumbar surgeries

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Abstract

BACKGROUND CONTEXT: Surgical site infection (SSI) is one of the most serious complications of spine surgery. Its predisposing factors, especially in routine surgeries, are less reported. However, a number of patient- and procedure-related risk factors could be avoided or at least determined preoperatively. Moreover, the patient-specific risk for SSI could be estimated before the elective surgery.
PURPOSE: The aim of the present study was to analyze the preoperatively determinable risk factors for SSI in patients who require elective routine surgery related to lumbar disc degeneration and to build a multivariable model for the individual risk prediction.
STUDY DESIGN: Analysis of prospectively collected standardized clinical data and the validation of the results on an independent prospective cohort were performed.
PATIENT SAMPLE: One thousand thirty (N=1,030) patients were included in the study. All subjects underwent primary lumbar single- or two-level decompression, microdiscectomy, or instrumented fusion.
OUTCOME MEASURES: Occurrence of an SSI defined according to the current Centers for Disease Control and Prevention guidelines that required surgical or nonsurgical therapy.
METHODS: The effect of preoperative patient characteristics, comorbidities, disease history, and invasiveness of the elective surgery on the risk of SSI was determined in uni- and multivariate logistic regression models in the test cohort (N=723). The performance of the final multivariable regression model was assessed by measuring its discriminative ability (c-index) in receiver operating characteristic analysis. Performance of the multivariable risk estimation model was tested on the validation (N=307) cohort.
RESULTS: The prevalence of SSI was 3.5% and 3.9% in the test and in the validation cohorts, respectively. The final multivariable regression model predictive (p=.003) for SSI contained the patient's age, body mass index (BMI), and the presence of 5 comorbidities, such as diabetes, ischemic heart disease, arrhythmia, chronic liver disease, and autoimmune disease as risk factors. The c-index of the model was 0.71, showing good discriminative ability, and it was confirmed by the data of the independent validation cohort (c=0.72).
CONCLUSIONS: Predisposing factors for SSI were older age, higher BMI, and the presence of certain comorbidities in the present study. The cumulative number of risk factors significantly associated with the increasing risk for an SSI (p<.0001). Our model needs further validation but it may be used for individual risk assessment and reduction in the future.

Keywords: Multivariable logistic regression; Predictive model; Risk factors; Spine surgery; Validation; Wound infection

Introduction

Surgical site infections (SSIs), defined as a hospital-acquired infection of the skin, soft tissue, or bone, are one of the most serious complications of spine surgery, increasing morbidity [1], mortality [2], unfavorable surgical outcomes [3], length of hospital stays, and costs [4,5]. Spinal SSIs can be superficial (above the fascia) or deep (below the fascia). Spondylitis, discitis, spondylodiscitis, and epidural abscess

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are always defined as deep infections. Diagnosis of an SSI, which is based on signs and symptoms, laboratory and radiologic imaging findings, and microbiologic tests [6], and its management can be challenging for both clinician and patient.

The prevalence of spinal SSI is reported to be between 0.7% and 12%, depending on the type of the surgery and the studied population [7–12]. A number of patient- and procedure-specific risk factors have been identified, such as age, diabetes, atrial fibrillation, previous spinal surgery; higher American Society of Anesthesiologists classification, perioperative transfusion, extended procedure, postsurgical incontinence (bowel, bladder, or both), and duration of hospital stay [7–9]. However, most of these studies focused on specific spine surgery patient groups, such as adults with spinal deformities, and they applied only simplified study designs and analyses. Furthermore, only a few studies reported on the occurrence of SSIs in the general population of spine surgery patients, including those undergoing routine elective procedures. Therefore, a validated presurgical risk estimation of spinal SSIs is important to identify at-risk patients and to reduce risk.

The aim of the present study was to determine the prevalence of SSI, in a cohort of patients after elective routine, primary degenerative lumbar surgeries, and to identify measurable presurgical risk factors. By using a multivariable statistical approach, we built a predictive model, and then we validated it by comparing with data collected from a subsequently studied independent cohort.

Methods

Cohorts

Data were collected prospectively from consecutive adults (above the age of 18 years old) who underwent elective surgery for lumbar disc degeneration at one or two levels at a tertiary spine center. Data from patients undergoing either acute intervention because of neurological emergency or because of revision surgery were excluded.

Surgeries were done by board-certified orthopedics or neurosurgeons who did only spine surgeries. Surgical procedures included microdiscectomy, decompression, and instrumented fusion (transforaminal lumbar interbody fusion or posterior fusion). All procedures were done using the standard median-sagittal posterior approach. The type and invasiveness of the procedures were scored using the Spine Invasiveness Index (SII) [10]. The SII scores of the surgeries were ranked from 1 (one-level microsequestrectomy from the posterior approach) to 15 (two-level transforaminal lumbar interbody fusion from the posterior approach with intervertebral cages, posterior instrumentation, and 360° bony fusion).

The first cohort, the test cohort, comprised eligible patients who underwent surgery from May 2009 to April 2012. The second cohort, the validation cohort, comprised eligible patients who underwent surgery from May to December 2012.

Outcome measure and types of data collection

In the present study, the preoperatively measurable risk factors (demography, comorbidities, type of the surgery) have been collected to build a clinically usable prognostic system for elective surgeries. The outcome measure was the number of spinal SSIs defined according to the current Centers for Disease Control and Prevention guidelines [11] that required surgical debridement or nonsurgical therapy, occurring during the study period (a minimum follow-up of 3.5 years after the index procedure). Data were collected from standard patient records. Patients completed the visual analogue scale score for pain; the validated Oswestry Disability Index and the Core Outcome Measurement Index; the Zung Depression Scale; and the Modified Somatic Perception Questionnaire before the surgery and during the follow-up period. Data about comorbidities were obtained from the medical charts prepared during the detailed presurgical preparation. Some specific diseases were grouped into disease groups, such as chronic hepatitis and cirrhosis grouped into chronic liver disease. To avoid missing any important medical condition, previously published simplified scoring systems for the comorbidities have not been used.

Diagnosis and management of SSIs

Surgical site infection was defined according to the guidelines published by the Centers for Disease Control and Prevention in 2014 [11]. Diagnosis and follow-up of an SSI were based on clinical findings, laboratory tests and radiologic imaging studies, and microbiologic tests [6]. The SSIs were treated according to national [12] and international [6] evidence-based guidelines. In case of a superficial or deep abscess or of a deteriorating sepsis, surgical debridement was performed. Antibiotics were administered systemically depending on the patient's condition, laboratory findings, and the results of microbiologic cultures.

Statistical analysis

The predictive effect of all patient- and procedure-specific variables on the occurrence of SSI was analyzed in logistic regression models. After the univariate analysis of the variables, those with a p-value less than .1 were entered into a final multivariable predictive model. The beta coefficients from the final logistic regression analysis were used to develop a probabilistic model to predict the probability of SSI occurrence. The discrimination ability of the model was measured by its sensitivity and specificity using receiver operating characteristic (ROC) curve analysis. ROC curves were used to determine the cutoff points of the continuous predictive variables. The validity of the multivariable predictive model was tested on the data from an independent validation cohort. Alpha was set at 0.05. To determine the probability of a Type II error for the predictive power analysis of the final model, a sample size calculation based on the ROC curve of the test cohort was performed. In case of an alpha level of 0.05, the sample size