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Diabetes Associated with Increased Surgical Site Infections in Spinal Arthrodesis

**Sam Chen MD, Matt V. Anderson BS,
Wayne K. Cheng MD, Montri D. Wongworawat MD**

Abstract Diabetes mellitus (DM) is a major risk factor for surgical site infection (SSI). Spinal surgeries are also associated with an increased risk of SSI. To confirm previous reports we evaluated the association of DM with spine infection in 195 patients who underwent elective posterior instrumented lumbar arthrodesis over a 5-year period: 30 with DM and 165 without. Other known risk factors for SSI in spinal surgery were examined: age, gender, tobacco use, body mass index, American Society of Anesthesiologists (ASA) class, intraoperative antibiotic redosing, surgical time, bone allograft use, estimated blood loss (EBL), and drain use. The adjusted relative risk of having DM for developing SSI was 4.10 (95% C.I. = 1.37–12.32). Other factors did not appear as risk factors for SSI. The data confirm DM is a risk factor for surgical site infections in spinal arthrodesis surgery.
Level of Evidence: Level II, prognostic study (retrospective study). See the Guidelines for Authors for a complete description of levels of evidence.

S. Chen, M. V. Anderson, W. K. Cheng,
M. D. Wongworawat (✉)
Department of Orthopaedic Surgery, Loma Linda University,
Loma Linda, CA, USA
e-mail: wongworawat@gmail.com

Introduction

Surgical site infection is one of the most common postoperative complications in the United States [14]. Spinal surgeries have a reported surgical site infection (SSI) rate from 2% to 15% [8, 17]. The Centers for Disease Control and Prevention maintains an SSI surveillance system known as the National Nosocomial Infections Surveillance (NNIS) system [14]. The last NNIS study in 2004 reported a 2.1% SSI rate after spinal arthrodesis. Substantial morbidity is associated with SSI, including an increased risk for intensive care unit hospitalization, subsequent hospital readmission, and mortality [11]. Multiple risk factors for SSI after spinal operations have been reported: tobacco use [1], blood loss [16], obesity [8], prior infection [8], prolonged surgery duration [19], increased age [1], admission from a healthcare facility [12], and prolonged preoperative hospitalization [5].

Because of heightening awareness regarding the relative risk of having diabetes mellitus (DM) with respect to surgical complications, and in light of recent case-controlled evidence pointing to DM as an independent risk factor, we sought to confirm the previously reported association of DM with spine infection in a cohort model with a higher level of evidence.

Our goals were: (1) to confirm DM as a risk factor for infection after spinal surgery and (2) to evaluate other potential (and potentially confounding) factors (American Society of Anesthesiologists class, surgical time, antibiotic dosing regimen and redose if given, bone allograft use, drain placement, tobacco history, and estimated blood loss).

Materials and Methods

We retrospectively reviewed the medical records of all 244 patients who underwent elective posterior instrumented

lumbar arthrodesis from January 1, 2003 until March 31, 2008. Thirty-three patients were excluded from the study due to a history of previous spinal surgery or spinal infection, age younger than 18 or older than 90 years of age, or having received antibiotic prophylaxis other than cefazolin. We included patients if they had a minimum followup of 12 months (average, 30 months; range, 12 to 60 months). Sixteen patients were lost to followup prior to this minimum, leaving 195 patients for further review. Of these patients, 165 were nondiabetic and 30 were diabetic (as diagnosed and treated by their primary care physician but without confirmation of treatment compliance).

The diagnosis of infection was determined using the CDC definition of SSI [13]. This included deep surgical site and organ-space infections within 30 days of surgery (or 1 year with implant placement) as well as superficial surgical site infections within 30 days. Included in this definition is any physician diagnosis of a SSI. The medical records of the patients enrolled were then reviewed. The data were collected from the medical records using a standardized data collection form, which included demographic data, American Society of Anesthesiologists (ASA) class, surgical time, antibiotic dosing regimen and redose if given, bone allograft use, drain placement, tobacco history, and estimated blood loss. These potential risk factors for SSI were derived after review of the literature.

Univariate and multivariate Cox proportional hazards regression models were used to study the association between postoperative spinal infections and DM. The time from surgery to infection or last visit was used as a time variable. The basic model included DM only. Potential confounding variables included age, gender, BMI, tobacco use, surgery time, antibiotic redosing, bone allograft, drain placement, EBL, and ASA. All potential confounding variables were entered into the basic model one at a time, and confounding variables that produced more than a 10% change in the relative risk due to DM were entered into the final model. The Statistical Package for the Social Sciences (SPSS 16.0; SPSS Inc., Chicago, Illinois) was used for all analyses.

Results

Nine of the 30 (30%) diabetic patients developed infections, all of which were deep. Eighteen of the 165 (11%) nondiabetic patients developed infections; of these 17 were deep, and one was superficial (Table 1).

Age, gender, body mass index (BMI), surgical time, ASA class, estimated blood loss, intraoperative antibiotic redosing, bone allograft use, drain placement, and tobacco use were not risk factors for SSI. EBL was a risk factor for SSI with a relative risk of 1.61 (confidence interval 1.08 to

Table 1. Univariate analysis of SSI risk factors

Variable	Relative risk	95% C.I.	
		Lower	Upper
Diabetes mellitus	3.271	1.457	7.344
Age	1.002	0.994	1.011
Male gender	1.305	0.605	2.816
BMI > 35	1.864	0.810	4.287
Surgical time > 2.5 hours	1.061	0.896	1.257
ASA ≥ 3	1.274	0.589	2.754
EBL	1.608	1.083	2.390
Antibiotic redosing	1.557	0.677	3.580
Bone allograft	0.753	0.316	1.791
Drain placement	1.843	0.822	4.135
Tobacco use	1.195	0.520	2.748

BMI = body mass index; ASA = American Society of Anesthesiologists; EBL = estimated blood loss.

2.39). However, only ASA changed the relative risks of DM > 10% and was retained in the final model. The adjusted relative risk of having DM for developing SSI was 4.10 with a 95% confidence interval of 1.37 to 12.32.

Discussion

Diabetes mellitus is a known major risk factor for SSI. Patients with diabetes also reportedly have a higher risk of SSI with spinal surgery. To confirm previous reports we assessed the risk of SSI in patients with DM in a retrospective cohort model. Furthermore, we set out to identify other factors that may have an association with SSI in the multivariate model.
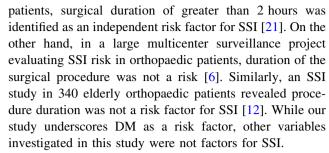
This study had several limitations. First, we narrowed our study group to spine patients with instrumentation because of the higher incidence for infection when compared to other clean orthopaedic surgeries [14]. This higher incidence may increase the ability to detect a true statistical difference. Second, we excluded patients who only underwent spinal surgery through the anterior approach because of the lower infection rate when compared with posterior spinal instrumentation and fusion [3]. Third, we selected a single surgeon's series to minimize potential bias as introduced by differing surgical techniques. Fourth, we included only patients who received cefazolin to avoid potential confounding effects from other antibiotics, such as vancomycin. Fifth, we chose our study variables of potential risk factors based on a survey of the literature [12, 15, 19]. Sixth, our patients were not case-matched with respect to other risk factors. Therefore, multivariate adjustment was performed to evaluate for other potential risk factors that may present as confounders. However, the strong association between DM

and SSI as presented by our results cannot be ignored. Seventh, the followup in our series is relatively short. We recognize SSI may present late, as evident from several case reports in the literature [4, 10, 22]. While uncommon late infection may present months to years later, most posterior spinal SSIs usually occur in the early postoperative course due to seeding at the time of operation or due to hematogenous seeding within a few weeks of the procedure [10, 19]. Finally, we did not study the effects of glycemic control. The addition of perioperative serum glucose management is a potential subject of study in the future; such a prospective study may shed light on the actual causal effect of perioperative diabetic management on the development of SSI.

DM is a known risk factor for developing SSI in posterior spinal instrumentation patients. In one retrospective study of 124 patients divided into cohorts of those with and those without DM, the diabetic patients had higher rates of postoperative infection and prolonged hospitalization although statistical comparisons were not presented [20]. In a more recent retrospective case-controlled study of 273 spine surgery patients with and without infection, among other risk factors, DM was the highest of a number of independent risks for spinal surgical site infection [15]. Interestingly, in a matched, case-controlled study of 340 elderly general orthopaedic patients, perioperative glycemic status was not a risk factor for SSI; however, it was difficult to abstract power information for this particular variable from the study as presented [12]. Our data suggest DM is associated with infection in patients with posterior spinal instrumentation.

Other potential factors did not appear to be risk factors for SSI in posterior spinal instrumentation patients; several of these factors will be discussed. Regarding prophylactic antibiotics, from recent literature the choice seems clear: two studies recommend administering cefazolin as the perioperative antibiotic of choice [7, 9]. However, the benefit of intraoperative redosing is unclear. An intraoperative dose is recommended if the duration of the procedure exceeds one to two times the half-life of the antibiotic or if there is substantial blood loss [7, 9, 19]. However, in a prospective, controlled study evaluating blood loss on serum cefazolin level in spine fusion patients, the authors reported no difference between blood loss and cefazolin level [18]. In another study utilizing tissue and serum pharmacokinetics, blood loss of over 1500 mL or surgery exceeding 4 hours is associated with inadequate tissue levels of cefazolin. Even in light of these recommendations, the actual preventive effect of redosing on the development of SSI is unclear. Another variable of interest is that of surgical time. A recent review article addressing spinal infection risk suggests surgical time greater than 3 hours predisposes the patient to postoperative infection [2]. In a more recent cohort study of 582 orthopaedic patients, surgical duration of greater than 2 hours was identified as an independent risk factor for SSI [21]. On the other hand, in a large multicenter surveillance project evaluating SSI risk in orthopaedic patients, duration of the surgical procedure was not a risk [6]. Similarly, an SSI study in 340 elderly orthopaedic patients revealed procedure duration was not a risk factor for SSI [12]. While our study underscores DM as a risk factor, other variables investigated in this study were not factors for SSI.

Our study shows that DM is a risk factor for SSI after posterior spinal instrumentation. In shared decision making prior spinal surgery, diabetic patients should receive specific counseling regarding the risk of SSI in the informed consent process.

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