Received: 15 November 2020 | Revised: 16 January 2021 | Accepted: 21 January 2021

DOI: 10.1111/iwj.13562

ORIGINAL ARTICLE

IWJ WILEY

Surgical site infection after posterior lumbar interbody fusion and instrumentation in patients with lumbar degenerative disease

Honglei Pei[1] | **Haiying Wang**[2] | **Meiyun Chen**[3] | **Lei Ma**[4] | **Guobin Liu**[1] | **Wenyuan Ding**[4]

[1]Department of Orthopaedic Surgery, The 1st Hospital of Hebei Medical University, Shijiazhuang, Hebei, P. R. China

[2]Department of Orthopaedic Surgery, The 1st Central Hospital of Baoding, Baoding, Hebei, P. R. China

[3]Department of General Medicine, the 2nd Hospital of Hebei Medical University, Shijiazhuang, Hebei, P. R. China

[4]Department of Spinal Surgery, The 3rd Hospital of Hebei Medical University, Shijiazhuang, Hebei, P. R. China

Correspondence
Wenyuan Ding, MD, Department of Spine Surgery, The 3rd Hospital of Hebei Medical University, No. 139 Ziqiang Road, Shijiazhuang, Hebei 050051, P. R. China.
Email: wenyuanding@hebmu.edu.cn

Abstract

We designed this retrospective study with aims to investigate the incidence and risk factors associated with surgical site infection (SSI) following posterior lumbar interbody fusion (PLIF) and instrumentation in patients with lumbar degenerative disease. Eligible patients treated between January 2016 and June 2019 were included. Electronic medical records were inquired for data extraction and collection. Patients with SSI and without SSI were compared using the univariate analyses, and the association between variables and risk of SSI was investigated using multivariate logistics regression analyses. Among 1269 patients, 43 were found to have SSI, indicating a rate of 3.4%. Microbiological culture tests showed 88.4% patients had a positive result. Four SSIs were caused by mixed bacterial, and the remaining 34 by single bacteria. Multiple drug-resistant strains were detected in 25 (65.8%) SSIs, with *meticillin-resistant coagulase-negative staphylococcus* (MRCNS) predominating (12, 48.0%). ASA III and above (odd ratio (OR), 1.67; 95% confidence interval (CI), 1.11 to 3.07), preoperative stay (OR, 1.13; 95% CI, 1.04 to 1.23), heart disease (OR, 2.88; 95% CI, 1.24 to 6.71), diabetes mellitus (OR, 3.28; 95% CI, 1.66 to 6.47) and renal insufficiency (OR, 4.23; 95% CI, 1.26 to 10.21), prolonged prophylactic antibiotics use (OR, 4.43; 95% CI, 2.30 to 8.54), and the reduced lymphocyte count (OR, 2.11; 95% CI, 1.03 to 4.33) were identified as independent risk factors associated with SSI. These factors, although most not modifiable, should be kept in mind, optimised for surgical conditions, or readily adjusted in the future postoperative management of antibiotics, to reduce postoperative SSIs.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.
© 2021 The Authors. International Wound Journal published by Medicalhelplines.com Inc (3M) and John Wiley & Sons Ltd.

KEYWORDS

lumbar degenerative disease, posterior lumbar interbody fusion, risk factor, surgical site infection

1 | INTRODUCTION

Posterior lumbar interbody fusion (PLIF) surgery is widely used in the field of spinal surgery for treatment of spondylolisthesis and lumbar spinal stenosis, due to its simple approach and surgical effectiveness. However, as every other surgery, the surgical effect of PLIF is occasionally compromised by the postoperative complications. In a meta-analysis of 192 studies, de Kunder et al[1] conducted that PLIF group had a significantly higher complication rate than in transforaminal lumbar interbody fusion (TLIF), with absolute rate difference of one-fold (17.0% versus 8.7%). Surgical site infection (SSI), a common complication but can lead to serious consequence after spinal surgeries, varied in incidence rate, from 0% to 20.0%.[2-6] As was estimated, SSI was associated with 11 additional days of hospitalisation per patient and 20% increased risk of readmission within 30 days of surgery.[2,4] Besides, the increased health care cost by additional hospitalisation and health care management is another public concern.

In the past decade, numerous risk factors associated with SSI after spinal fusion have been identified, and indeed they provided a theoretical basis for construction of risk prediction model and enhanced patient decision making. In recent two meta-analyses, researchers pooled the original results and concluded that diabetes, prolonged surgical time, obesity, surgical approach (posterior versus others), number of operated levels, instrumented surgery (versus non instrumented surgery), and open surgery (versus minimally invasive surgery) were predictors of SSI.[5,7] From above, we can speculate that patients undergoing the PLIF and instrumentation will experience a higher chance of SSI. However, as far as we know, there are scarce studies specifying this subgroup to characterise the postoperative SSI. Another concern is that most findings were available from western studies, and it is likely that they are not applicable to Asian population, because some parameters of clinical importance such as body mass index (BMI), prevalence of osteoporosis, and comorbidities, are recognised to be distinctly different between both populations.[8,9]

In this study, we aimed, first to analyse the incidence of postoperative SSI in patients who underwent PLIF and instrumentation in our hospital from 2016 to June 2019, and second to analyse multiple perioperative variables and identify their independent association with SSI.

Key Messages

- SSI after PLIF and instrumentation for lumbar disease was not infrequent, with incidence of 3.4% within 1-year postoperatively
- multiple drug-resistant strains caused 65.8% of the overall SSIs, an alarming figure, and should be more paid attention to; necessary adjustment of postoperative antibiotics use strategy should be considered
- multiple perioperative have been identified to be associated with SSI, although most not modifiable, they aid in assessment of SSI risk and accordingly stratifying patients

2 | METHODS

This retrospective study was approved by the ethics committee of the 3rd Hospital of Hebei Medical University, which waived requirement for informed consent due to the retrospective design and use of anonymous data.

Patients with lumbar degenerative disease treated by PLIF and instrumentation in the 3rd Hospital of Hebei Medical University between January 2016 and June 2019 were included for data extraction and analysis. Inclusion criteria were: clinical and imaging diagnosis of lumbar degenerative disease (i.e. lumbar disc herniation, lumbar spondylolisthesis, lumbar spinal stenosis and adjacent lesions), age over 18 years, the surgical treatment by PLIF and instrumentation, complete medical records, as well as follow-up at least 1 year.

Exclusion criteria were: patients lost to follow-up or with incomplete medical records, surgery other than PLIF surgery and instrumentation or PLIF only, patients with primary or metastatic malignant tumours of the lumbar spine, history of previous lumbar surgery (open or minimally invasive surgery of the lumbar spine, excluding epidural injections, needle biopsies, vertebroplasty, or kyphoplasty), history of radiotherapy in the lumbar region or death during hospital stay or follow-up period.

All surgical procedures via classic open posterior approach for removal of spinous process, laminar decompression, and instrumented fixation were accomplished by 17 orthopaecis or spinal surgeons, with average of 74.6

(range, 13 to 273) procedures for each surgeon. Antibiotic prophylaxis (cefuroxime, ceftriaxone, or ceftazidime) in single dose was routinely administered 30 to 60 minutes before skin incision, and for procedure lasting more than 3 hours, an extra dose is given. Postoperative antibiotic prophylaxis, either for type or duration, was not standardised, primarily dependent on surgeon experience and preference.

2.1 | Definition and confirmation of SSIs

The diagnostic criteria for postoperative SSI are based on the US Centers for Disease Control and Prevention Guidelines (2017 edition) for the prevention of SSI.[10] Superficial SSI refers to an infection occurring at skin and subcutaneous tissues only within 30 days of surgical procedure, with symptoms and signs of redness, tenderness, heat, and pain over the site. Deep SSI refers to an infection involving the fascia and muscle, occurring within 1 year (implant left in place), and often leads to fever, pain, tenderness, persistent wound discharge or dehiscence, abscess or gangrenosis that requires surgical debridement and implant removal.

SSI cases were identified by reviewing the patients' medical records for the potential documented signs or symptoms during their hospitalisation stay, and by retrieving the outpatient notes at scheduled visits and reconfirming SSIs by telephone visit at the time point of 1 year after operation.

The reports of microbiological culture results from patients who developed SSI were reviewed to confirm the causative bacteria and their drug susceptibility.

2.2 | Data collection and definition of variables

Based on presence or absence of SSI, patients were divided into two groups, SSI and non-SSI group. Data on each patient were extracted from the inpatient electronic medical record and the outpatient follow-up registration. The following data were extracted: patient-related factors, such as gender, age, body mass index (BMI), smoking, hypertension, diabetes, cardiovascular disease, cerebrovascular disease, liver disease, renal insufficiency, respiratory disease; surgery-related factors, such as American Society of Anesthesiologists (ASA) score, number of levels operated, operative time, intraoperative blood loss, use of allograft bone, allogeneic blood transfusion, postoperative prophylactic antibiotics use and the duration; and laboratory biomarkers, such as preoperative serum albumin, white blood cell count, neutrophil count, total lymphocyte count, red blood cell count, haematocrit, haemoglobin, fasting blood glucose. As for patients who had multiple times of laboratory tests preoperatively, the one examined at the most approaching time to surgery was selected for statistical analysis, for purpose of eliminating their time-dependent effect.

Comorbidities were diagnosed after admission by their treating surgeon, based on patients' self-reports; hypertension and diabetes mellitus were further confirmed by the consecutive measurements (blood pressure, blood glucose level) by the nurse in charge after admission. Respiratory disease refers to a previous diagnosis of chronic obstructive pulmonary disease (COPD), asthma, tuberculosis, and occupational pulmonary disease (e.g. pneumoconiosis). Cardiovascular disease refers to coronary, congestive, valvular, and congenital heart disease. Cerebrovascular disease includes cerebral infarction (ischemic and haemorrhagic) and history of cerebral apoplexy. Chronic liver disease refers to hepatitis virus antigen positive and liver cirrhosis. Renal insufficiency refers to a definite history of renal insufficiency, based on patient self-reports.

2.3 | Statistical analysis

Mean ± standard deviation (SD) and count (percentage) were used to characterise the continuous and categorical variables, respectively. Comparisons between SSI and non-SSI group were performed using Chi-square or Fisher's exact test for categorical data, and using Student-*t* test or Mann Whitney-*U* test for continuous data, as appropriate.

The variables tested to be significant at the statistical level of $P < .1$ in the univariate analyses were subsequently included in the multivariate logistic regression model for adjusted analyses. Stepwise backward elimination method was used to remove variables whose independent association with SSI was not significant at a threshold of $P < .10$. The effect size for each variable retained in the final model was reported as odds ratios (ORs) with corresponding 95% confidence intervals (95% CIs). Hosmer–Lemeshow (H-L) test was used to determine the goodness-of-fit of the final model, with a $P > .05$ indicating an acceptable result; and Nagelkerke R^2 was used to further quantify that, with greater value representing the better result. $P < .05$ was regarded as indicative of statistical significance for all analyses. SPSS 25.0 software package (IBM, Armonk, NY) was used to perform all analyses.

3 | RESULTS

Forty-three patients were diagnosed with an SSI, representing an incidence rate of 3.4% (95% CI, 2.5% to

4.4%). The SSI group consisted of 14 males and 29 females, with mean age of 55.9 years (SD, 14.6 years). The onset time of SSI was at median of 9 days post operation, with the earliest occurrence at postoperative day 3 and the latest at postoperative day 76. Of these SSIs, 27 were superficial and 16 were deep. Microbiological culture was routinely performed in all the 43 patients with SSI, and 38 (88.4%) had a positive culture result. In four patients with deep SSI and one with superficial SSI, no organisms were isolated. There were 4 SSIs caused by mixed bacterial, and the remaining 34 by single bacteria. The details for the causative organisms were listed in Table 1.

Multiple drug-resistant strains were found in 25 (65.8%) SSIs, including 3 caused by mixed bacterial and 22 by single bacterial, with *meticillin-resistant Staphylococcus aureus* (MRSA) in 4 (16.0%), *meticillin-resistant coagulase-negative staphylococcus* (MRCNS) in 12 (48.0%) and extended-spectrum beta-lactamase (ESBLs) in 8 (32.0%) and carbapenems resistant acinetobacter baumannii (CR-AB) in 1 (4.0%) case.

The univariate analyses showed no significant differences between SSI and non-SSI groups in term of gender, age in categorical variable, BMI (including prevalence of obesity), cigarette smoking, hypertension, cerebrovascular disease, pulmonary disease, cerebrovascular disease, liver disease, ASA, operated levels, use of allogeneic blood transfusion, white blood cell, neutrophil count and red blood cell in categorical variable, lymphocyte count in continuous variable, total protein and platelet count in both continuous and categorical variable (both forms). Both groups significantly differed regarding age in continuous variable, prevalence of diabetes mellitus, heart disease and renal insufficiency, preoperative stay (days), postoperative drainage volume, surgical duration, postoperative use of antibiotics in days and proportion of that above 3 days, albumin, haemoglobin, and fasting blood glucose in both forms, white blood cell, neutrophil count, red blood count and haematocrit in continuous variable, and lymphocyte count in categorical variable. SSI was associated with a 9.8-day more hospitalisation stay for the index PLIF surgery (23.5 versus 13.7 days, $P < .001$) (Table 2).

The multivariate analyses showed that ASA III and above (vs I and II) ($P = .039$), prolonged preoperative stay (in each day increment, $P = .005$), presence of chronic heart disease ($P = .014$), diabetes mellitus ($P = .001$) and renal insufficiency ($P < .001$), prolonged use of prophylactic antibiotics (>3 days) ($P < .001$), and the reduced lymphocyte count ($<1.1 \times 10^9$/L) ($P = .042$) were identified as independent risk factors associated with SSI following PLIF surgery and instrumentation of lumbar degenerative disease (all $P < .05$) (Table 3).

The final multivariate model was demonstrated to be with adequate goodness-of-fit ($P = .413$, H-L test; Nagelkerke $R^2 = .160$).

TABLE 1 Frequency of causative bacterial

Bacteria type	Frequency
Single-bacteria causing SSI	34
Staphylococcus aureus	15
Pseudomonas aeruginosa	2
Escherichia coli	6
Acinetobacter baumannii	2
Staphylococcus epidermidis	7
Coagulase negative staphylococcus	2
Mixed-bacteria causing SSI	4
Staphylococcus aureus + *pseudomonas aeruginosa*	1
Staphylococcus aureus + *Enterobacter cloacae* + *Acinetobacter baumanii*	1
Escherichia coli + *Kleber pneumoniae*	2

4 | DISCUSSION

In this study, 1269 patients who underwent PLIF surgery and instrumentation for degenerative lumbar disease were retrospectively analysed and the incidence rate of SSI was 3.4% during the 1-year follow-up period post-operation. About two thirds of SSI were caused by multiple drug-resistant strains, especially the MRCNS. Patients with SSI had a significantly prolonged hospitalisation stay ($P < .001$), about 10 days than those without SSI. Seven factors, including ASA III and above (vs I and II), prolonged preoperative stay, presence of chronic heart disease, diabetes mellitus and renal insufficiency, prolonged use of prophylactic antibiotics (>3 days), and the reduced lymphocyte count ($<1.1 \times 10^9$/L) were identified to be independently associated with SSI.

The incidence rate of SSI following lumbar fusion via different surgical approaches was varied, ranging from 0% to 20%,[2-6] consistent with our result (3.4%). These figures reflected the differences in study methodology, patient characteristics, definition of SSI, and follow-period. In a meta-analysis of outcomes of transforaminal lumbar interbody fusion (TLIF) versus TLIF, de Kunder et al[1] concluded that PLIF resulted in a significantly higher pooled infection rate (2.8% versus 1.6%) and the overall complication rate (17.0% verses 8.7%) than TLIF. This difference can be explained by the surgical approach itself. Compared to TLIF, PLIF uses bilateral approach instead of unilateral approach for discectomy, bone graft,

TABLE 2 Univariate analyses of variables between SSI and non-SSI group following PLIF and instrumentation of elective spinal degenerative disease

Variables	Number (%) of DVT (n = 43)	Number (%) of non-DVT (n = 1226)	*P*
Gender (male)	14 (32.6)	562 (45.8)	.086
Age (yr)	55.9 ± 11.2	52.0 ± 12.7	.048
18 to 44	7 (16.3)	312 (25.4)	.292
45 to 64	26 (60.5)	708 (57.7)	
65 or older	10 (23.3)	206 (16.8)	
BMI (kg/m^2)	26.6 ± 4.1	25.6 ± 3.7	.072
Obesity (≥28.0 kg/m^2)	14 (32.6)	279 (22.8)	.134
Cigarette smoking	9 (20.9)	215 (17.5)	.566
Diabetes mellitus	15 (34.9)	142 (11.6)	.186
Hypertension	16 (37.2)	331 (27.0)	.140
Chronic heart disease	8 (18.6)	75 (6.1)	.001
Cerebrovascular disease	6 (14.0)	89 (7.3)	.101
Pulmonary disease	2 (4.7)	37 (3.0)	.542
Chronic liver disease	4 (9.3)	53 (3.2)	.121
Renal insufficiency	5 (11.6)	28 (2.3)	<.001
Preoperative stay	5.0 ± 3.3	3.4 ± 2.6	<.001
Total hospital stay	23.5 ± 10.4	13.7 ± 4.5	<.001
ASA class			.077
I and II	28 (65.1)	939 (76.6)	
III or above	15 (34.9)	287 (23.4)	
Operated levels	2.2 ± 2.6	1.7 ± 1.8	.063
Postoperative drainage (ml)	343.5 ± 132.6	274.2 ± 107.2	.004
Allograft bone graft	11 (25.6)	258 (21.0)	.474
Intraoperative bleeding (ml)	902.3 ± 477.8	634.7 ± 436.3	<.001
Allogeneic blood transfusion (yes)	19 (44.2)	376 (30.7)	.060
Surgical duration	203.9 ± 69.1	176.9 ± 76.7	.023
Duration of postoperative use antibiotics (d)	4.1 ± 3.7	2.5 ± 2.2	<.001
Duration of postoperative use antibiotics (>3 d)	21 (48.8)	244 (19.9)	<.001
TP (g/L)	62.8 ± 8.8	64.4 ± 7.8	.168
TP (<58 g/L)	12 (27.9)	241 (19.7)	.183
ALB (g/L)	38.3 ± 6.4	40.9 ± 5.2	.001
ALB (<35 g/L)	12 (27.9)	165 (13.5)	.007
WBC ($\times 10^9$/L)	9.4 ± 5.3	8.2 ± 3.6	.033
WBC (>10 × 10^9/L)	17 (37.8)	373 (25.8)	.070
NEUT ($\times 10^9$/L)	7.0 ± 5.2	5.7 ± 3.7	.024
NEUT (>6.3 × 10^9/L)	17 (39.5)	358 (29.2)	.144
LYM ($\times 10^9$/L)	1.6 ± 0.9	1.0 ± 1.7	.182
LYM (<1.1 × 10^9/L)	14 (32.6)	206 (16.8)	.007
RBC ($\times 10^{12}$/L)	4.0 ± 0.6	4.3 ± 0.6	<.001
RBC (<lower limit)	10 (23.3)	166 (13.5)	.070
HGB (g/L)	125.0 ± 18.5	133.3 ± 17.9	.003
HGB (<lower limit)	11 (25.6)	164 (13.4)	.023

TABLE 2 (Continued)

Variables	Number (%) of DVT (n = 43)	Number (%) of non-DVT (n = 1226)	*P*
HCT (%)	37.3 ± 5.4	39.7 ± 5.2	.002
HCT (<lower limit)	16 (37.2)	308 (25.1)	.074
FBG (mmol/L)	7.0 ± 2.7	5.7 ± 1.4	<.001
FBG (>6.1 mmol/L)	22 (51.2)	318 (25.9)	<.001
PLT ($\times 10^9$/L)	217.2 ± 90.2	217.8 ± 59.8	.956
PLT (>300 × 10^9/L)	6 (14.0)	110 (9.0)	.265

Note: SSI, surgical site infection; BMI, body mass index; ASA, American Society of Anesthesiologists; RBC, red blood cell, reference range: Female, 3.5 to 5.0 × 10^{12}/L; males, 4.0 to 5.5 × 10^{12}/L. HGB, haemoglobin, reference range: Females, 110 to 150 g/L; males, 120 to 160 g/L; FBG, fasting blood glucose; HCT, haematocrit, reference range: male, 40% to 50%; female: 35% to 45%; WBC, white blood cell; NEUT, neutrophile; LYM, lymphocyte; PLT, platelet; TP, total protein; ALB, albumin; FBG, fasting blood glucose.

TABLE 3 Multivariate analyses of risk factors associated with SSI following PLIF surgery and instrumentation of lumbar degenerative disease

Variable	OR and 95% CI	*P* value
Prolonged preoperative stay (in each day increase)	1.13 (1.04 to 1.23)	.005
Chronic heart disease	2.88 (1.24 to 6.71)	.014
Diabetes mellitus	3.28 (1.66 to 6.47)	.001
Renal insufficiency	4.23 (1.26 to 10.21)	<.001
ASA III and above	1.67 (1.11 to 3.07)	.039
Postoperative prophylactic antibiotics use >3 d	4.43 (2.30 to 8.54)	<.001
Reduced lymphocyte count (<1.1 × 10^9/L)	2.11 (1.03 to 4.33)	.042

Abbreviations: ASA, American Society of Anaesthesiologists score; CI, confidence interval; OR, odd ratio; SSI, surgical site infection.

and fusion cage implantation, therefore increasing the duration for traction on the surrounding tissues and subsequently the chance for bacterial colonisation.

Comorbid disease burden remains a significant case of adverse events following surgery, and in this study, we found chronic heart disease, diabetes mellitus, and renal insufficiency were independent risk factors associated with SSI, with the particularly strong magnitude of association, from 2.88 to 4.23. The heart disease and diabetes mellitus as risk factors for SSI in various surgical fields have been investigated and the mechanisms referred to poorer microcirculation of the tissues around surgical tissues, resulting from venous stasis, surgical trauma to small blood vessels or microvessels, or the diabetic angiopathy.[11-14] Preoperative renal insufficiency as a significant risk factor for SSI following PLIF was first reported. While we are unable to elucidate the precise underlying, we presume that patients with a history of renal insufficiency may have experienced long-term haemodialysis, autoimmune dysfunction, and use of glucocorticoid therapy, which were well-established factors for infection complications.[5,15,16] The future study should focus on clarifying the role of renal insufficiency in development of SSI and excluding the confounding effects.

Contrary to partial but not all previous findings,[17-19] age was not identified as an independent factor for SSI in our multivariate analysis, although marginally significant in the univariate analysis. Of note, we selected chronological age rather than physiologic age as a variable for statistical analysis. However, to some extent, it is speculated that the specific comorbidities have significant impact on the aging process, thereby protruding the role of physiologic age. In a study of preoperative complications following TLIF, Claus et al[20] concluded that age was not a predictor either for major or minor complications. Additionally, we found ASA grade III or above versus and I and II was significantly more related to SSI occurrence (OR, 1.67), further confirming our speculation. Therefore, chronological age should not be a major factor when deciding a surgery, and attention should focus on a thorough evaluation and optimization of comorbidity, especially the heart disease, diabetes mellitus, and renal insufficiency.

Prolonged hospitalisation stay was identified as a predictor of SSI, with 1-day increment associated with 1.7-fold increased risk of SSI. Consistent with our finding, Xu et al[16] reported the incidence rate of SSI being 3.49% following 3326 orthopaedic surgeries and found preoperative stay above 7 days was associated with 5.0-fold increased risk of SSI (9.73% versus 1.63%). It should be note that, this was a tertiary referral hospital, and prolonged preoperative hospitalisation stay is generally commonly seen, due to the high occupancy rate of operation room and the personnel. In our opinion, the prolonged hospitalisation stay was more a reflection of a poor surgical medical condition, which required more time for optimization to meet the surgical

condition. In addition, for some patients the surgery itself may incur more psychological stress and possible homeostasis disorders, which, in turn, prolonged the preoperative stay.[21] Accordingly, adequate preoperative information, timely adjustment of plan for optimization of medical conditions, and psychological counselling when necessary, are advocated for those with likely prolonged preoperative stay.

In our institution, postoperative prophylactic use of antibiotics, either the types or the duration, was mainly decided by the treating surgeon based on their preference or experience. We arbitrarily divided patients into two groups, with >3 days of prophylactic use of antibiotics versus ≤3 days, and found the former was 4.4-fold increased risk of SSI. In a recent study, Li et al[17] did not get the significant finding in their study of lumbar fusion surgery, although the duration of postoperative prophylactic use of antibiotics was overall similar as ours (3.0 verse 2.6 days). Leslie et al[22] conducted a prospective comparative study evaluating the effectiveness of preoperative cefazolin-only protocol versus preoperative plus postoperative cefazolin protocol in instrumented fusion, demonstrating the absolute difference in SSI incidence (4.3% for pre plus post protocol, and 1.7% for pre only protocol), although not significant in statistics primarily due to the relatively less sample. In another study of comparing postoperative results from the use of antibiotic prophylaxis for 1 versus 5 days, researchers got the same complication rate in the surgical wound (28.6% versus 27.9%). Therefore, postoperative strategy on prophylactic antibiotics use urgently needed to be adjusted in our institution, and duration of prophylactic antibiotics use <24 hours is recommended.[10]

This study suffered from several limitations. First, the retrospective nature of this study might compromise the accuracy and precision in data collection, which was primarily associated with patients' recall bias. Second, there is also the possibility of a selection bias because this was a tertiary referral centre, and patients with severe lumbar degenerative disease or more complex underlying medical conditions were more likely referred. Third, as every multivariate analysis, the residual confounding bias remains because for some infrequent comorbidities such as rheumatoid disease in which case glucocorticoid is generally prescribed, or C-reactive protein (CRP) which was closed related to inflammatory/immune reaction, relevant data were not available or not routinely measured.

In summary, we found the SSI incidence rate of 3.4% following PLIF surgery and instrumentation for degenerative lumbar disease. Several factors, including ASA III and above (vs I and II), prolonged preoperative stay, presence of chronic heart disease, diabetes mellitus, and renal insufficiency, prolonged use of prophylactic antibiotics (>3 days), and the reduced lymphocyte count (<1.1*10^9/L) were identified to be independently associated with SSI. These factors, although most not modifiable, should be kept in mind, be optimised for surgical condition, or be adjusted in the future postoperative antibiotics use strategy, to reduce the risk of postoperative SSI.

ACKNOWLEDGEMENTS

We are grateful to J. Wang and S. Zhong of the Department of Orthopaedics, and to Y. Zhang of the Department of statistics and applications for their kind assistance.

CONFLICT OF INTEREST

All the authors declare that they have no conflict of interest.

AUTHORS' CONTRIBUTIONS

Wenyuan Ding designed the study; Honglei Pei, Haiying Wang and Lei Ma inquired the EMR for data collection and followed up the patients, and searched relevant literature; Meiyuan Chen and Guobin Liu performed the statistical analyses and interpret the results; Honglei Pei wrote the manuscript and Wenyuan Ding approved the final version.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

REFERENCES

1. de Kunder SL, van Kuijk SMJ, Rijkers K, et al. Transforaminal lumbar interbody fusion (TLIF) versus posterior lumbar interbody fusion (PLIF) in lumbar spondylolisthesis: a systematic review and meta-analysis. *Spine J*. 2017;17(11):1712-1721.
2. Olsen MA, Nepple JJ, Riew KD, et al. Risk factors for surgical site infection following orthopaedic spinal operations. *J Bone Joint Surg Am*. 2008;90(1):62-69.
3. Gu W, Tu L, Liang Z, et al. Incidence and risk factors for infection in spine surgery: a prospective multicenter study of 1764 instrumented spinal procedures. *Am J Infect Control*. 2018;46(1):8-13.
4. Blumberg TJ, Woelber E, Bellabarba C, Bransford R, Spina N. Predictors of increased cost and length of stay in the treatment of postoperative spine surgical site infection. *Spine J*. 2018;18(2):300-306.
5. Fei Q, Li J, Lin J, et al. Risk factors for surgical site infection after spinal surgery: a meta-analysis. *World Neurosurg*. 2016;95:507-515.
6. Yan DL, Pei FX, Li J, Soo CL. Comparative study of PILF and TLIF treatment in adult degenerative spondylolisthesis. *Eur Spine J*. 2008;17(10):1311-1316.
7. Zhou J, Wang R, Huo X, Xiong W, Kang L, Xue Y. Incidence of surgical site infection after spine surgery: a systematic review and meta-analysis. *Spine*. 2020;45(3):208-216.

8. Melton LJ. The prevalence of osteoporosis. *J Bone Miner Res*. 2010;12(11):1769-1771.
9. Moltó A, Etcheto A, Désirée VDH, et al. Prevalence of comorbidities and evaluation of their screening in spondyloarthritis: results of the international cross-sectional ASAS-COMOSPA study. *Ann Rheum Dis*. 2015;75(6):1016-1023.
10. Berríos-Torres SI, Umscheid CA, Bratzler DW, et al. Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. *JAMA Surg*. 2017;152:784-791.
11. Sun Y, Wang H, Tang Y, et al. Incidence and risk factors for surgical site infection after open reduction and internal fixation of ankle fracture: a retrospective multicenter study. *Medicine*. 2018;97(7):9901-9906.
12. Wimmer C, Gluch H, Franzreb M, Ogon M. Predisposing factors for infection in spine surgery: a survey of 850 spinal procedures. *Clin Spine Surg*. 1998;11(2):124-128.
13. Thangarajah T, Prasad PSV, Narayan B. Surgical site infections following open reduction and internal fixation of ankle fractures. *Open Orthopaed J*. 2009;3(1):56-60.
14. Deng H, Chan A, Ammanuel S, et al. Risk factors for deep surgical site infection following thoracolumbar spinal surgery. *J Neurosurg Spine*. 2019;32(2):292-301.
15. Miao J, Chen D. Risk factors for incision infection after spinal surgery. *Chin J Spin Cord*. 2010;3:246-249.
16. Xu X, Zhang D. Retrospective study of orthopedic surgical site infection rate and risk factors. *Chin J Infect Contr*. 2010;02:109-111.
17. Li Z, Liu P, Zhang C, et al. Incidence, prevalence, and analysis of risk factors for surgical site infection after lumbar fusion surgery: ≥2-year follow-up retrospective study. *World Neurosurg*. 2019;131:e460-e467.
18. Liu JM, Deng HL, Chen XY, et al. Risk factors for surgical site infection after posterior lumbar spinal surgery. *Spine*. 2018;43(10):732-737.
19. Huang L, Cai Z, Chen K, et al. Multifactor analysis of risk factors for complications after posterior lumbar fusion. *Chin J Orthop*. 2017;37(020):1285-1293.
20. Claus CF, Lytle E, Tong D, et al. Elderly as a predictor for perioperative complications in patients undergoing multilevel minimally invasive Transforaminal lumbar Interbody fusion: a regression modeling study. *Spine*. 2020;45:735-740.
21. Shi A. Effect of psychological intervention on preoperative tension of patients undergoing surgery. *Chin J Misdiagn*. 2005;5(10):1933-1933.
22. Hellbusch LC, Helzer-Julin M, Doran SE, et al. Single-dose vs multiple-dose antibiotic prophylaxis in instrumented lumbar fusion—a prospective study. *Surg Neurol*. 2008;70(6):622-627. discussion 627.

How to cite this article: Pei H, Wang H, Chen M, Ma L, Liu G, Ding W. Surgical site infection after posterior lumbar interbody fusion and instrumentation in patients with lumbar degenerative disease. *Int Wound J*. 2021;18:608–615. https://doi.org/10.1111/iwj.13562