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Case study

Impact of surgical site infection and surgical debridement on lumbar arthrodesis: A single-institution analysis of incidence and risk factors

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ABSTRACT

This study identifies the rate of pseudarthrosis following surgical debridement for deep lumbar spine surgical site infection and identify associated risk factors. Patients who underwent index lumbar fusion surgery from 2013 to 2014 were included if they met the following criteria: 1) age >18 years, 2) had debridement of deep lumbar SSI, and had 3) lumbar spine AP, lateral and flexion/extension X-rays and computed tomography (CT) at 12 months or greater postoperatively. Criteria for fusion included 1) solid posterolateral, facet, or disk space bridging bone, 2) no translational or angular motion on flexion/extension X-rays, and 3) intact posterior hardware without evidence of screw lucency or breakage. Twenty-five patients (age 63.2 ± 12.6 years, 10 male) involving 58 spinal levels met inclusion criteria. They underwent fusion at a mean of 2.32 [range 1–4] spinal levels. Sixteen (64.0%) patients received interbody grafts at a total of 34 (58.6%) spinal levels. All underwent surgical debridement with removal of all non-incorporated posterior bone graft and devascularized tissue. At one-year postoperatively, (56%) patients and 30 (52%) spinal levels demonstrated radiographic evidence of successful fusion. Interbody cage during initial fusion was significantly associated with successful arthrodesis at follow-up ($p = 0.017$). There is a high rate of pseudoarthrosis in 44% of patients (48% of levels) undergoing lumbar fusion surgery complicated by SSI requiring debridement. Use of interbody cage during initial fusion was significantly associated with higher rate of arthrodesis.

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1. Introduction

Advances in surgical techniques and patient selection have resulted in improved outcomes following spine fusion. However, these procedures still require the introduction of foreign hardware and significant tissue dissection and manipulation of native anatomy. As a result, spine fusion patients can experience significant postoperative pain and other less common complications including cerebrospinal fluid (CSF) leak, hardware failure, hematoma, and nerve damage [9]. Surgical site infection is another uncommon but morbid complication for lumbar spine fusion, and has an incidence of 0.3%-9%, depending on a multitude of factors including preoperative diagnosis, type of operation, and patient demographics [1,11,17,21–23]. Following diagnosis of postoperative wound infection, patients typically undergo wound irrigation and debridement with removal of graft bone. Postoperatively, patients are then placed on oral or intravenous (IV) antibiotics and then monitored for resolution of infection [14].

Infection and debridement surgery has significant short-term and long-term sequelae including increased hospital stay, 30-day readmission, decreased quality of life and decreased satisfaction with the index procedure [7,19,26]. However, there is no consensus on the impact of irrigation and debridement or wound infection on long-term fusion rates. There has been previous laboratory data suggesting inflammatory markers associated with infection are beneficial in achieving bone growth [13,25,28]. However, other groups have not shown this association, and in fact, have suggested that the inflammatory response is detrimental for achieving successful arthrodesis [8]. Therefore, the authors designed a retrospective review to assess the rate of arthrodesis following irrigation and debridement following lumbar spine fusion. By doing so, the authors hope to better characterize the rate of arthrodesis following surgical debridement for wound infection, and identify any pre-, peri-, and post-operative factors predictive of either arthrodesis or pseudoarthrosis.

2. Materials and methods

Patients who were: 1) age ⩾18 years at time of surgery, 2) had lumbar spine fusion between 2008 and 2014, 3) debridement of

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deep lumbar SSI, and 4) lumbar spine anterior and posterior (AP), lateral flexion/extension X-rays and computed tomography (CT) at 12 months or greater postoperatively were retrospectively included for statistical analysis. Institutional Review Board (IRB) approval was obtained prior to data collection and chart review.

Demographic data including age, sex, race, and body mass index (BMI) were recorded. Patient comorbidities including smoking status, diabetes, hypertension (HTN), osteoporosis, hyperlipidemia (HLD), chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), coronary artery disease (CAD), peripheral vascular disease (PVD) and atrial fibrillation (A-fib) were logged. Details of the initial surgical procedure including type of procedure, indications for surgery, spinal levels involved, estimated blood loss (EBL), urine output (UOP), operating room time, use of interbody cage, and use of intrawound vancomycin powder were recorded. Investigators also verified the any instances of intraoperative complications including neurological worsening and durotomy. Details of infection and debridement were recorded, including tissue culture results, date of debridement, and 30-day readmission. All patients underwent surgical debridement with removal of all non-incorporated posterior bone graft and devascularized tissue, pulse lavage with antibiotic, and drain placement. Intraoperative tissue cultures confirmed infectious etiology. Additional postoperative complications including mortality, pneumonia, UTI, and blood loss requiring packed red blood cell transfusion (pRBC) were recorded.

All patients' 12-month postoperative AP, lateral, and flexion/extension lumbar spine plain films and lumbar spine CT scan were then reviewed for presence of bony fusion. Criteria for fusion included 1) solid posterolateral, facet, or disk space bridging bone, 2) no translational or angular motion on flexion/extension X-rays, and 3) intact posterior hardware without evidence of screw lucency or breakage. Patients with imaging that satisfied all three criteria were deemed to have achieved successful fusion. Those who did not completely satisfy all three criteria were deemed to have pseudoarthrosis. Patient examples of those who did and did not satisfy fusion criteria are shown in Figs. 1 and 2, respectively.

Demographic, pre-, peri-, and postoperative data as well as infection and debridement data were then compared between patients who achieved successful fusion and those who did not. Statistical analysis was performed using JMP 12.0 (SAS Institute, Inc., Cary, NC, USA). Patient characteristics were summarized as counts with percentages or means with standard deviation (SD), as appropriate. Number of vertebral levels was represented as mean [interquartile range]. Student's *t*-test for independent samples was used to assess continuous data. Fisher exact tests were used to analyze categorical variables. Statistical significance was set at $\alpha \leqslant .05$.

3. Results

3.1. Patient characteristics

In total, 25 patients (15 female, 10 male) involving 58 spinal levels met inclusion criteria and were reviewed in this study. From 2008 to 2014, an additional 8 patients underwent lumbar spine fusion complicated by infection and wound debridement, but did not meet inclusion criteria due to lack of imaging follow-up. The mean age and BMI were 63.2 ± 12.6 years and 31.6 ± 7.5 kg/m^2, respectively. Fifteen (60%) patients were obese (BMI >30.0 kg/m^2), 2 (8.0%) were active smokers, 4 (16.0%) had CAD, 19 (76.0%) had hypertension, and 7 (28.0%) had type II diabetes mellitus. Patient demographic data, comorbidities, and surgical levels are summarized in Table 1. A total of 11 (44.0%) patients and 28 (48.0%) spinal levels met criteria for failure of fusion. There were no significant differences in demographic data, risk factors, or comorbidities between the fusion and pseudoarthrosis groups, as detailed in Table 2.

3.2. Intraoperative data

Of the 25 patients reviewed, 13 (52.0%) patients underwent lumbar fusion and 12 (48.0%) patients underwent lumbosacral fusion. The average number of fusion levels was 2.32 with a range of 1–4. The number of spinal levels involved was not statistically different between fusion and pseudoarthrosis groups. Ten (40.0%) patients underwent simultaneous laminectomy; 4 (16.0%) patients at 1 spinal level, 5 (20.0%) patients at 2 spinal levels, and 1 (4.0%) patients at 3 spinal levels. Number of laminectomy levels had no statistically significant association with successful fusion. Ten patients (40.0%) underwent fusion including an anterior approach, while 19 (76.0%) patients underwent fusion including a posterior

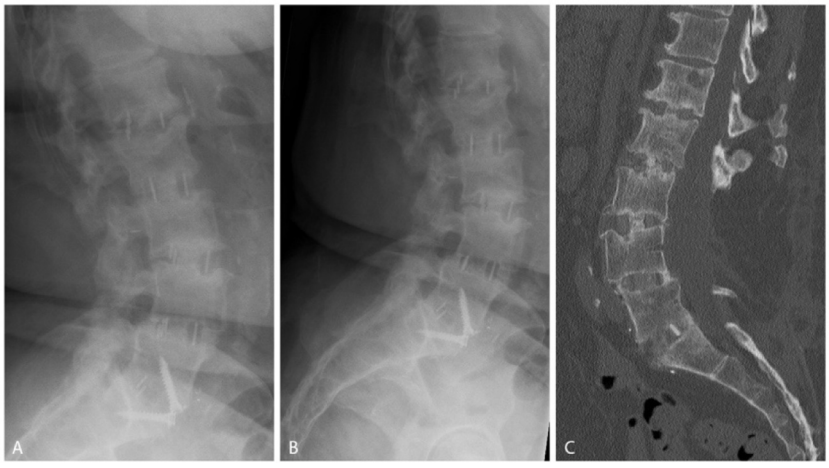

Fig. 1. Patient case of successful interbody fusion at 1 year follow-up. The above patient had combined anterior-posterior approach L1-S1 interbody fusion with polyetheretherketone (PEEK) interbody grafts in all disk spaces. Initial lumbar fusion was complicated by wound infection with *Pseudomonas aeruginosa*, which resolved with debridement and ciprofloxacin therapy. Patient had interval posterior hardware removal 1-year following irrigation and debridement. The two anterior L5-S1 anterior screws were not removed. Lateral flexion (A) and extension (B) plain films showed no motion segment instability, and sagittal-view lumbar CT (C) showed successful bridging bone at disk spaces for all levels. The patient met all study criteria for successful fusion. Image series for this patient was obtained at 1-year follow-up from initial lumbar spine fusion.