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Bacteriology and Risk Factors for Development of Late (Greater Than One Year) Deep Infection Following Spinal Fusion With Instrumentation

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Abstract

Study Design: Retrospective cohort review.
Objectives: To evaluate patients who underwent instrumented spinal fusion procedures and compare late (more than 1 year) and early infection (less than 1 year).
Summary of Background Data: Centers for Disease Control and Prevention criteria for surgical site infections with implants include infections occurring at less than 1 year postoperatively. The authors observed a high rate of deep infection at more 1 year after instrumented spinal fusion. Retrospective review was conducted to determine whether differences in bacteriology, patient demographics, or surgical factors exist between late and early infection.
Methods: A total of 1,390 patients underwent spinal fusion with instrumentation from 2000 to 2009. Deep infection requiring operative debridement occurred in 112 patients (70 at less than 1 year and 42 at more than 1 year after the index surgery). Clinical, operative, and microbiology reports were reviewed and logistic regression was performed to evaluate the relationship between these factors and time of infection.
Results: The most common organisms in the greater than 1 year group were *Propionibacterium acnes*, compared with *Staphylococcus aureus* in the less than 1 year group. The odds of late infection in the *P acnes* group were 15.5 (95% confidence interval [CI], 4.36–54.72) times the odds among all other organisms ($p < .0001$). Patient demographics and surgical factors were not different between groups. Among all patients, the infection rate was significantly higher in patients who received stainless-steel implants (11.56%) compared with those who received titanium implants (3.53%) ($p < .0001$). In univariate analysis, the odds of late infection in the stainless-steel group were 6.09 (95% CI, 1.62–39.88) times the odds in the titanium group ($p = .0042$). However, in multivariate analysis, controlling for organism type reduced the odds ratio to 4.62 (95% CI, .53–40.14), with only a trend to significance ($p = .1656$).
Conclusions: *Propionibacterium acnes* was more commonly identified in late infection. Patients with stainless-steel implants had a higher incidence of late infection than those with titanium implants, but this was not significant after controlling for organism type.

Keywords: Scoliosis; Spinal fusion; Infection; Bacteriology; Implant type

Introduction

The deep infection rate after instrumented surgery for spinal deformity has been reported to be between 1.4% and 12% [1-9]. The Center for Disease Control and Prevention (CDC) defines a surgical site infection as one that occurs less than 12 months postoperatively if implants are used [10,11]. Perhaps based on this, investigators have often used margins of 3 to 6 months after the index surgery to describe late infection, rather than times greater than 1 year [3,6,12-16].

The authors' institution has noticed an increase in the incidence of late deep infection after instrumented spinal fusion. Their own clinical experiences as well as microbiological-focused studies have suggested that late

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deep infection after instrumented spinal fusion is frequently caused by *Propionibacterium acnes* [3,6,17-20].

The purpose of this retrospective study was to investigate the incidence and bacteriology of late deep infection after instrumented spinal fusion at greater than 1 year postoperatively. A time period greater than the CDC definition for a surgical site infection involving implants (less than 12 months postoperatively) was employed, and all infections occurring at greater than 1 year were classified as late-occurring infections. The authors hypothesized that *P acnes* would be the most frequently isolated pathogen in late deep infection after instrumented spinal fusion and that titanium implants would have a lower incidence of infection than stainless steel.

Materials and Methods

The researchers obtained institutional review board approval before initiating the study. A retrospective cohort study was then conducted. Examination of the institution's spine case register identified 1,390 patients between the ages of 6 and 25 years who underwent instrumented spinal fusion between 2000 and 2009. All approaches and both index and revision procedures were included. Patients who received concomitant Vertical Expandable Prosthetic Titanium Rib DePuy Synthes Spine (Raynham, MA) or growing rod procedures during spinal fusion were excluded. Deep infection was defined as one requiring operative debridement down to spinal implants. Superficial infections managed only by local wound care and/or antibiotics were excluded. Early infection and late infection were defined as deep infections occurring less than and greater than 1 year after the infecting spinal fusion procedure, respectively.

The authors' previously published institutional risk determination labeled patient as high risk if they had neuromuscular disease (carrying such diagnoses as cerebral palsy, spina bifida, muscle disease, spinal cord injuries, traumatic brain injuries, paralytic deformities, or chromosome anomalies), underwent a vertebral column resection, or had other underlying comorbidities putting them at an increased risk for infection [21].

Clinical, operative, and microbiology reports were retrospectively examined to determine the onset of infection as well as to collect variables of interest. The following variables were evaluated: surgical approach, ambulatory status, gender, length of surgery, seasonal quarter in which infection occurred, body mass index (BMI), diagnosis, use of pelvic fixation, institutional risk determination, age, implant alloy type, and type of organism. Organism type was defined as the pathogen(s) identified from intraoperative cultures obtained at surgical debridement. Numerous organism types were identified, but for the purpose of analysis these were collapsed into the following groups: *P acnes* only, *Staphylococcus aureus* only, polymicrobial, or other single organism. Variables with incomplete data were excluded from the analysis.

A univariable logistic regression analysis was used to identify variables significantly associated with infection type. Variables that were significant or marginally significant ($p \leqslant .10$) in single-predictor models were considered for inclusion in the final multivariable model. The researchers also performed a Kaplan-Meier survival analysis to evaluate time, as a continuous variable, from date of initial surgery to infection (taken as the date of the first operative debridement). The log-rank test was used to compare the probability of infection free survival across the 4 organism groups. A supplementary analysis was used to examine the relationship between implant type and infection (infection vs. no infection) among all subjects who underwent instrumented spinal fusion between 2000 and 2009; potential confounding factors relating implant type and infection were controlled for in a multivariable model. Chi-square test was used to compare the distribution of implant types among subjects who did versus did not develop an infection. Finally, the authors used Fisher exact test to compare the distribution of implants in the 4 organism groups.

Results

Deep infection occurred in 112 of 1,390 patients (8.1%). Forty-two patients were identified with late deep infection after instrumented spinal fusion, representing an overall late infection incidence of 3.0%. Seventy patients were identified with early deep infection after instrumented spinal fusion, resulting in an early infection incidence of 5.2%.

Patient factors including diagnosis, age, gender, BMI, and surgical factors including length of surgery, number of fusion levels, and presence of pelvic fixation were not different between groups (Table 1). Forty-six patients were identified as high risk, whereas the remaining 66 were identified as low risk. All patients had a minimum follow-up of 2 years after

Table 1
Demographics of early versus late infection.

Variable	Early (n = 70)	Late (n = 42)
Diagnosis		
Neuromuscular	39%	48%
Idiopathic	30%	21%
Other	31%	31%
Gender		
Female	61%	60%
Male	39%	40%
Pelvic fixation		
No	64%	71%
Yes	36%	29%
Total	100%	100%
Average (standard deviation)		
Age, years	14.6 (2.8)	15.5 (2.4)
Cobb angle	60.3° (24.9)	60.1° (18.7)
Body mass index	21.1 (6.4)	20.3 (4.8)
Surgery length, hours	4.1 (1.5)	4.0 (1.8)
Fusion levels, n	12.0 (3.4)	11.3 (3.4)