Recidivism Rates After Smoking Cessation Before Spinal Fusion

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**abstract**

Tobacco use has documented negative effects on perioperative complications and clinical outcomes. Smoking cessation before spinal surgery may improve clinical outcomes. The goal of this study was to determine the recidivism rate after smoking cessation before spinal fusion. A prospective observational study was performed at the University of Kansas Medical Center between 2006 and 2011. All patients with serum-confirmed nicotine cessation before spinal fusion surgery were eligible. Smoking status was determined with questionnaires at 3 months, 6 months, and 1 year postoperatively. All reported nonsmokers had confirmatory serum nicotine and cotinine tests. Two-tailed Pearson chi-square and independent t tests were conducted, and significance was set at α = 0.05. A total of 42 subjects (21 women, 21 men) with confirmed preoperative serum-negative test results were prospectively enrolled over a period of 3.9 years. Of these patients, 1 opted out at 6 months and 1 died of unknown cause. The findings showed a recidivism rate (response rate) of 60% (40 of 41) at 3 months, 61% (33 of 41) at 6 months, and 68% (25 of 40) at 1 year. One case of asymptomatic pseudarthrosis occurred 1 year postoperatively in a confirmed nonsmoker. No correlation was found between smoking status at 3 months and sex, primary vs revision surgery, or complications (P > 0.05). Smokers who relapsed at 3 months were older than nonsmokers (55.2 vs 44.2 years, respectively; P = .03). Some patients are willing to cease smoking before spinal fusion for optimal clinical outcomes; however, the rate of recidivism is high (60%) within the first 3 months postoperatively. [Orthopedics. 2016; 39(2):e318-e322.]

Tobacco use is the leading cause of preventable death in the United States.1 Multiple smoking cessation methods are available, with variable reported rates of success. Different motivations for quitting smoking have been identified and used in smoking cessation efforts. Some programs identify patients who are willing to quit smoking through a health care encounter. These encounters may include primary care visits, diagnosis of a smoking-related condition, the need for medical care for a child or another family member, or hospitalization for a condition unrelated to smoking.2-5 Studies have shown an association with smoking and back pain.6-8 Furthermore, smoking and nicotine use adversely affect surgical outcomes in patients undergoing spinal fusion. Increased complications include poor wound healing, infection, perioperative pulmonary complications, and incomplete bone fusion healing, or pseudarthrosis.9-16

Patients with spinal disorders often have painful or debilitating conditions that can be treated with elective surgery. Current evidence shows higher complication rates in tobacco users, and many
spinal surgeons now require nicotine cessation before surgery. Nicotine status is commonly verified with a serum test. This clinical scenario creates new motivation for smoking cessation in patients who wish to proceed with spinal surgery.

Despite the common protocol of nicotine cessation before spinal surgery, minimal data are available on clinical outcomes, perioperative complications, and postoperative recidivism rates. The goal of this study was to describe the natural history of smoking recidivism after serum-confirmed cessation in patients undergoing spinal fusion.

Materials and Methods

After approval was obtained from the institutional review board at the University of Kansas, a prospective observational clinical study of patients treated by 2 orthopedic spine surgeons (D.C.B., R.S.J.) from 2006 to 2011 was performed. The study population included patients with spinal disorders who were treated with spinal fusion and were self-reported tobacco users. The current treatment protocol requires cessation of all nicotine products for 30 days prior to considering elective surgery. Patients are instructed to call after they have been nicotine-free for 30 days to schedule a preoperative clinical visit. This visit includes biochemical confirmation of cessation with a serum nicotine and cotinine test.

Study enrollment occurred at the preoperative visit. Patients had standard follow-up at 6 weeks, 3 months, 6 months, and 1 year postoperatively. At each visit, clinical staff administered questionnaires on tobacco use, serum nicotine and cotinine tests, clinical examinations, and radiographs.

Inclusion criteria were as follows: (1) a spinal disorder treated with spinal fusion; (2) self-reported cessation of all nicotine products for 30 days before scheduling surgery; and (3) negative preoperative serum nicotine and cotinine test results. The following patients were excluded: (1) nonsurgical patients and (2) nonsmokers.

During the study period, 46 patients who were seen by the treating physicians self-reported tobacco use, met the inclusion criteria, and were asked to participate in the study. All 46 subjects reported smoking tobacco cigarettes as their primary nicotine consumption. Enrollment was voluntary, and participants could discontinue participation at any time. Participants did not receive compensation.

The treating physician documented smoking status, use of cessation aids, and implant and fusion status at each visit. Additional data collected from patient records included sex, age at surgery, procedure performed, primary vs revision surgery, and complications.

Tobacco use status was self-reported during clinical interviews. Patients who reported continued nicotine cessation underwent a confirmatory serum nicotine and cotinine laboratory test on the same day. The test that was used quantifies serum nicotine and cotinine (nicotine metabolite) levels with a liquid chromatography-tandem mass spectrometry technique and is sensitive for determining active vs passive nicotine exposure. To minimize risk and cost, patients who reported nicotine use were exempt from serum testing. All samples were processed by Mayo Medical Laboratories (Mayo Clinic, Rochester, Minnesota).

Descriptive statistics and data analysis were performed with SPSS version 21.0 software (IBM Corp, Armonk, New York). Data were tested for normality with the Kolmogorov-Smirnov test and Levene’s test for equality of variance. Data for the 6-week and 3-month follow-up visits were combined into a single time point called 3 months. Participants were grouped according to serum-confirmed nicotine status, and separate analyses were performed for each follow-up time point.

The recidivism rate was the primary outcome variable. Two recidivism rates were calculated: a “responders” recidivism rate calculated as the number of patients smoking divided by the number of responders, and an “all subjects” recidivism rate calculated as the number of patients smoking divided by the total number of subjects, with nonresponders conservatively categorized as smokers.

Student’s independent t test was used to assess differences in continuous variables between groups. Differences in categorical variables were assessed with Pearson’s chi-square test. Significance was set at α=0.05.

Results

Of 46 eligible subjects, 42 (91%) provided consent and were enrolled in the study between 2006 and 2011. The study group included 21 men and 21 women, with a mean age of 48±12.8 years (range, 23-81 years). All subjects had negative preoperative test results for both nicotine and cotinine.

All study subjects underwent spinal fusion surgery. No intraoperative complications occurred, but there were 2 immediate postoperative complications (4.8%). One patient had a superficial wound hematoma that resolved without additional surgery, and another had immediate postoperative cervical seroma with a neurologic deficit, believed to be associated with the use of bone morphogenetic protein fusion material, and was previously reported.

The main outcome variable was the recidivism rate at 3 months, 6 months, and 1 year postoperatively. Results for these time points are shown in the Table. At 3 months, 40 of 41 eligible subjects were seen at a mean of 2.9±1.0 months after surgery. One subject died of an unknown cause after successful hospital discharge with no complications. The recidivism rate for responders was 60% (24 smoking vs 16 nonsmoking). The recidivism rate for all subjects was 61%. For responders, the mean age of smokers was 55.2 years. This group included 12 men and 12 women, and of these, 16 had a primary procedure and 8 underwent revision. There were no complications. The...
Comparison of Responders After Smoking Cessation Before Spinal Fusion

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<tr>
<th>Postoperative Follow-up</th>
<th>Mean Age, y</th>
<th>Sex (F/M)</th>
<th>Primary vs Revision</th>
<th>Complications</th>
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<td>8/8</td>
<td>14 vs 2</td>
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Abbreviations: F, female; M, male.
aTwo-tailed Student's independent t test, P=.03.
bA 62-year-old woman with asymptomatic pseudarthrosis who underwent C4-C6 anterior fusion with autograft and allograft.

At 6 months, 33 of 41 eligible subjects were seen at a mean of 6.5±1.0 months. Eight patients either did not keep their 6-month appointment or were lost to follow-up. For responders, the recidivism rate was 61% (20 smokers vs 13 nonsmokers). The recidivism rate for all subjects was 68%. No complications occurred in either group. No significant difference in sex or type of surgery was observed between groups (P>.05).

At 1 year, 25 of 40 eligible subjects were seen at a mean of 13.1±3.1 months. One subject opted out after the 6-month visit. Subjects who were not included at 1 year were lost to follow-up and could not be located. The recidivism rate for responders was 68% (17 smokers and 8 nonsmokers). The recidivism rate for all subjects was 80%. One complication occurred in the nonsmoking group. A serum-confirmed nonsmoker had asymptomatic radiographic pseudarthrosis (fusion nonunion). To date, no further surgery has been necessary for this patient. No difference in sex or type of surgery was observed between groups (P>.05).

Three subjects (7.3%) reported using cessation aids. One subject reported bupropion use at the 3-month visit and had a negative test result for nicotine and cotinine at all follow-up visits. Another subject reported using varenicline at the 1-year appointment, beginning 1 month earlier, and endorsed using tobacco at all follow-up visits. The third subject had a negative test result at 3 months and reported use of a nicotine inhaler at the 6-month visit and use of a nicotine patch at 1 year.

**Discussion**

Tobacco smoking is associated with increased complications, worse outcomes, and increased rates of pseudarthrosis in patients undergoing spinal fusion. All study participants completed self-reported 30-day tobacco cessation as part of a preoperative spine surgery protocol. Adherence was confirmed biochemically with a serum test, and all subjects had negative results. Spinal surgeons commonly require tobacco cessation, and this represents a unique opportunity to incentivize cessation in active smokers undergoing spinal fusion. The current study subjects were not surveyed about their motivations for smoking cessation or their cessation methods. This topic is clinically important and should be investigated.

The recidivism rates observed indicate that patients are highly susceptible to relapse during the first 3 months after spinal surgery. Multiple studies show that recidivism rates are high within the first 5 months after smoking cessation, regardless of the cessation method used. A meta-analysis reported mean recidivism rates of 69.5% to 88.2% for all types of cessation interventions and mean recidivism rates of 82.6% to 93.3% for nonintervention or placebo groups. The current study reported a recidivism rate of 60% at 3 months with no intervention, which is lower than previously reported rates; however, the populations may not be comparable. To the authors’ knowledge, this is the first study to report recidivism rates in patients who recently quit nicotine use and underwent spinal surgery.

Establishing the natural history of smoking recidivism without intervention in this unique patient population is important for understanding and quantifying the efficacy of relapse prevention. There is a new focus on pharmacotherapy and/or psychosocial techniques to prevent relapse and maintain nonsmoking status. The strongest evidence on relapse prevention indicates that extended use of varenicline therapy can significantly reduce smoking recidivism. However, because of inconsistency across studies, variations in study designs, and differences in popu-
lations and intervention techniques, it is difficult to obtain conclusive evidence for or against other techniques for relapse prevention.21 No studies have reported on relapse prevention in patients with spinal disorders who recently quit nicotine use, and this is a topic of ongoing research at the study institution. This study had several strengths. The study critically examined the effect of the widespread but poorly studied clinical practice of tobacco cessation before spinal fusion. It employed prospective data collection with 1-year follow-up. At the most relevant follow-up visit, 3 months, this study had a 98% response rate. Response rates at all clinical visits were relatively high, even though patients were not compensated. Nonsmoking status was confirmed with an objective, highly sensitive serum test, with all tests performed at the same laboratory. All surgical procedures were performed at the same institution by the same 2 surgeons.

The study also had several limitations. Initial screening for smoking status was by self-report. Some patients may have concealed their tobacco use and therefore were not considered for inclusion. The study did not include patients who were unwilling to quit smoking after learning of the preoperative protocol. Studying differences between patients who were willing to quit and those who were not willing to quit may be clinically important. The small sample size is a weakness of the study. Expanding this research to a multicenter model could increase the size of the study group and allow for comparisons between groups based on demographics, comorbid conditions, and other perioperative factors. Serum tests are sensitive for up to 14 days after nicotine use.17,22 Thus, the authors could not control for patients who had negative test results but then used nicotine and quit again before the next follow-up appointment. One method for controlling against this is performing random blood tests. However, requesting random samples is logistically challenging and may discourage study participation. There was collection bias, with the treating physicians completing the data collection forms. However, recidivism rates (the primary outcome) were determined with objective data from serum tests.

The authors believe that this is the first report of recidivism rates after smoking cessation before spinal fusion surgery. The study focused on a specific patient population that has evidence supporting preoperative tobacco cessation for optimal surgical and clinical outcomes. The study findings contribute to the understanding of smoking recidivism natural history in postsurgical spinal disorder patients who quit smoking before surgery. The current findings can be used to help determine the efficacy of future postoperative interventions for maintenance of smoking cessation.

**CONCLUSION**

Preoperative protocols offer a unique opportunity for initiating tobacco cessation in current smokers undergoing spinal fusion surgery. The smoking recidivism rate 3 months postoperatively in patients with no cessation maintenance interventions was 60%. Relapsed smokers were significantly older than nonsmokers. Patients with spinal disorders who recently quit tobacco use may benefit from interventions to maintain nonsmoking status in the early postoperative period.

**REFERENCES**

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