



## Reduced Impact of Smoking Status on 30-Day Complication and Readmission Rates After Elective Spinal Fusion ( $\geq 3$ Levels) for Adult Spine Deformity: A Single Institutional Study of 839 Patients

Aladine A. Elsamadicy<sup>1</sup>, Owoicho Adogwa<sup>2</sup>, Amanda Sergesketter<sup>1</sup>, Victoria D. Vuong<sup>2</sup>, Emily Lydon<sup>1</sup>, Shay Behrens<sup>1</sup>, Joseph Cheng<sup>3</sup>, Carlos A. Bagley<sup>4</sup>, Isaac O. Karikari<sup>1</sup>

■ **BACKGROUND:** Smoking status has been shown to affect postoperative outcomes after surgery. The aim of this study was to determine whether patients' smoking status impacts 30-day complication and readmission rates after elective complex spinal fusion ( $\geq 3$  levels).

■ **METHODS:** The medical records of 839 adult spinal deformity patients undergoing elective complex spinal fusion ( $\geq 3$  levels) at a major academic institution from 2005 to 2015 were reviewed. We identified 124 (14.8%) smokers and 715 (85.2%) nonsmokers. Patient demographics, comorbidities, intraoperative and postoperative complications, and 30-day readmission rates were collected for each patient. The primary outcome investigated in this study was the rate of 30-day postoperative complication and readmission rates.

■ **RESULTS:** Patient demographics and comorbidities were similar between both groups, including age, sex, and body mass index. Median [interquartile] number of fusion levels and operative time were similar between the cohorts (smoker: 5 [4–7] vs. nonsmoker: 5 [4–8],  $P = 0.58$ ) and (smoker:  $309.6 \pm 157.9$  minutes vs. nonsmoker:  $287.5 \pm 131.7$  minutes,  $P = 0.16$ ), respectively. Both cohorts had similar postoperative complication rates and lengths of hospital stay. There was no significant difference in 30-day readmission between the cohorts (smoker: 12.9% vs.

nonsmoker: 10.8%,  $P = 0.48$ ). There were no observed differences in 30-day complication rates, including pain ( $P = 0.46$ ), UTI ( $P = 0.54$ ), hardware failure ( $P = 0.36$ ), wound dehiscence ( $P = 0.29$ ), and wound drainage ( $P = 0.86$ ). Smokers had greater rates of 30-day cellulitis (smoker: 1.6% vs. nonsmoker: 0.3%,  $P = 0.05$ ) and DVT (smoker: 0.8% vs. nonsmoker: 0.0%,  $P = 0.02$ ).

■ **CONCLUSIONS:** Our study suggests that smoking does not significantly affect 30-day readmission rates after complex spinal surgery requiring  $\geq 3$  levels of fusion. Further studies are necessary to corroborate our findings.

### INTRODUCTION

Despite increasing efforts in smoking cessation, nearly 1 in 4 adults in the United States continues to smoke cigarettes according to the Centers for Disease Control and Prevention's National Health Report published in 2014.<sup>1</sup> In health care, the number of smokers undergoing surgery remains high, leading to increased incidence of tobacco-related surgical complications and associated health care costs.<sup>2,3</sup> In fact, complications including infection, failure of wound closure, thromboembolism, and 30-day readmission have been associated independently with tobacco use across surgical specialties,<sup>3,5</sup>

#### Key words

- 30-Day readmission
- Complication
- Deformity
- Fusion
- Smoking
- Spine surgery

#### Abbreviations and Acronyms

- DVT:** Deep-vein thrombosis  
**EBL:** Estimated blood loss  
**MI:** Myocardial infarction  
**PE:** Pulmonary embolism

**SSI:** Surgical-site infection

**UTI:** Urinary tract infection

From the <sup>1</sup>Department of Neurosurgery, Duke University Medical Center, Durham, North Carolina; <sup>2</sup>Department of Neurosurgery, Rush University Medical Center, Chicago, Illinois; <sup>3</sup>Department of Neurosurgery, Yale University, New Haven, Connecticut; and <sup>4</sup>Department of Neurosurgery, University of Texas Southwestern, Dallas, Texas, USA

To whom correspondence should be addressed: Owoicho Adogwa, M.D., M.P.H.

[E-mail: owoicho.adogwa@gmail.com]

Citation: *World Neurosurg.* (2017) 107:233-238.

<http://dx.doi.org/10.1016/j.wneu.2017.07.174>

Journal homepage: [www.WORLDNEUROSURGERY.org](http://www.WORLDNEUROSURGERY.org)

Available online: [www.sciencedirect.com](http://www.sciencedirect.com)

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leading to many surgeons considering tobacco use a contraindication for surgery.<sup>6,7</sup>

In spinal surgery, the relationship between tobacco use and surgical outcomes has been studied extensively.<sup>2,8-24</sup> However, although a multitude of studies suggest that smoking leads to greater postoperative complication rates and poor surgical outcomes,<sup>2,8-19</sup> others have shown no difference in outcomes between smokers and nonsmokers undergoing spinal surgery.<sup>20,22,23,25,26</sup> As the result of this discrepancy, it has been suggested that the effect of tobacco use on spinal surgery may be region and procedure-dependent,<sup>8,21,27</sup> warranting examination of postoperative outcomes after specific subtypes of spinal surgery. The aim of this study was to determine whether current smoking status impacts complication and 30-day readmission rates after elective complex spinal fusion ( $\geq 3$  levels).

## METHODS

The medical records of 839 adult ( $\geq 18$  years old) patients with spine deformity undergoing elective complex spinal fusion ( $\geq 3$  levels) at a major academic institution from 2005 to 2015 were reviewed. Institutional review board approval was obtained before the initiation of the study. Inclusion criteria included patients with 1) available demographics and treatment data; 2) had a diagnosis of scoliosis, kyphosis, or kyphoscoliosis; 3) who underwent elective complex spinal fusion of  $\geq 3$  levels; and 4) identification of current smoking status on medical records. We identified 124 (11.7%) smokers and 715 (88.3%) nonsmokers (smoker:  $n = 124$ , nonsmoker:  $n = 715$ ). Patients were categorized as "smoker" if current tobacco use was indicated on their medical record at time of surgery and "nonsmoker" if either former tobacco use or no current tobacco use was listed on their medical record. The primary outcomes of this study were complication rates and unplanned hospital readmissions within 30 days after hospital discharge.

Demographic variables evaluated included patient age, sex, race, and body mass index. Comorbidities included depression, anxiety, diabetes, congestive heart failure, coronary artery disease, atrial fibrillation, peripheral vascular disease, myocardial infarction (MI), hypertension, hyperlipidemia, anemia, previous pulmonary embolism (PE), previous deep-vein thrombosis (DVT), and chronic kidney disease.

Operative variables included median fusion levels, estimated blood loss (EBL), number of packed red blood cell transfusions, and whether the surgery was minimally invasive. Other operative variables assessed included use of radiographs, fluoroscopy, electromyography, somatosensory-evoked potentials, and transcranial motor-evoked potentials. Intraoperative complications included incidence of intraoperative durotomy. Postoperative complications included length of hospital stay, intensive care unit transfer, delirium, urinary tract infection (UTI), fever, ileus, deep and superficial surgical-site infections (SSI), hypotension, hematoma, MI, DVT, PE, sepsis, motor weakness, sensory deficit, urinary retention, and discharge with Foley catheter.

Readmission variables assessed included rates of readmission within 30 days. Thirty-day complications included pain, altered mental status, UTI, fever, cellulitis, wound dehiscence, wound drainage, dysphagia, hardware failure, hypotension, MI, PE, DVT, dysphagia, new weakness, and new sensory/motor deficits.

Parametric data were expressed as means  $\pm$  standard deviation and compared with the Student *t* test. Nonparametric data were expressed as median (interquartile range) and compared via the Mann-Whitney *U* test. Nominal data were compared with the  $\chi^2$  test. All tests were 2 sided and were statistically significant if the *P* value was less than 0.05. Statistical analysis was performed with JMP, Version 12 (SAS Institute Inc., Cary, North Carolina, USA).

## RESULTS

A total of 839 patients (smoker:  $n = 124$ , nonsmoker:  $n = 715$ ) were included in this study. There were no significant differences in age between both cohorts (smoker:  $60.3 \pm 11.6$  years vs. nonsmoker:  $62.5 \pm 13.4$  years) and proportion of males included in each cohort (smoker: 45.2% vs. nonsmoker: 38.2%) (Table 1). There was no significant difference in body mass index between both cohorts (smoker:  $28.2 \pm 6.5$  kg/m<sup>2</sup> vs. nonsmoker:  $28.8 \pm 6.7$  kg/m<sup>2</sup>,  $P = 0.36$ ) (Table 1). There were no significant differences between both groups in prevalence of other comorbidities, including depression, anxiety, diabetes, congestive heart failure, coronary artery disease, atrial fibrillation, peripheral vascular disease, MI, hypertension, hyperlipidemia, anemia, PE, DVT, and chronic kidney disease (Table 1).

The median [interquartile range] number of fusion levels and operative time were similar between both cohorts (smoker: 5 [4–7]

**Table 1.** Preoperative Variables

Variables	Smoker ( $n = 124$ )	Nonsmoker ( $n = 715$ )	<i>P</i> Value
Male	45.2	38.2	0.14
Age, years	60.3 $\pm$ 11.6	62.5 $\pm$ 13.4	0.06
BMI, kg/m <sup>2</sup>	28.2 $\pm$ 6.5	28.8 $\pm$ 6.7	0.36
Depression	37.1	29.5	0.09
Anxiety	25.0	22.4	0.52
Diabetes	15.3	15.9	0.86
CHF	2.4	2.0	0.74
CAD	15.3	11.6	0.24
A-Fib	5.7	6.4	0.74
PVD	1.6	1.4	0.85
MI	4.8	2.9	0.27
HTN	66.9	58.6	0.08
HLD	47.6	39.2	0.08
Anemia	4.8	8.1	0.20
Previous DVT	3.2	3.4	0.94
Previous PE	0.8	2.4	0.27
CKD	4.0	3.9	0.95

Values are percentages unless otherwise indicated.

BMI, body mass index; CAD, coronary artery disease; CHF, congestive heart disease; A-Fib, atrial fibrillation; PVD, peripheral vascular disease; MI, myocardial infarction; HTN, hypertension; HLD, hyperlipidemia; DVT, deep-vein thrombosis; PE, pulmonary embolism; CKD, chronic kidney disease.

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