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ORIGINAL ARTICLE

Tobacco use is associated with increased rates of infection and revision surgery after primary superior labrum anterior and posterior repair

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Background: Although the general health consequences of tobacco use have been well defined, the effects of perioperative tobacco use on arthroscopic shoulder procedures remain largely unknown. The purpose of this study is to use a national database to investigate the relationship between tobacco use and rates of superior labrum anterior and posterior (SLAP) repair failure and postoperative infection after primary SLAP repair compared with matched controls.

Methods: A national private-payer insurance database was queried for patients who underwent arthroscopic primary SLAP from 2005-2012. These patients were divided into tobacco use and non–tobacco use cohorts using *International Classification of Diseases, Ninth Revision* coding. The non–tobacco use patients were then matched to the patients with coded tobacco use. Both cohorts were assessed for postoperative infection within 90 days and subsequent ipsilateral revision SLAP repair or biceps tenodesis within up to 7 years postoperatively.

Results: The incidences of revision SLAP repair or revision to a biceps tenodesis ($P = .023$) and postoperative infection ($P = .034$) were significantly higher in patients who used tobacco versus matched controls.

Conclusions: SLAP repair in patients who use tobacco is associated with significantly increased rates of postoperative infection and revision SLAP repair or conversion to a biceps tenodesis.

Level of evidence: Level III; Retrospective Cohort Design Using Large Database; Treatment Study

Keywords: SLAP repair; tobacco; revision surgery; infection; biceps tenodesis; complications

Although smoking rates have declined, a recent estimate by the Centers for Disease Control and Prevention estimated that nearly 18% of adults are current, every day smokers.[11] More importantly, however, smoking remains the leading cause of preventable disease and death in the United States, accounting for 1 of every 5 deaths.[27] Although the general health consequences of tobacco use have been well delineated in the current literature, the musculoskeletal effects of perioperative tobacco use continue to evolve and are often difficult to isolate.[1] Whereas it is known that tobacco use increases the risk of fracture, tendon injury, perioperative complications, nonunion and delayed union of fractures, infections, and wound-healing complications, less literature is available on its effects on arthroscopic soft-tissue shoulder surgery.[13] It is thought that transient effects on the tissue microvasculature, which decreases tissue oxygenation, account for some of the negative effects of tobacco and result in the

This study meets exempt criteria for our Health Sciences Research Institutional Review Board as all data were de-identified and anonymous.

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inhibition of reparative cell functions, which ultimately lead to delayed healing.[24] This would make the shoulder particularly susceptible to the effects of tobacco, as it intrinsically has a limited blood supply and relies on vascular ingrowth and inflammatory responses to heal after injury or surgery.[21,26]

Superior labrum anterior and posterior (SLAP) tears are recognized as a common cause of shoulder pain, and there has been an increasing incidence of surgical treatment of these lesions with largely good to excellent results.[4-6,9,10,28] Although substantial research has been conducted on surgical outcomes after SLAP repairs, few studies have specifically examined the relationship between tobacco use and SLAP repair failure requiring revision surgery.[19-21] Furthermore, the actual impact of tobacco use on the success of SLAP repair and other postoperative complications, such as infection, remain largely ill-defined because of the small, retrospective nature of studies in the existing literature.[19-21]

The purpose of this study was to use a national database to evaluate the relationship between tobacco use and rates of postoperative infection and subsequent revision SLAP repair or biceps tenodesis after primary SLAP repair compared with matched controls. Our hypothesis was that patients undergoing primary SLAP repair who use tobacco would have higher rates of postoperative infection and revision surgery than matched controls without documented tobacco use.

Materials and methods

The PearlDiver Patient Records Database (www.pearldiverinc.com; Fort Wayne, IN, USA), a for-fee insurance-based database of patient records, was used for this study. The database contains procedural volumes, patient demographic data, and average charge information for patients with *International Classification of Diseases, Ninth Revision* (ICD-9) diagnoses and procedures or Current Procedural Terminology (CPT) codes. The PearlDiver data for this study were derived from the Humana private-payer database within the PearlDiver records, which contains over 18 million unique patients from 2007-2014.

The database was queried using CPT code 29807 to identify patients who underwent arthroscopic SLAP repair. If patients had more than 1 CPT code for SLAP repair, the first code was used to reduce the chances of including revision SLAP repairs. This cohort of primary SLAP repairs was then divided into tobacco use and non–tobacco use cohorts using ICD-9 code 305.1 (tobacco use disorder). The non–tobacco use patients were matched to patients with a coded tobacco use disorder by using the maximum number of available patients in the database who underwent SLAP repair without a coded tobacco use disorder that could be included and matched to achieve a statistically similar distribution of several key variables: age, sex, obesity, concomitant rotator cuff repair, and concomitant instability repair. The sequential matching algorithm first matched based on age; then sex; then obesity, diabetes, and rotator cuff repair; and finally, instability repair, with the goal of creating a matched control group with a statistically similar distribution of the matched variables compared with the study group patients.

Table I Cohort demographic data

	Smokers (n = 837)	Matched nonsmokers (n = 2246)	*P* value
Age group			
15-19 y	11 (1.3%)	30 (1.3%)	.896
20-24 y	18 (2.2%)	49 (2.2%)	.931
25-29 y	24 (2.9%)	65 (2.9%)	.935
30-34 y	47 (5.6%)	126 (5.6%)	.934
35-39 y	52 (6.2%)	139 (6.2%)	.953
40-44 y	91 (10.9%)	245 (10.9%)	.971
45-49 y	107 (12.8%)	287 (12.8%)	.955
50-54 y	125 (14.9%)	336 (15.0%)	.969
55-59 y	113 (13.5%)	303 (13.5%)	.958
60-64 y	94 (11.2%)	253 (11.2%)	.970
65-69 y	89 (10.6%)	239 (10.6%)	.953
70-74 y	54 (6.5%)	145 (6.5%)	.938
75-79 y	11 (1.3%)	30 (1.3%)	.896
Sex			
Female	299 (35.7%)	783 (34.9%)	.687
Male	538 (64.3%)	1463 (65.1%)	
Concomitant procedure			
Rotator cuff repair	286 (34.2%)	775 (34.5%)	.895
Instability repair	122 (14.6%)	338 (15.0%)	.786

The infection rate within 90 days postoperatively was assessed for both the tobacco use SLAP repair cohort and the matched controls using ICD-9 codes 998.5, 998.51, 998.59, 711.91, 711.01, 711.41, and 711.81 and CPT codes 20000, 20005, 10180, 23030, 23031, and 23040. Subsequent ipsilateral revision SLAP repair and biceps tenodesis after the index procedure were assessed by querying for CPT codes 29807 and 29828 or 23430, respectively, with CPT modifiers for laterality, within the time limitation of the database (up to 7 years postoperatively).

Statistical comparisons of final cohort demographic data, matched variables, and postoperative complication rates were compared using Pearson χ^2 analysis. Odds ratios were calculated with respective 95% confidence intervals. For all statistical comparisons, $P < .05$ was considered significant. SPSS for Macintosh (version 22; IBM, Armonk, NY, USA) was used for all statistical calculations.

Results

A total of 3083 patients who underwent primary SLAP repair met the inclusion and exclusion criteria and were included in the study. This included 837 patients with a tobacco use disorder and 2246 matched controls. Demographic data including age group and sex, relevant medical comorbidities, and concomitant procedures for both the study and matched control cohorts are provided in Table I. There were no statistically significant differences between the study cohort and