Systematic Review

Smoking Predisposes to Rotator Cuff Pathology and Shoulder Dysfunction: A Systematic Review

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Purpose: To investigate the association of smoking with rotator cuff (RTC) disease and shoulder dysfunction, defined as poor scores on shoulder rating scales. **Methods:** A systematic review was performed using a search strategy based on "shoulder AND [smoke OR smoking OR nicotine OR tobacco]." English-language clinical or basic science studies testing the association of smoking and shoulder dysfunction on shoulder rating scales or disease of the soft tissue of the shoulder were included. Level V evidence studies and articles reporting only on surgery outcomes, subjective symptoms, adhesive capsulitis, or presence of fracture or oncologic mass were excluded. **Results:** Thirteen studies were included, comprising a total of 16,172 patients, of whom 6,081 were smokers. All 4 clinical studies addressing the association between smoking and patient-reported shoulder symptoms and dysfunction in terms of poor scores on shoulder rating scales (i.e., Simple Shoulder Test; University of California, Los Angeles shoulder scale; and self-reported surveys) confirmed this correlation with 6,678 patients, of whom 1,723 were smokers. Two of four studies documenting provider-reported RTC disease comprised 8,461 patients, of whom 4,082 were smokers, and found a time- and dose-dependent relation of smoking with RTC tears and a correlation of smoking with impingement syndrome. Smoking was also reported in 4 other articles to be associated with the prevalence of larger RTC tears or tears with pronounced degenerative changes in 1,033 patients, of whom 276 were smokers, and may accelerate RTC degeneration, which could result in tears at a younger age. In addition, 1 basic science study showed that nicotine increased stiffness of the supraspinatus tendon in a rat model. **Conclusions:** Smoking is associated with RTC tears, shoulder dysfunction, and shoulder symptoms. Smoking may also accelerate RTC degeneration and increase the prevalence of larger RTC tears. These correlations suggest that smoking may increase the risk of symptomatic RTC disease, which could consequently increase the need for surgical interventions. **Level of Evidence:** Level IV, systematic review of Level II through IV studies.

See commentary on page 1606

The prevalence of smoking remains close to 20% in the general population, being highest in persons below the poverty level or aged 22 to 44 years.[1] Smoking has been strongly linked to cancer, chronic obstructive pulmonary disease, and cardiovascular disease.[2] Smoking has also been shown to have adverse clinical musculoskeletal effects, including an increased risk of sustaining a fracture, nonunion and delayed union of fractures, and decreased bone mineral density.[3] In addition, we recently showed in a systematic review that smoking is associated with poor clinical outcomes after rotator cuff (RTC) repair and poor healing outcomes of small to medium tears.[4] Because smoking temporarily decreases tissue oxygenation and nicotine is a potent vasoconstrictor, the effect of smoking may be marked in already hypovascular areas, such as the soft tissue within the shoulder.[5] Hence it is reasonable to assume that smoking is associated with RTC pathology.

Although individual studies have been published on the effects of smoking on normal shoulder tendon tissue, to date, there have been no comprehensive reviews of the literature on the topic. With the increasing life expectancy and as the baby boomer generation ages, orthopaedic surgeons are seeing more elderly patients presenting with degenerative RTC tears.[6] Some studies suggest that the prevalence

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and extent of degenerative RTC tears increase with advancing age,[7,8] highlighting the importance of addressing risk factors to prevent RTC tears. Therefore the purpose of this study was to investigate the association of smoking with RTC disease and shoulder dysfunction. We hypothesized that smoking has a negative effect on shoulder health.

Methods

A systematic review was conducted according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines[9] (Fig 1). The search strategy was based on "shoulder AND [smoke OR smoking OR nicotine OR tobacco]." The search was independently confirmed by the coauthors (J.Y.B., J.E.S-T., N.R., D.C.F.) on October 4, 2014. The following medical databases were used: PubMed, CINAHL (Cumulative Index to Nursing and Allied Health Literature), SPORTDiscus, and The Cochrane Library. We included studies with Levels I, II, III, and IV evidence as defined by the Oxford Centre for Evidence-Based Medicine and used by the American version of *The Journal of Bone and Joint Surgery*.[10] Meeting and conference abstracts were not eligible for inclusion. The senior author (J.Y.B.) made the final decision on article inclusion if there was disagreement among authors. Top hits in Web search engines and all references within included studies were checked to identify potentially relevant studies missed by the initial database search.

Any English-language clinical articles studying smoking and shoulder function assessed with shoulder rating scales or RTC or glenoid labrum disease with evidence Levels I through IV were included. Basic science studies analyzing the anatomy, histology, pathology, biomechanics, or imaging characteristics associated with RTC or glenoid labrum disorders were also included.

The exclusion criteria consisted of non–English-language studies and studies of Level V evidence (i.e., single-case report, expert opinion, or personal observation). Any clinical and basic science studies analyzing any joint other than the shoulder were also excluded. In addition, studies reporting only subjective pain findings or on adhesive capsulitis were excluded. Finally, studies reporting on fractures or oncologic masses around the shoulder were excluded, as were studies analyzing only the outcomes of surgery, without reporting preoperative status.

Continuous variable data were reported as means and standard deviations from the means. Categorical variable data were reported as frequencies with percentages. Associations were reported as odds ratios (ORs) with corresponding 95% confidence intervals (CIs). $P < .05$ was considered significant.

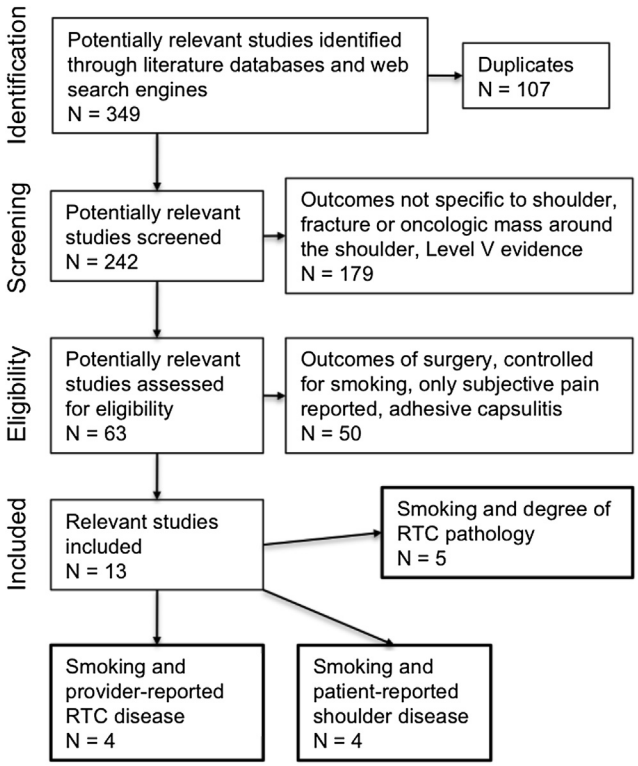

Fig 1. Search strategy according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Thirteen studies were identified for inclusion. No studies on smoking and glenoid labrum disease were found. (RTC, rotator cuff.)

Results

Thirteen studies were identified for inclusion and analysis, comprising 16,172 patients, of whom 6,081 were smokers. Four of these studies were clinical studies that addressed the association between smoking and patient-reported shoulder dysfunction (i.e., poor scores on shoulder rating scales) and symptoms (Table 1). Another 4 clinical studies examined the correlation between smoking and provider-reported RTC disease (Table 2). The other studies investigated the relation of smoking and degree of RTC pathology or mechanical properties of the RTC (3 clinical, 1 cadaveric, and 1 basic science study) (Table 3). No studies specifically exploring the effects of smoking on the glenoid labrum were found.

Patient-Reported Shoulder Symptoms and Dysfunction

Smokers were more likely to report shoulder pain and decreased shoulder function (Table 1). With a total of 6,678 patients (mean age, 52 years), of whom 1,723 were smokers, all 4 clinical studies reviewed found a significant negative association between smoking and shoulder function and symptoms.