Sleep Disturbance and Anatomic Shoulder Arthroplasty

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abstract

Sleep disturbance is commonly encountered in patients with glenohumeral joint arthritis and can be a factor that drives patients to consider surgery. The prevalence of sleep disturbance before or after anatomic total shoulder arthroplasty has not been reported. The authors identified 232 eligible patients in a prospective shoulder arthroplasty registry following total shoulder arthroplasty for primary glenohumeral joint arthritis with 2- to 5-year follow-up. Sleep disturbance secondary to the affected shoulder was characterized preoperatively and postoperatively as no sleep disturbance, frequent sleep disturbance, or nightly sleep disturbance. A total of 211 patients (91%) reported sleep disturbance prior to surgery. Patients with nightly sleep disturbance had significantly worse ($P<.05$) Constant pain, Constant activity, and Western Ontario Osteoarthritis Shoulder index scores prior to surgery. Postoperatively, there was a significant improvement in the prevalence of sleep disturbance, with 186 patients (80%) reporting no sleep disturbance ($P<.001$). The no sleep disturbance group had significantly greater patient-reported outcome scores and range of motion following surgery compared with the other sleep disturbance groups for nearly all outcome measures ($P\leq.01$). Patients have significant improvements in sleep after anatomic shoulder arthroplasty. There was a high prevalence of sleep disturbance preoperatively (211 patients, 91%) compared with postoperatively (46 patients, 20%). [*Orthopedics.* 201x; xx(x):xx-xx.]

There is an increasing need to better identify patients who will achieve optimal outcomes after shoulder surgery. Glenohumeral joint osteoarthritis can be a chronic debilitating condition that may eventually require surgery. There is no consensus on when to intervene with surgical treatment in the setting of glenohumeral joint osteoarthritis. Surgeons rely on patients to gauge the level of pain and impact on their quality of life as part of a shared decision-making process. Surgeons and patients often consider sleep disturbance as part of the matrix to determine whether surgical intervention may be warranted. However, the prevalence of sleep disturbance prior to anatomic total shoulder arthroplasty (TSA) has not been reported, and it is not clear what impact TSA has on sleep disturbance.

Night pain and poor sleep quality have been highlighted as common findings in shoulder patients and are thought to negatively impact quality of life and daytime activities and be associated with anxiety and depression.[1-3] The incidence of sleep

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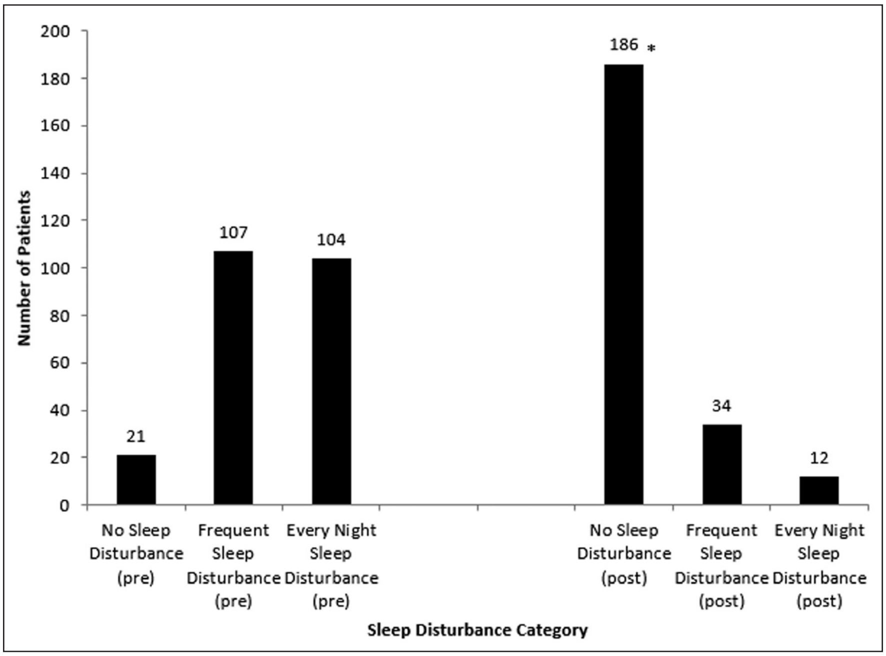

Figure 1: Preoperative (pre) and postoperative (post) sleep disturbance. *Significantly greater number of patients compared with frequent and every night sleep disturbance groups (P<.001).

disturbance prior to arthroscopic rotator cuff repair was recently reported to be 89% (50 of 56 patients).[4] Twenty-one patients (38%) continued to report sleep disturbance 6 months following rotator cuff repair surgery.[4]

The purposes of this study were to (1) determine the prevalence of preoperative and postoperative sleep disturbance in patients with primary osteoarthritis undergoing TSA and (2) assess the impact of sleep disturbance on patient-reported outcome scores. The authors hypothesized that patients would have a high prevalence of preoperative sleep disturbance and would show significant improvements in sleep disturbance following TSA. They also hypothesized that patients with sleep disturbance would have lower shoulder function scores and lower patient satisfaction scores.

Materials and Methods

Patient Inclusion Criteria and Demographics

The authors identified all patients in a prospective shoulder arthroplasty registry following TSA for primary glenohumeral joint osteoarthritis with 2- to 5-year follow-up. A total of 254 patients were identified and 22 patients were excluded because of subsequent revision surgery or intraoperative or postoperative complications. These patients were excluded to limit confounding variables. The senior author (T.B.E.) completed all of the surgeries at a high-volume shoulder arthroplasty center using similar implants for all cases (Aequalis, Aequalis Ascend, and Aequalis Ascend Flex; Tornier Inc, Bloomington, Minnesota). A previously described surgical technique and standardized postoperative rehabilitation were used.[5-7]

Patient demographic and clinical characteristics were prospectively recorded. The senior author (T.B.E.) completed all clinical and radiographic evaluations. Range of motion measurements were determined using a goniometer. A digital dynamometer (Chatillon Digital Force Gauge 90.7 kilogram force; AMETEK, Largo, Florida) was used to measure strength of abduction. Radiographic evaluation included preoperative computed tomographic arthrography to evaluate rotator cuff status and glenoid morphology according to Walch et al.[8]

Sleep disturbance was determined prior to surgery and at annual follow-up by asking patients, "Is your sleep disturbed by your shoulder—no, frequently, or every night?" Multiple validated patient-reported outcome measures were completed preoperatively and at annual follow-up, including the Constant-Murley shoulder score,[9] the American Shoulder and Elbow Surgeons score,[10] the Western Ontario Osteoarthritis Shoulder index,[11] and the Single Assessment Numeric Evaluation.[12] Patient satisfaction was assessed by patients describing themselves as very dissatisfied, dissatisfied, satisfied, or very satisfied. Very satisfied or satisfied patients were considered to be "satisfied," and very dissatisfied or dissatisfied patients were considered to be "dissatisfied." Institutional review board approval was obtained.

Statistical Analysis

Analysis of variance was used to compare age, duration of follow-up, and body mass index with preoperative sleep disturbance response. Chi-square tests were performed to determine if differences existed between the groups for sex, smoking status, back pain, depression, diabetes, heart disease, preoperative opioid use, and satisfaction. Separate one-way analyses of variance (preoperative sleep disturbance and preoperative outcome scores, postoperative sleep disturbance and postoperative outcome scores, and postoperative sleep disturbance and preoperative/postoperative change in outcome scores) with a Bonferroni post hoc correction were used to determine if the relative change in each outcome score differed between sleep disturbance responses. Statistical analyses were performed using Stata version 13.1 software (StataCorp, College Station, Texas), with P<.05 considered statistically significant.

Results

There was a high prevalence of preoperative sleep disturbance, with 211 patients (91%) reporting frequent or nightly sleep disturbance (**Figure 1**). No statistical differences were noted between the 3 sleep disturbance groups regarding age, body mass index, follow-up duration, smoking status, low back pain, depression, diabetes, heart disease, preoperative opioid use, or glenoid morphology (**Table 1**). There was a significantly greater percentage of females in the frequent sleep disturbance group compared with the nightly sleep disturbance group (*P*=.002). The mean clinical follow-up was 3.5±1 years (range, 2-5 years).

Preoperatively, the no sleep disturbance and frequent sleep disturbance groups consistently outperformed the nightly sleep disturbance group on patient-reported outcome scores, with patients reporting nightly sleep disturbance preoperatively having significantly worse (*P*<.05) Constant pain, Constant activity, and Western Ontario Osteoarthritis Shoulder index scores. No statistical differences were noted for other patient-reported outcome measures preoperatively.

Postoperatively, there was a significant improvement in the prevalence of sleep disturbance, with 186 patients (80%) reporting no sleep disturbance compared with 34 patients (15%) reporting frequent sleep disturbance and 12 patients (5%) reporting nightly sleep disturbance (*P*<.001) (**Figure 1**). The no sleep disturbance group had significantly greater patient-reported outcome scores and range of motion measurements following surgery compared with the other sleep disturbance groups for all variables (*P*≤.01) except Constant strength score (*P*≥.07) and external rotation range of motion (*P*>.90) (**Table 2**). The no sleep disturbance group also had significantly greater Single Assessment Numeric Evaluation scores following surgery compared with the nightly sleep disturbance group (*P*=.002) but not the frequent sleep disturbance group (*P*=.18) (**Table 2**).

Table 1

Comparison of Patient Demographics and Clinical Characteristics (n=232)

	Preoperative Sleep Disturbance			
Characteristic	**None (n=21)**	**Frequently (n=107)**	**Every Night (n=104)**	***P***
Sex, female	33%	46%[a]	23%	.002
Age at surgery, mean±SD (range), y	68±11 (49-88)	67±10 (43-93)	66±9 (38-89)	.73
Body mass index, mean±SD (range), kg/m^2	29±7 (20-48)	30±6 (19-50)	30±5 (19-46)	.84
Follow-up, mean±SD (range), y	3±1 (2-5)	3.5±1 (2-5)	3±1 (2-5)	.71
Active smoking, No.	0 (0%)	4 (4%)	1 (1%)	.33
Chronic back pain, No.	10 (48%)	32 (30%)	40 (38%)	.20
Depression, No.	2 (10%)	9 (8%)	4 (4%)	.34
Diabetes, No.	1 (5%)	4 (4%)	12 (12%)	.08
Heart disease, No.	1 (5%)	9 (8%)	14 (13%)	.33
Preoperative opioid use, No.	1 (5%)	32 (30%)	27 (26%)	.07
Glenoid morphology (Walch classification[8]), No.				
A1	9 (45%)	52 (49%)	43 (42%)	.57
A2	4 (20%)	8 (8%)	8 (8%)	.17
B1	1 (5%)	11 (10%)	11 (11%)	.73
B2	6 (30%)	30 (28%)	37 (36%)	.49
C	0 (0%)	5 (5%)	4 (4%)	.61

[a]Significantly greater percentage of females in frequent sleep disturbance group compared with nightly sleep disturbance group.

Preoperative and postoperative Constant pain scores were compared between the 3 groups (**Figure 2**). The no sleep disturbance group had significantly better Constant pain scores after surgery compared with the frequent and nightly sleep disturbance groups (*P*<.001). The group with frequent sleep disturbance had significantly better Constant pain scores after surgery compared with the nightly sleep disturbance group (*P*<.001). Constant pain scores significantly improved preoperatively to postoperatively for all groups (*P*<.001). No differences were noted in preoperative Constant pain scores between the 3 groups.

Additionally, 88% of all patients (205 of 232) were satisfied following surgery. Satisfaction following surgery varied with 94% of patients (175 of 186) in the no sleep disturbance group reporting being satisfied, 74% (25 of 34) in the frequent sleep disturbance group being satisfied, and only 42% (5 of 12) in the group reporting nightly sleep disturbance being satisfied. The no sleep disturbance group had a significantly greater proportion of patients who were satisfied following surgery compared with the other 2 groups (*P*<.001), while there was no statistical difference between the patients with frequent and nightly sleep disturbance (*P*=.08).

Discussion

The purposes of this study were to determine the prevalence of preoperative and

Table 2

Comparison of Postoperative Patient-Reported Outcome Measure Scores and Range of Motion Measurements

	Mean±SD		
Outcome Measure	**No Sleep Disturbance (n=186)**	**Frequent Sleep Disturbance (n=34)**	**Every Night Sleep Disturbance (n=12)**
Constant: pain	14±2[a]	10±4[b]	5±5
Constant: activity	18±2[a]	14±5[b]	8±6
Constant: mobility	37±4[a]	33±9	29±12
Constant: strength	15±7	12±6	10±8
Constant: total	83±10[a]	69±18[b]	53±26
Constant: adjusted	111±14[a]	91±24[b]	67±33
ASES	92±11[a]	77±19[b]	55±27
WOOS	7±12[a]	28±22[b]	54±28
SANE	73±36[c]	61±33	36±28
Forward flexion	165°±12°[a]	154°±32°	141°±48°
Abduction	164°±13°[a]	152°±32°	139°±48°
External rotation	45°±12°	46°±14°	47°±16°

Abbreviations: ASES, American Shoulder and Elbow Surgeons score; SANE, Single Assessment Numeric Evaluation; WOOS, Western Ontario Osteoarthritis Shoulder index.
[a]*No sleep disturbance group had significantly greater scores compared with both frequent and every night sleep disturbance groups (*$P \leq .01$*).*
[b]*Frequent sleep disturbance group had significantly greater scores compared with the every night sleep disturbance group (*$P \leq .001$*).*
[c]*No sleep disturbance group had significantly greater scores compared with the every night sleep disturbance group (*$P = .002$*).*

postoperative sleep disturbance in patients with primary glenohumeral osteoarthritis undergoing anatomic TSA and assess the impact of sleep disturbance on patient-reported outcome scores. To the authors' knowledge, this represents the first attempt to quantify and understand sleep disturbance as it relates to anatomic TSA. Their hypotheses were supported in that there was a high prevalence of sleep disturbance prior to TSA and significant improvement in sleep disturbance after surgery. Nightly sleep disturbance before or after surgery was associated with significantly worse patient-reported outcomes and lower patient satisfaction.

A prevalence of 91% sleep disturbance prior to TSA was the same as the recently reported 91% of shoulder patients with night pain[3] and similar to 89% sleep disturbance prior to arthroscopic rotator cuff repair.[4] Sleep disturbance was still reported in 38% of patients 6 months following rotator cuff repair[4] compared with 20% of patients 2 to 5 years following TSA in the current study. This suggests that there is likely a subset of shoulder patients who will follow a somewhat delayed recovery with sleep disturbance persisting longer than 6 months. Although it appears that roughly half of these patients will recover normal sleep patterns, the other half will not. The subset with persistent sleep disturbance appears to be at greater risk of poor patient-reported outcomes and reduced patient satisfaction.

There appears to be an inherent relationship between shoulder pain, sleep disturbance, and other patient-reported symptoms. Patients with chronic shoulder pain have shown a high prevalence of depression, anxiety, and sleep disturbance.[2] Shoulder pain has been reported to be the strongest predictor of sleep disturbance ($P<.001$), with 81.5% of the patients reporting sleep disturbance.[2] In the current study, those with sleep disturbance had not only worse postoperative Constant pain scores but also reduced Constant function scores. These findings further support the interwoven relationships between pain, function, sleep disturbance, patient satisfaction, and, in some cases, depression and anxiety disorders. The Constant-Murley score, the American Shoulder and Elbow Surgeons score, and the Western Ontario Osteoarthritis Shoulder index score all have a sleep subcomponent, so it is not unexpected to have lower patient-reported outcome scores for patients who have sleep disturbance.

There are many variables that contribute to the shared decision of the surgeon and the patient to proceed with surgery. Furthermore, results after surgery, although typically positive, are still fraught with a small population of patients who are not satisfied. Sleep disturbance is thought to be an important indicator of pain severity, disease severity, and satisfaction, and it may be an underrecognized component. Empirically, it is common for patients with glenohumeral joint osteoarthritis to present with night pain and sleep disturbance; however, the prevalence before surgery had not been characterized prior to this work. Furthermore, the authors assume that TSA leads to substantial improvement in sleep disturbance; however, to their knowledge, this has not been described in the literature. They hope that these data will improve their ability to counsel patients and set reasonable expectations following TSA. Most patients in the current series had no sleep disturbance (80%) and a high level of patient satisfaction (88%) following TSA. However, patients also need to be aware that they can still experience sleep disturbance following surgery and may not be satisfied with their TSA results, as shown by the 20% of patients who still experienced some form of shoulder-related sleep disturbance postoperatively. Studies are necessary to determine what interventions may be used to improve pain and function in patients with persistent sleep disturbances.

There are strengths and weaknesses of the study. To the authors' knowledge, this is the only cohort assessing the effects of sleep disturbance and TSA; however, it is a relatively small number of patients and a multicenter cohort could strengthen the data. Although sleep disturbance was assessed in the context of shoulder pain, it is possible that other, undiagnosed sleep disorders may have contributed to sleep disturbance. A homogeneous patient population was included, with all patients requiring TSA to treat primary glenohumeral osteoarthritis, the most common indication for TSA.[13] Furthermore, a single surgeon treated all cases with standardized surgical and rehabilitation protocols.

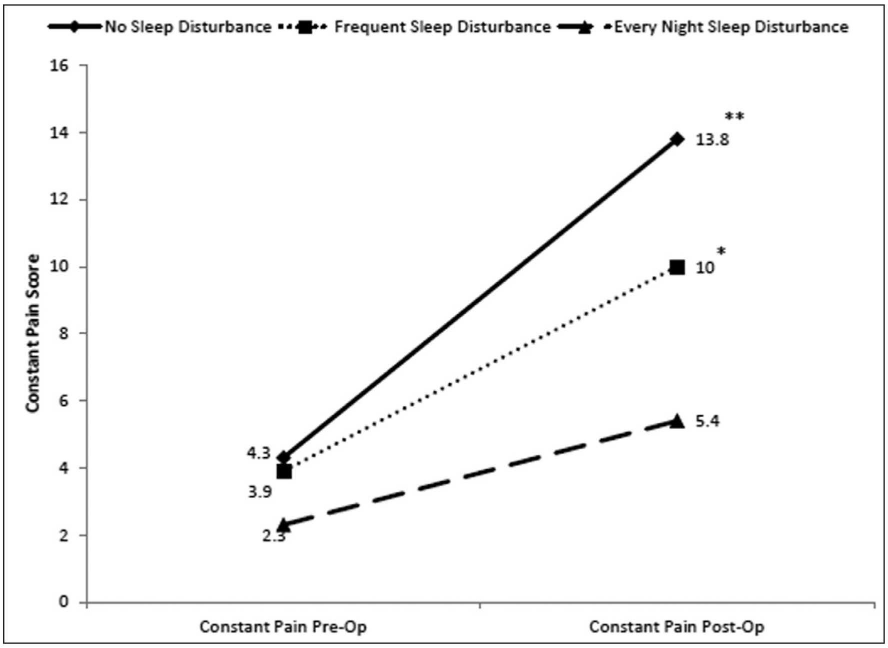

Figure 2: Comparison of preoperative (pre-op) and postoperative (post-op) Constant pain scores between patients with and without sleep disturbance. *Frequent sleep disturbance group had significantly better Constant pain scores after surgery compared with the every night sleep disturbance group (P<.001). Constant pain scores significantly improved preoperatively to postoperatively for all groups (P<.001). No differences were noted in preoperative Constant pain scores between the 3 groups. **No sleep disturbance group had significantly better Constant pain scores after surgery compared with the frequent and every night sleep disturbance groups (P<.001).

Conclusion

Sleep disturbance is a common phenomenon in patients with primary osteoarthritis. Anatomic TSA allowed patients to experience improved sleep, with a 91% prevalence of sleep disturbance preoperatively being reduced to 20% following surgery. Patient-reported outcome measures and satisfaction were positively affected by improvements in sleeping.

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