Systematic Review

Improvements in Sleep After Shoulder Arthroscopy Are Correlated With Improvements in Various Patient-Reported Outcomes: A Systematic Review

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Purpose: To determine the prevalence of sleep disturbances in patients before and after arthroscopic surgery of the shoulder and to evaluate the association between patient-reported outcomes and standardized sleep disturbance tools after shoulder arthroscopy. **Methods:** A systematic review, following PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines, was conducted by searching the PubMed, Embase, and Scopus databases using the terms "arthroscopic surgery" and "sleep." Two independent reviewers evaluated the studies based on the inclusion criteria focused on the effects of shoulder arthroscopy on sleep disturbance and the use of outcome measures related to sleep. Data on sleep quality and functional outcomes were collected and analyzed using various assessment tools, including the Pittsburgh Sleep Quality Index and American Shoulder and Elbow Surgeons score. The methodologic quality of included studies was assessed using the Methodological Index for Non-randomized Studies (MINORS) criteria. **Results:** The review included 15 studies (9 Level IV, 5 Level III, and 1 Level II) comprising 1,818 arthroscopic patients (average age, 57.4 ± 8.86 years; follow-up range, 6 months to 75.7 months). The prevalence rates of sleep disturbances before and after shoulder arthroscopy ranged from 75.8% to 100% and from 19% to 62%, respectively. Every study included in this analysis reported an improvement in rates of sleep disturbances postoperatively compared with preoperatively. Improvements in standardized sleep disturbance scores were associated with functional outcomes. **Conclusions:** Sleep disturbances are commonly observed before and after arthroscopic surgery of the shoulder. Arthroscopic surgery of the shoulder appears to improve sleep quality, and surgeons can expect functional outcomes, specifically the American Shoulder and Elbow Surgeons score, Simple Shoulder Test score, numeric rating scale or visual analog scale score, and Constant-Murley score, to improve in line with sleep quality. **Level of Evidence:** Level IV, systematic review of Level II to IV studies.

Sleep disturbances are frequently observed before and after arthroscopic shoulder procedures. Studies focusing on shoulder arthroscopy have documented a preoperative incidence as high as 100%.[1] Shoulder pain for 3 months or longer has been found to be predictive in the development of sleep disturbance, and these disturbances are frequently cited as patient dissatisfaction with nonoperative management.[2] Studies have shown that the development of chronic sleep disturbance is related to obesity, hypertension, depression, and anxiety.[3,4] Additionally, disturbances leading to sleep deprivation have considerable effects on patients' quality of life and activities of daily living.[5]

The association between sleep disturbance and functional outcomes in shoulder arthroscopy is well studied. The literature shows that preoperative and postoperative sleep outcome scores correlate with functional outcomes such as 36-Item Short Form (SF-36), Simple Shoulder Test (SST), and American Shoulder and Elbow Surgeons (ASES) Standardized Shoulder Assessment Form scores.[1,6-8] Despite the abundance of literature regarding shoulder arthroscopy and sleep disturbance, few studies have aimed to summarize the literature and evaluate sleep disturbance across

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multiple domains of shoulder arthroscopy. Barandiaran et al.[9] performed a systematic review analyzing the relation between sleep disturbances and functional outcomes in shoulder surgery. However, they included non-arthroscopic surgical procedures such as total shoulder replacement, reverse total shoulder replacement, and hemiarthroplasty. Additionally, their review failed to represent the incidence of sleep disturbance surrounding arthroscopic surgery because only 2 of the included studies reported the prevalence of sleep disturbances before and/or after arthroscopic surgery.

Similarly, Kunze et al.[10] and Longo et al.[11] performed systematic reviews aimed at evaluating the prevalence of poor sleep quality in patients undergoing arthroscopic rotator cuff repair (RCR). Kunze et al.[10] reported preoperative and postoperative incidences of sleep disturbance ranging from 40.8% to 89% and from 38% to 58%, respectively. Longo et al.[11] used the average Pittsburgh Sleep Quality Index (PSQI) and visual analog scale (VAS) scores of entire study cohorts to characterize the incidence of sleep disturbances before and after surgery. They found that PSQI scores reliably improved after shoulder arthroscopy. However, both reviews only included patients undergoing arthroscopic RCR. Given that Mulligan et al.[12] found that patients with adhesive capsulitis of the shoulder have worse sleep quality, evidenced by higher PSQI scores, when compared with patients with rotator cuff tears, it is reasonable to assume that the incidences of sleep disturbances reported in these reviews do not accurately represent the general incidences of sleep disturbances in arthroscopic surgery of the shoulder.

The purposes of this systematic review were to determine the prevalence of sleep disturbances in patients before and after arthroscopic surgery of the shoulder and to evaluate the association between patient-reported outcomes (PROs) and standardized sleep disturbance tools after shoulder arthroscopy. We hypothesized that the incidence of sleep disturbances would be lower after shoulder arthroscopy and that sleep disturbance scores would be correlated with functional outcomes.

Methods

Literature Search

A systematic review of multiple databases was performed following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines. Two independent reviewers (D.T. and L.W.) searched the PubMed, Embase, and Scopus databases up to May 15, 2023. The reviewers were a postgraduate year 1 resident and a medical school student. The reviewers used the search terms "arthroscopic surgery" and "sleep." Discrepancies between reviewers were discussed, and a decision for inclusion or exclusion was agreed on. The inclusion criteria included (1) studies that investigated the effects of arthroscopic surgery of the shoulder on sleep disturbance, (2) studies that used any type of outcome measure related to sleep, and (3) studies that were published in peer-reviewed journals. The exclusion criteria included (1) studies unrelated to arthroscopic surgery of the shoulder and sleep, (2) case reports, (3) letters or editorials, (4) non−English-language publications, (5) protocol proposals, (6) studies pertaining to pediatric arthroscopy, (7) systematic reviews or meta-analyses, (8) biomechanical studies, (9) studies related to non-arthroscopic procedures, (10) technique articles, and (11) studies with less than 6 months of follow-up. The initial screening was performed to identify studies that met the inclusion and exclusion criteria based on the abstract or title. The full texts of all resulting studies were subjected to a secondary review by the same 2 independent reviewers (D.T. and L.W.) to assess the studies' suitability in addressing the objectives of this systematic review.

Quality Assessment

The Methodological Index for Non-randomized Studies (MINORS) checklist was used to evaluate the quality of all included studies.[13] The checklist involves 12 items to assess quality. Non-comparative studies were evaluated with the first 8 questions, and comparative studies were evaluated with all 12 questions. The maximum MINORS score is 16 for non-comparative studies and 24 for comparative studies.

Outcome Tools to Assess Sleep Quality

Sleep disturbances were reported in a variety of ways. The PSQI was used in a number of studies.[8,14-20] The PSQI has been proved to be a reliable and valid way to identify sleep disturbances.[21] It consists of a combination of Likert-type and open-ended questions, which are later converted to scaled scores. Scores for each question range from 0 to 3, with higher scores indicating greater sleep disturbances. The maximum score achievable on the PSQI is 21. A score of 5 or greater for the global score identified 88.5% of patients with sleep disturbances in a validation study.[21] The Epworth Sleepiness Scale was used in 1 study.[21] The Epworth Sleepiness Scale is widely used in the field of sleep medicine, and it serves as a subjective rating of how sleepy patients are. Each question is rated from 0 to 3, with higher scores indicating a greater chance of dozing off during the situation stated in the question. The maximum score achievable is 24. An answer of no to question 2 on the SST form was used in some studies to identify patients with sleep disturbance.[6,22] The question asks, "Does your shoulder allow you to sleep comfortably?" Many studies used a wide array of questionnaires designed to identify patients with sleep disturbances.

Data Extraction and Statistical Analysis

The relevant data were extracted from the included studies through the use of a custom spreadsheet. The level of evidence was assigned according to the design of the study, as described by Wright et al.[23] Cohen κ values were calculated to determine the level of inter-rater reliability between the 2 reviewers (D.T. and L.W.) when evaluating studies with the MINORS criteria. Data of interest included publication information, study design, sample size broken down by sex, average body mass index, average patient age, length of follow-up, inclusion and exclusion criteria of the study, outcome tool used to identify or quantify sleep disturbances, type of surgery performed, and preoperative pathology necessitating surgery. Additionally, functional outcomes relating to the shoulder were collected to describe the relation between sleep disturbances and outcomes after surgery. Means and standard deviations were extracted, when available, to calculate pooled values for the study population's demographic characteristics. Ranges were reported when available. Forest plots were used to describe studies that provided preoperative and postoperative PSQI scores. The incidences of preoperative and postoperative sleep disturbances, along with the relation between sleep disturbances and functional outcomes, were reported narratively.

Results

Study Demographic Characteristics

Three hundred ninety-nine studies were initially screened by abstract or title for eligibility for inclusion. From this group, 26 studies met the criteria for full-text review. Of these, 15 studies with an overall population of 1,818 patients undergoing arthroscopic surgery were included in the final analysis (Fig 1). There were 879 male and 883 female patients; 1 study was excluded from this count because it reported a patient population of 56 but did not delineate female patients from male patients.[15] The average age and body mass index (mean ± standard deviation) of the population were 57.4 ± 8.86 years and 29.0 ± 0.64, respectively. Follow-up ranged from 6 months to 75.7 months. Patient demographic characteristics for the included studies are presented in Table 1. Of the included studies, 9 were case series, 3 were case-control studies, 2 were retrospective cohort studies, and 1 was a prospective cohort study. All additional study methods are presented in Table 2.

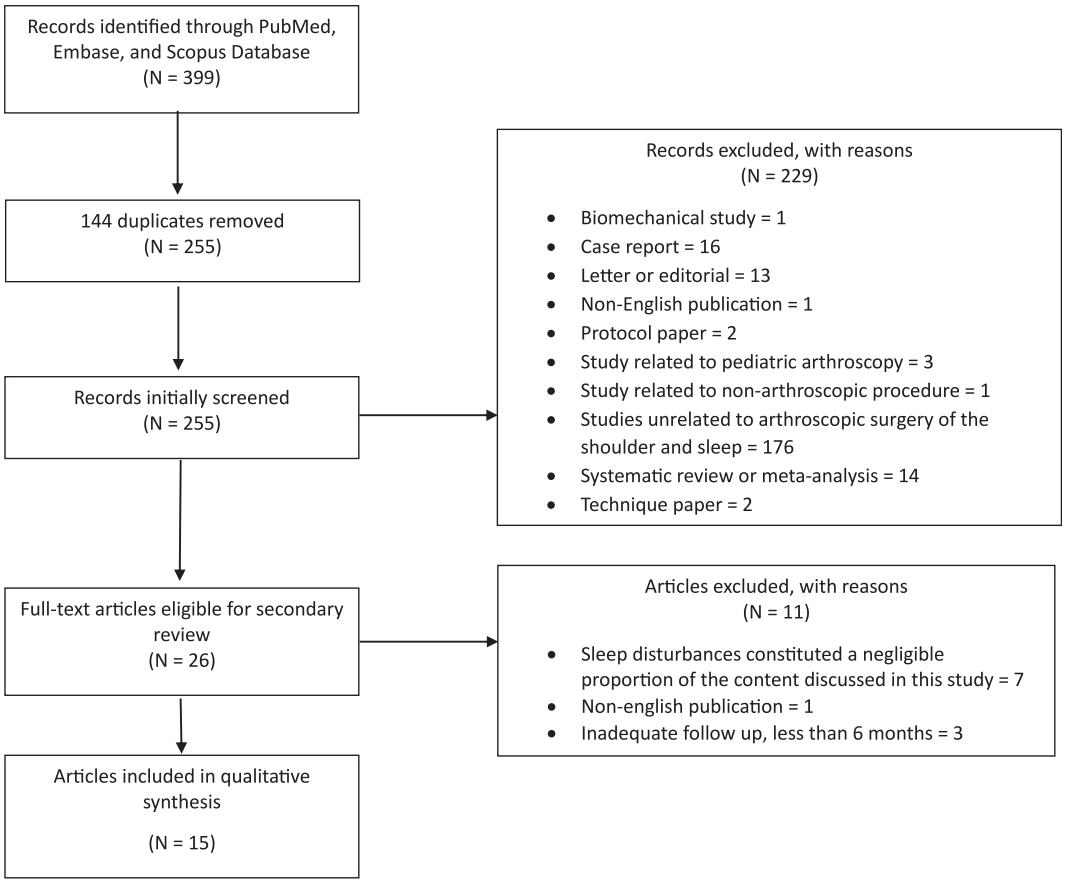

Fig 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) flowchart for study selection.

Table 1. Demographic Characteristics

Authors (Year)	N	Sex: M/F, n	BMI (mean)	Patient Age (years)	Follow-up months (Range)
Weekes et al.[7] (2020)	144	77/67	29.9 ± 5.9	59.3 ± 10.4	12 mo (NR)
Harryman et al.[1] (1997)	30	16/14	NR	47 (26-81)	32 mo (12-56 mo)
Longo et al.[8] (2021)	58	29/29	NR	63.4 ± 13	6 mo (NR)
Qian et al.[14] (2022)	62	Group 1 (Parkinson disease): 13/18 Group 2 (no Parkinson disease): 14/17	NR	Group 1: 63.8 ± 6.0 Group 2: 61.1 ± 7.4	≥2 yr (NR)
Gerber et al.[26] (2001)	45	37/8	NR	50.8 (21-70)	26 mo (12-33 mo)
Hasegawa et al.[24] (2021)	60	Group 1 (duration of symptoms <6 mo): 13/14 Group 2 (duration of symptoms >6 mo): 12/21	NR	Group 1: 61.2 ± 10.0 Group 2: 59.2 ± 11.8	6 mo (NR)
Hurley et al.[25] (2022)	144	132/12	NR	26.9 (17-40)	75.7 mo (NR)
Horneff et al.[15] (2017)	56	NR	NR	(18-NR)	28.8 mo (24-37.9 mo)
Dolan et al.[22] (2022)	250	120/130	28.6 ± 5.6	55.6 ± 9.5	— (6-24 mo)
Glogovac et al.[16] (2019)	48	25/23	NR	62 (34-81)	8 mo (NR)
Serbest et al.[17] (2017)	31	9/22	28 (22-35)	61(26-75)	6 mo (NR)
Zheng et al.[6] (2023)	293	145/148	28.7 ± 5.7	56.2 ± 9.7	2 yr (NR)
Austin et al.[18] (2015)	56	27/29	29.6 (19-50)	59.8 (45-78)	6 mo (NR)
Gumina et al.[19] (2016)	508	Group A (RCT): 156/168 Group B (no RCT): 80/104	NR	Group A: 64.94 ± 6.97 Group B: 63.34 ± 6.26	≥2 yr (NR)
Gulcu[20] (2022)	33	11/22	29.27 ± 3.83 (21-37)	59.79 ± 9.0	6 mo (NR)

BMI, body mass index; F, female; M, male; NR, not reported; RCT, rotator cuff tear.

Bias Assessment

Table 2 shows the MINORS scores of the 15 included studies. The mean score was 14.4 ± 3.3, and the 2 raters achieved a high inter-rater reliability (κ = 0.893). The specific criteria missing from each study are detailed in Appendix Table 1.

Sleep Disturbances Before and After Shoulder Arthroscopy

Nine studies specifically evaluated the incidence or prevalence of sleep disturbances before and/or after shoulder arthroscopy.[1,6,7,15,18,19,22,24,25] There was a significant amount of heterogeneity among the tools used to identify sleep disturbances (Table 3).

Three studies used a PSQI score greater than 5 to identify patients with sleep disturbances before and after arthroscopic surgery of the shoulder.[15,18,19] The incidences of preoperative and postoperative sleep disturbances observed in these studies ranged from 40.8% to 89% and from 41% to 62%, respectively.[15,18,19]

Three studies used the second question of the SST questionnaire to assess sleep disturbances.[1,6,22] The incidence of preoperative sleep disturbance was between 89% and 94%. Within a range of 6 to 24 months of follow-up, Dolan et al.[22] reported a postoperative sleep disturbance rate of 19%. At 24 months of follow-up, 42% of the population reported by Zheng et al.[6] reported sleep disturbances. Harryman et al.[1] followed up patients for 32 months and reported a postoperative sleep disturbance incidence of 27%.

Two studies used a custom questionnaire to evaluate sleep disturbance.[24,25] Hasegawa et al.[24] evaluated patients with frozen shoulders for sleep disturbances after arthroscopic capsular release by administering a questionnaire indicating the presence or absence of nocturnal pain with sleep disturbance. Group 1 had symptoms related to frozen shoulder for less than 6 months, and group 2 had symptoms for greater than 6 months. After surgery, Hasegawa et al. found that both groups experienced significantly fewer sleep disturbances. Hurley et al.[25] evaluated athletes who underwent arthroscopic Bankart repair. Sleep trouble was graded on a scale from 1 to 5, with 1 representing no trouble and 5 representing sleep trouble every night. In their study, 62% of patients reported no sleep trouble at an average follow-up of 75.7 months.

Gerber et al.[26] used a custom numeric rating scale (NRS) for patients to report disturbances in their sleep. No disturbance was equal to a score of 2, and severe disturbance was equal to 0. Preoperatively, the average sleep quality score was 0.53, and postoperatively, the average sleep quality score was 1.53. This study was not

Table 2. Methods of Included Studies

Authors (Year)	Study Design	LOE	MINORS Score	Inclusion Criteria	Exclusion Criteria	Surgery Criteria	Baseline Pathology for Diagnosis
Weekes et al.[7] (2020)	Case series	IV	14	All patients aged >18 yr who underwent arthroscopic RCR for full- or partial-thickness RCT	Revision shoulder procedure, irreparable RCT, and concomitant biceps tenodesis procedure	Arthroscopic RCR	Full- or partial-thickness RCT
Harryman et al.[1] (1997)	Prospective cohort study	II	12	Patients with post-traumatic stiff shoulder, frozen shoulder, and isolated tight posterior capsule	1 patient with development of frozen shoulder after scapulothoracic fusion for peripheral nerve lesion	Arthroscopic ACR	Unilateral refractory shoulder stiffness
Longo et al.[8] (2021)	Case series	IV	12	Patients with RCT undergoing arthroscopic repair with failure of conservative treatment; Goutallier grade 2 and Patte stage 2 lesions included	Patients not undergoing surgery and those with other types of shoulder pathology	Arthroscopic RCR	Goutallier grade 2 and Patte stage 2 lesions
Qian et al.[14] (2022)	Case-control study	III	21	Shoulder discomfort unresponsive to conservative measures for minimum of 8 weeks and follow-up period of ≥2 yr; presence of Parkinson disease confirmed by neurologist	Massive RCT, partial-thickness tear, irreparable massive or acute trauma-related tear of supraspinatus tendon, revision rotator cuff procedure, degenerative arthritis of ipsilateral glenohumeral joint, Workers' Compensation case, or history of surgery on ipsilateral shoulder	Arthroscopic RCR	Small to large RCT
Gerber et al.[26] (2001)	Case series	IV	14	Failure of conservative treatment and primary diagnosis of idiopathic frozen shoulder, postoperative shoulder stiffness, or post-traumatic shoulder stiffness	NR	Arthroscopic capsulotomy	Idiopathic frozen shoulder, postoperative shoulder stiffness, or post-traumatic shoulder stiffness

(continued)

Table 2. Continued

Authors (Year)	Study Design	LOE	MINORS Score	Inclusion Criteria	Exclusion Criteria	Surgery Criteria	Baseline Pathology for Diagnosis
Hasegawa et al.[24] (2021)	Retrospective cohort study	III	20	Clinical diagnosis of frozen shoulder (idiopathic stiff shoulder), defined as painful, stiff shoulder with no identifiable cause, and minimum of 6 mo of follow-up	Patients whose affected shoulder had history of trauma or surgery or presence of RCT, glenohumeral arthritis, or calcific tendinitis or patients with <6 mo of follow-up	ACR	NR
Hurley et al.[25] (2022)	Retrospective cohort study	III	12	Athletes who underwent arthroscopic Bankart repair and played sports preoperatively	Non-athletes	Arthroscopic Bankart repair	Bankart lesions including those with glenoid bone loss or Hill-Sachs lesions
Horneff et al.[15] (2017)	Case series	IV	10	Primary arthroscopic RCR without concomitant procedures	Workers' Compensation benefits, irreparable tear, revision surgery, and concomitant severe GHOA or adhesive capsulitis	Arthroscopic RCR	All full-thickness RCT
Dolan et al.[22] (2022)	Case series	IV	13	All patients aged ≥18 yr who underwent primary RCR and had complete preoperative data	Revision cases	Arthroscopic RCR	Small, medium, and large RCT
Glogovac et al.[16] (2019)	Case series	IV	14	Patients aged ≥18 yr scheduled for arthroscopic repair of full-thickness RCT	<6 mo of follow-up	Arthroscopic RCR	Isolated tears of supraspinatus in majority of patients (50%), followed by combined supraspinatus and infraspinatus tears (23%) and combined supraspinatus and subscapularis tears (14.6%)
Serbest et al.[17] (2017)	Case series	IV	12	Primary arthroscopic RCR with full-thickness RCT that failed treatment with NSAIDs or physiotherapy after ≥3 mo	Irreparable tears, revision surgery, open RCR, severe GHOA, adhesive capsulitis, sleep apnea disorder, neuropsychiatric disease, and patients taking medication for sleep disorder	Arthroscopic RCR	All full-thickness RCT

(continued)

Table 2. Continued

Authors (Year)	Study Design	LOE	MINORS Score	Inclusion Criteria	Exclusion Criteria	Surgery Criteria	Baseline Pathology for Diagnosis
Zheng et al.[6] (2023)	Case-control study	III	20	Patients aged >18 yr who underwent primary RCR and had complete preoperative baseline data, as well as preoperative response to SST question 2 ("Does your shoulder allow you to sleep comfortably?")	NR	Arthroscopic RCR	Full- or partial-thickness RCT
Austin et al.[18] (2015)	Case series	IV	12	Male patients and nonpregnant female patients aged ≥18 yr with full-thickness RCT undergoing arthroscopic RCR surgery	Patients receiving Workers' Compensation benefits, those with irreparable tears, those undergoing revision surgery, and those with concomitant severe glenohumeral arthritis or concurrent adhesive capsulitis	Arthroscopic RCR	All full-thickness RCT
Gumina et al.[19] (2016)	Case-control study	III	17	Patients submitted to arthroscopic repair of full-thickness RCT	Previous operation on shoulder, inflammatory joint disease, and primary osteoarthritis of operated or contralateral shoulder	Arthroscopic RCR	All full-thickness RCT
Gulcu[20] (2022)	Case series	IV	13	Small and medium degenerative RCT repaired with arthroscopic double-row technique	Revision surgery patients; those with shoulder and elbow surgery history, glenohumeral joint arthritis, and other shoulder pathologies; those with neurologic deficit; those with obstructive sleep apnea syndrome; and those who were already under medical therapy for sleep disorders	Arthroscopic RCR	Small and medium degenerative RCT

ACR, arthroscopic capsular release; GHOA, glenohumeral osteoarthritis; LOE, level of evidence; MINORS, Methodological Index for Non-randomized Studies; NR, not reported; NSAIDs, nonsteroidal anti-inflammatory drugs; RCR, rotator cuff repair; RCT, rotator cuff tear; SST, Simple Shoulder Test.

Table 3. Studies Evaluating Prevalence or Incidence of Sleep Disturbances in Shoulder Arthroscopy

Authors (Year)	N	Surgery	Baseline Pathology	Quantification of Sleep Disturbance	Preoperative Value for Sleep Quantification	Postoperative Value for Sleep Quantification	Follow-up months (Range)
Weekes et al.[7] (2020)	144	Arthroscopic RCR	Full- or partial-thickness RCT	Questionnaire surveying inability to sleep	71.5% reported inability to sleep as reason patient wanted surgery	NR	12 mo
Harryman et al.[1] (1997)	30	ACR	Unilateral refractory shoulder stiffness	Questionnaire surveying ability to sleep comfortably on affected side	6% reported being able to sleep on affected side comfortably	73% reported being able to sleep on affected side comfortably	32 mo (12-56 mo)
Hasegawa et al.[24] (2021)	60	ACR	NR	Presence or absence of nocturnal pain with sleep disturbance	Group 1: 22 of 27 (81.5%) Group 2: 25 of 33 (75.8%)	Group 1: 4 of 27 (14.8%) Group 2: 5 of 33 (15.2%)	6 mo
Hurley et al.[25] (2022)	144	Arthroscopic Bankart repair	Bankart lesions including those with glenoid bone loss or Hill-Sachs lesions	Sleep trouble graded on scale from 1-5, with 1 representing no trouble and 5 representing sleep trouble every night	NR	62% of patients reported no sleep trouble at final follow-up	75.7 mo
Horneff et al.[15] (2017)	56	Arthroscopic RCR	All full-thickness RCT	PSQI	50 of 56 (89%) reported PSQI score $>$ 5 (of 21), indicative of preoperative sleep disturbance, with mean of 11.7 $\pm$ 4.6	15 of 37 (41%) with follow-up $>$24 mo reported PSQI score $>$ 5 (of 21), indicative of postoperative sleep disturbance, with mean of 5.5 $\pm$ 4.0	28.8 mo (24-37.9 mo)
Dolan et al.[22] (2022)	250	Arthroscopic RCR	Small, medium, or large RCT	Question 2 of SST form ("Does your shoulder allow you to sleep comfortably?")	89% marked no for question 2 of SST	19% marked no for question 2 of SST	— (6-24 mo)
Zheng et al.[6] (2023)	293	Arthroscopic RCR	Full- or partial-thickness RCT	Question 2 of SST form ("Does your shoulder allow you to sleep comfortably?")	89.8% marked no for question 2 of SST	42% marked no for question 2 of SST	2 yr

(continued)

Table 3. Continued

Authors (Year)	N	Surgery	Baseline Pathology	Quantification of Sleep Disturbance	Preoperative Value for Sleep Quantification	Postoperative Value for Sleep Quantification	Follow-up months (Range)
Austin et al.[18] (2015)	56	Arthroscopic RCR	All full-thickness RCT	PSQI	89% reported PSQI score indicative of sleep disturbance (>5 of 21), with mean of 11.70 ± 4.61	62% reported PSQI score ≥5, with mean of 6	6 mo
Gumina et al.[19] (2016)	508	Arthroscopic RCR	All full-thickness RCT	Preoperative PSQI or ESS	Group A: 40.8% had PSQI > 5, with mean of 5.22 ± 2.59/2.59 ± 2.54 Group B: 42.4% had PSQI > 5, with mean of 5.21 ± 2.39/5.76 ± 2.63	NR	≥2 yr

ACR, arthroscopic capsular release; ESS, Epworth Sleepiness Scale; NR, not reported; PSQI, Pittsburgh Sleep Quality Index; RCR, rotator cuff repair; RCT, rotator cuff tear; SST, Simple Shoulder Test.

included in the final analysis because the incidence of sleep disturbance could not be determined.

Effect of Shoulder Arthroscopy on PSQI Scores

Six studies reported PSQI scores before and after shoulder arthroscopy.[8,15,17-19,22] The mean preoperative PSQI score ranged from 7.19 to 15.0 (Fig 2). The mean postoperative PSQI score ranged from 3.64 to 7.10 (Fig 3). Heterogeneity among preoperative and postoperative PSQI scores reported in the studies was very high ($I^2 = 0.00$).

Association Between PROs and Standardized Sleep Disturbance Tools

Nine studies investigated the association between standardized sleep disturbance tools and PROs.[6,8,14-18,20,22] Seven studies evaluated sleep disturbances using the PSQI score.[8,14-18,20] The remaining 2 studies used question 2 of the SST form and Patient-Reported Outcomes Measurement Information System (PROMIS) sleep disturbance scores.[6,22] A wide range of PROs were evaluated (Table 4). These included the ASES questionnaire, Veterans RAND 12-Item Health Survey (VR-12), 12-Item Short Form Health Survey, SST, NRS, VAS for pain, Single Assessment Numeric Evaluation (SANE), Connor-Davidson Resilience Scale (CD-RISC), Constant-Murley score (CMS), Western Ontario Rotator Cuff Index (WORC), Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, and Oxford Shoulder Score (OSS). For the purposes of this review, studies that used the NRS or VAS pain scale were grouped because they have been shown to be strongly correlated (inter-scale correlations ranging from 0.79 to 0.96) with no significant difference.[27]

ASES Score. The ASES score is a composite instrument composed of a 7-item section on pain and a 10-item section on activities of daily living. Scores range from 0 to 100, with a score of 0 indicating a worse shoulder condition and 100 indicating a better shoulder condition.

Three studies evaluated the association between ASES scores and standardized sleep disturbance tools.[6,8,22] Zheng et al.[6] reported on 293 patients and compared outcomes after RCR between patients who reported a preoperative sleep disturbance (ie, those who answered no to question 2 of the SST) and patients who did not. They reported statistically significantly higher total ASES scores in patients whose sleep disturbance resolved compared with those whose disturbance did not resolve (89.5 vs 74.6, $P < .001$). Similarly, Longo et al.[8] retrospectively reported on 58 patients and found a statistically significant correlation between preoperative (Spearman $\rho = -0.505$,

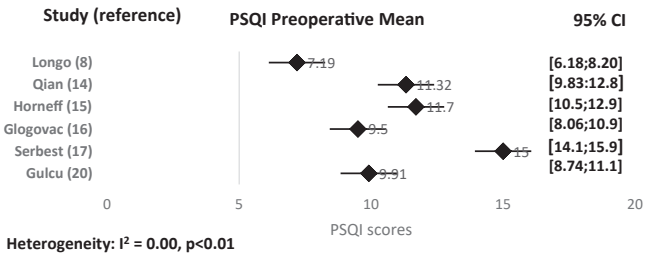

Fig 2. Forest plot displaying mean Pittsburgh Sleep Quality Index (PSQI) and 95% confidence interval before shoulder arthroscopy. The vertical line represents a PSQI score equal to 5, which is the threshold for poor sleep quality.

$P < .001$) and postoperative (Spearman $\rho = -0.393$, $P < .001$) PSQI and ASES scores. Dolan et al.[22] prospectively evaluated sleep disturbances in 250 patients undergoing primary arthroscopic RCR by using question 2 of the SST form. Preoperative and postoperative outcome measures, including ASES scores, were collected and analyzed. They found a statistically significant improvement in postoperative ASES scores 2 years after surgery when compared with preoperative ASES scores (89.07 ± 14.28 vs 46.36 ± 16.19, $P < .0001$).

SST Score. The SST is a questionnaire composed of a series of 12 yes or no questions that the patient answers regarding the function of the involved shoulder. SST scores are reported as the percentage of questions answered yes (0%-100%), or as the raw number of questions answered yes (0-12). In either case, lower values indicate greater shoulder dysfunction.

Three studies evaluated the association between PSQI scores and SST scores.[8,15,18] Longo et al.[8] (N = 58) prospectively analyzed the effects of RCR on quality of sleep. Additionally, they correlated PSQI scores with outcome measures, including SST scores. They found that the mean SST score increased from 3.41 ± 2.73 before surgery to 8.62 ± 2.65 at 6 months after surgery ($P < .001$). Horneff et al.[15] reported on 56 patients and found that improvements in sleep quality were maintained 2 years after arthroscopic RCR. At 24 months, the SST score displayed continued improvement and showed a moderate-strength correlation to the PSQI score (Spearman $\rho = -0.505$, $P < .001$). Similarly, in a case series of 56 patients, Austin et al.[18] showed that PSQI and SST scores are inversely correlated (Spearman $\rho = -0.490$, $P < .001$) after RCR.

NRS and/or VAS Score. The NRS is an outcomes measure by which patients indicate the severity of their symptoms on a scale of 0 to 10, with 0 indicating asymptomatic and 10 indicating severely symptomatic. The VAS is very similar to the NRS, but it includes a visual reference.

Six studies explored the association between sleep disturbances and NRS or VAS pain scores.[6,14,15,18,20,22] Qian et al.[14] retrospectively reviewed 62 patients to compare sleep disturbances before and after arthroscopic RCR in patients with Parkinson disease (PD). Patients with PD were propensity matched with patients without PD, and PSQI scores were correlated with outcome measures including VAS pain scores. For the purpose of our review, data from the control group (patients without PD) were extracted and analyzed. PSQI and VAS pain scores improved from 11.32 ± 4.24 and 4.77 ± 1.41, respectively, preoperatively to 5.19 ± 3.28 and 0.52 ± 1.18, respectively, postoperatively ($P < .001$).[14] Gulcu[20] prospectively evaluated 33 patients who underwent arthroscopic RCR with preoperative and postoperative functional scores, including PSQI and VAS pain scores. Preoperative PSQI scores improved from 9.91 ± 3.43 to 3.64 ± 2.41 ($P = .0001$). Preoperative VAS pain scores improved from 6.97 ± 0.73 to 1.82 ± 1.26 ($P = .0001$). Horneff et al.[15] (N = 56) found a moderately strong correlation between PSQI scores and VAS pain scores after arthroscopic RCR (Spearman $\rho = 0.479$, $P < .001$). In the same sentiment, Austin et al.[18] (N = 56) showed that PSQI scores and VAS pain scores are correlated after arthroscopic RCR (Spearman $\rho = 0.453$, $P < .001$). Zheng et al.[6] (N = 293) also evaluated the associations between VAS pain scores and sleep disturbance. They found that VAS pain scores improved in the patient group in which the postoperative sleep disturbance had resolved compared with the group with persistent postoperative sleep disturbance (0.8 vs 2.2, $P < .001$).

SANE Score. The SANE is a single-question PRO measure graded from 0% to 100%. Patients are asked, "How would you rate your affected joint/region of interest today as a percentage of normal (0% to 100% scale with 100% being normal)?"

Four studies assessed the association between PSQI scores and SANE scores.[6,15,18,22] Zheng et al.[6] (N = 293) found improved SANE scores in the patient group in which the postoperative sleep disturbance had resolved

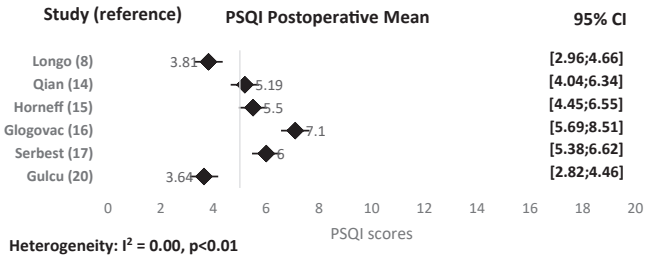

Fig 3. Forest plot displaying mean Pittsburgh Sleep Quality Index (PSQI) and 95% confidence interval after shoulder arthroscopy. The vertical line represents a PSQI score equal to 5, which is the threshold for poor sleep quality.

Table 4. Patient-Reported Outcomes

Authors (Year)	PSQI	ESS	SST	ASES	VR 12	SF-36	NRS or VAS	SANE	CMS	OSS	WORC	UCLA	CD-RISC	HADS	DASH
Arthroscopic rotator cuff repair															
Weekes et al.[7] (2020)	−	−	−	+	−	−	−	−	−	−	−	−	−	−	−
Harryman et al.[1] (1997)	−	−	+	−	−	+	−	−	−	−	−	−	−	−	−
Longo et al.[8] (2021)	+	−	+	+	−	+	−	−	+	+	−	−	−	−	−
Qian et al.[14] (2022)	+	−	−	−	−	−	+	−	+	−	+	+	−	+	−
Horneff et al.[15] (2017)	+	−	+	−	−	−	+	+	−	−	−	−	−	−	−
Dolan et al.[22] (2022)	−	−	+	+	+	−	+	+	−	−	−	−	−	−	−
Glogovac et al.[16] (2019)	+	−	−	−	−	−	−	−	−	−	−	−	+	−	−
Serbest et al.[17] (2017)	+	−	−	−	−	−	−	−	+	−	+	−	−	−	−
Zheng et al.[6] (2023)	−	−	+	+	+	−	+	+	−	−	−	−	−	−	−
Austin et al.[18] (2015)	+	−	+	−	−	−	+	+	−	−	−	−	−	−	−
Gumina et al.[19] (2016)	+	+	−	−	−	−	−	−	−	−	−	−	−	−	−
Gulcu[20] (2022)	+	−	−	−	−	−	+	−	−	−	−	−	−	−	+
Arthroscopic capsular release															
Gerber et al.[26] (2001)	−	−	−	−	−	−	−	−	+	−	−	−	−	−	−
Hasegawa et al.[24] (2021)	−	−	−	+	−	−	+	−	−	−	−	−	−	−	−
Arthroscopic Bankart repair															
Hurley et al.[25] (2022)	−	−	−	−	−	−	+	−	−	−	−	−	−	−	−
Total	8	1	6	5	2	2	8	4	4	1	2	1	1	1	1

NOTE. A plus sign indicates the outcome measure was observed, whereas a minus sign indicates the outcome measure was not observed.

ASES, American Shoulder and Elbow Surgeons; CD-RISC, Connor-Davidson Resilience Scale; CMS, Constant-Murley score; DASH, Disabilities of the Arm, Shoulder and Hand; ESS, Epworth Sleepiness Scale; HADS, Hospital Anxiety and Depression Scale; NRS, numeric rating scale; OSS, Oxford Shoulder Score; PSQI, Pittsburgh Sleep Quality Index; SANE, Single Assessment Numeric Evaluation; SF-36, Short Form 36 Health Survey; SST, Simple Shoulder Test; UCLA, University of California, Los Angeles Shoulder Rating Scale; VAS, visual analog scale; VR-12, Veterans RAND 12-Item Health Survey; WORC, Western Ontario Rotator Cuff Index.

compared with the group with persistent postoperative sleep disturbance (78.0 vs 67.1, $P = .011$). Dolan et al.[22] found that most sleep disturbances resolved within 3 months after RCR. Additionally, they reported a statistically significant SANE score improvement (38.57 ± 18.88 vs 9.80 ± 26.00, $P < .0001$). Horneff et al.[15] (N = 56) and Austin et al.[18] (N = 56) reportedly analyzed the association between PSQI scores and SANE scores. However, such an analysis was not found in the respective articles.

Constant-Murley Score. The CMS is a 100-point scale composed of 4 subscales: pain (15 points), activities of daily living (20 points), strength (25 points), and range of motion (40 points). Higher scores correlate with greater quality of function.

Three studies included the CMS in their analyses.[8,14,17] Longo et al.[8] (N = 58) found a moderately strong correlation between preoperative (Spearman $\rho = -0.527$, $P < .001$) and postoperative (Spearman $\rho = -0.383$, $P = .003$) PSQI score and CMS. Qian et al.[14] (N = 62) showed that the CMS (47.66 ± 12.02 vs 82.20 ± 12.99, $P < .001$) is likely to improve in line with the PSQI score (12.89 ± 3.45 vs 5.85 ± 3.47, $P < .001$) after RCR. Serbest et al.[17] reported similar findings in a case series of 31 patients (PSQI score [range], 15 [7-17] vs 6 [3-10], $P < .0001$; CMS, [range] 46 [36-74] vs 78 [62-90], $P < .0001$).

WORC Score. The WORC is a self-administered questionnaire that has 21 items, exploring 5 different domains: physical symptoms, sports and recreation, work, social function, and emotion. Each question is rated on a scale from 0 to 100, and the maximum score, which is correlated to the most severe symptoms, is 2,100.

Qian et al.[14] (N = 62) and Serbest et al.[17] (N = 31) analyzed preoperative and postoperative PSQI and WORC scores. Qian et al. reported statistically significant improvements in postoperative PSQI scores (12.89 ± 3.45 vs 5.85 ± 3.47, $P < .001$) and WORC scores (40.62 ± 14.90 vs 83.10 ± 15.26, $P < .001$). Serbest et al. reported similar findings (PSQI score [range], 15 [7-17] vs 6 [3-10], $P < .0001$; WORC score [range], 80 [54-98] vs 36 [24-49], $P < .0001$).

SF-36 Health Survey Score. The SF-36 is an outcome measure composed of 36 questions that cover 8 domains of health: (1) limitations in physical activities because of health problems, (2) limitations in social activities because of physical or emotional problems, (3) limitations in usual role activities because of physical health problems, (4) bodily pain, (5) general mental health (psychological distress and well-being), (6) limitations in usual role activities because of emotional problems, (7) vitality (energy and fatigue), and (8) general health perceptions. Scores for each domain are converted and pooled using a scoring key and range from 0 to 100. Lower scores indicate greater disability.

The study by Longo et al.[8] (N = 58) was the only study that reported outcomes using the SF-36 Health Survey. They found that SF-36 scores correlated with PSQI scores preoperatively (Spearman $\rho = -0.570$, $P < .001$) and at 1 month postoperatively (Spearman $\rho = -0.594$, $P < .001$), 3 months postoperatively (Spearman $\rho = -0.577$, $P < .001$), and 6 months postoperatively (Spearman $\rho = -0.538$, $P < .001$).

CD-RISC Score. The CD-RISC consists of 25 items aimed at assessing a patient's resilience. The score is evaluated on a 5-point scale from 0 to 4. A score of 0 indicates that the statement is not true at all, and a score of 4 indicates that the statement is true nearly all the time. These ratings result in scores between 0 and 100, with higher scores indicate higher resilience.

Glogovac et al.[16] aimed to determine whether changes in sleep quality after RCR are predicted by a patient's narcotic use or ability to cope with stress. They prospectively evaluated 48 patients undergoing arthroscopic RCR and collected PSQI and CD-RISC scores. Linear regression showed a significant positive predictive value of CD-RISC score on changes in PSQI score ($R^2 = 0.09$, $P = .028$) at 2 weeks. Glogovac et al. did not find statistically significant predictive value at any other time point.

VR-12 Score. The VR-12 is a self-administered health survey composed of 12 items. The questionnaire corresponds to eight principal physical and mental health domains, including general health perceptions, physical functioning, role limitations due to physical and emotional problems, bodily pain, energy fatigue, social functioning, and mental health. The score can be separated into physical and mental components, with lower scores indicating greater dysfunction.

Zheng et al.[6] (N = 293) explored the association between VR-12 scores and standardized sleep disturbance tools. They found that patients who experienced ongoing sleep disturbance after RCR had lower VR-12 physical component scores than those whose sleep disturbance had resolved (42.7 vs 48.7, $P < .001$). However, they did not find a significant difference in VR-12 mental component scores (52.4 vs 54.3, $P = .133$).

DASH Score. The DASH questionnaire is a 30-item questionnaire that evaluates patients' function. Patients self-report difficulties and interference with daily life on a 5-point scale. The responses are then converted to a 100-point scale using the following formula: DASH score for disability/symptoms = [(the number of responses − 1)/the number of responses] × 25. A score of 0 points represents

complete, unrestricted function of the upper extremities, whereas a score of 100 points represent the greatest possible functional impairment.

Gulcu[20] (N = 33) reported on preoperative and postoperative PSQI and DASH scores after arthroscopic RCR. He reported that PSQI scores improved from 9.91 ± 3.43 preoperatively to 3.64 ± 2.41 postoperatively ($P = .0001$). Similarly, DASH scores improved from 79.67 ± 3.49 preoperatively to 20.97 ± 11.35 postoperatively ($P = .0001$).[20]

Oxford Shoulder Score. The OSS is a patient-reported questionnaire including 12 items related to pain and shoulder function. Answer responses range from 1 to 5, and the total score is calculated by summing all the responses. Scores range from 12 (least pain and most function) to 60 (most pain and least function).

The OSS was reported in 1 study: Longo et al.[8] (N = 58) found that the OSS only correlated with the PSQI score 1 month after arthroscopic RCR (Spearman $\rho = -0.317$, $P = .015$). The OSS was not found to be significantly correlated with preoperative PSQI (Spearman $\rho = -0.071$, $P = .598$), 3-month postoperative PSQI (Spearman $\rho = -0.136$, $P = .308$), or 6-month postoperative PSQI ($\rho = -0.195$, $P = .142$) scores.

Discussion

The most important finding from this systematic review is that sleep disturbances are common before and after arthroscopic surgery of the shoulder and there is a clear trend showing that the high incidence of preoperative sleep disturbances significantly decreases postoperatively.[1,6,7,15,18,19,22,24-26] Additionally, this review revealed an association between sleep disturbances and functional outcomes after shoulder arthroscopy.[6,8,14-18,20,22] Our hypothesis that sleep disturbances would be highly prevalent both before and after arthroscopic surgery was found to be supported by the available literature. Furthermore, our hypothesis that standardized sleep outcomes would be associated with functional outcomes was also supported by the current literature surrounding the topic.

Among the 15 studies included in our review, 10 gathered data both before and after the surgical procedure.[1,6,7,15,18,19,22,24-26] The incidence of sleep disturbance before surgery varied from 40.8% to 89%, whereas that of postoperative sleep disturbance ranged from 41% to 62%.[15,18,19] Additionally, every study that reported sleep disturbances before and after arthroscopic surgery reported improvements in sleep disturbances postoperatively.[1,6,15,18,22,24]

Standardized sleep outcome scores (PSQI and question 2 of the SST) were generally associated with functional outcomes after shoulder arthroscopy.[6,8,14-18,20,22] PSQI scores were found to be correlated with the ASES score (preoperative Spearman $\rho = -0.505$, $P < .001$; postoperative Spearman $\rho = -0.303$, $P < .001$),[8] SST score (preoperative Spearman $\rho = -0.505$, $P < .001$; postoperative Spearman $\rho = -0.490$, $P < .001$),[15,18] and SF-36 score (preoperative Spearman $\rho = -0.570$, $P < .001$; postoperative Spearman $\rho = -0.538$, $P < .001$).[8] This finding is expected because of the temporal relation between pain, function, and the ability to sleep comfortably. Sleep disturbance has been shown to be the only predictor of patient dissatisfaction with nonoperative treatment of rotator cuff tears.[28] Hawkins and Dunlop[28] assessed factors contributing to treatment dissatisfaction in 33 patients with full-thickness rotator cuff tears undergoing nonoperative treatment. Their findings revealed that sleep disturbances and insurance claims, rather than rotator strength, symptom duration, or functional impairment, were the primary factors linked to patient dissatisfaction with nonoperative treatment.[28] Although the PSQI questionnaire offers a more in-depth analysis of sleep disturbance, its length limits its practicality in most busy orthopaedic clinics. For this reason, we recommend that orthopaedists, at the very least, use question 2 of the SST form to describe their patients' sleep disturbances.

Arthroscopic surgery of the shoulder improves both sleep disturbances and functional outcomes. As such, it presents as a confounding variable when evaluating the correlation between PROs and sleep disturbance. Only 1 study included in this review presented findings that may suggest that correlations between sleep disturbances and PROs exist irrespective of arthroscopic surgery: Longo et al.[8] reported Spearman correlation coefficients for PROs and PSQI scores both preoperatively and postoperatively. Preoperatively, they found statistically significant correlations between PSQI scores and ASES (Spearman $\rho = -0.505$), SST (Spearman $\rho = -0.585$), and SF-36 (Spearman $\rho = -0.570$) scores. This finding suggests that correlations between PSQI scores and the aforementioned functional outcomes exist independently of arthroscopic surgery.[8]

Naturally, a discussion of sleeping comfortably after surgery requires the mention of narcotics and their role in addressing or contributing to sleep disturbance. Narcotics after shoulder arthroscopy have been shown to either have a negative effect on sleep disturbance or no effect.[15,16,18] Horneff et al.[15] found that continued use of narcotics was the only independent variable or surgical parameter that affected postoperative sleep. At 2-year follow-up, chronic narcotic users averaged a PSQI score that was 7.4 points higher than narcotic nonusers (standard error, 1.93; $P = .00017$). Similarly, Austin et al.[18] found that patients taking narcotics preoperatively experienced worse sleep postoperatively, as indicated by increased PSQI scores at 12, 18, and 24 weeks postoperatively ($P < .001$). Glogovac et al.[16] reported that preoperative and postoperative

narcotic use did not significantly predict changes in PSQI scores or nocturnal pain frequency at any interval ($P > .05$). The role of narcotics after arthroscopic surgery is complicated because surgeons must balance adequate pain control with the risk of the development of narcotic dependency in patients. Of note, outside of the orthopaedic surgical literature, opioid use is well documented to cause sleep disturbances, including sleep architecture changes, worsening subjective sleep quality, suppression of breathing rhythm, and increased risk of central sleep apnea and exacerbation of obstructive sleep apnea.[29]

Limitations

Our study results must be interpreted in the context of the limitations present. Over half of the studies included were case series,[7,8,15-18,20,22,26] making it difficult to draw definitive conclusions. The baseline pathology of the patients included in the studies was variable, which makes direct comparison of studies challenging. Additionally, there was significant variability in the tools used to measure sleep disturbance and PROs. A significant number of studies used patient surveys to quantify sleep disturbance. The subjective nature of these questionnaires introduces a degree of bias and variability. Only 9 studies were dedicated to evaluating sleep disturbances.[8,14-18,20] Consequently, it is challenging to derive significant conclusions about sleep from studies in which sleep was not the primary outcome. It is important to note that we believe surgical intervention is a substantial confounding variable when describing the correlations between sleep disturbances and PROs. The presence of this uncontrolled confounding variable within most of the studies restricts the conclusions that can be drawn regarding sleep and shoulder arthroscopy.

Conclusions

Sleep disturbances are commonly observed before and after arthroscopic surgery of the shoulder. Arthroscopic surgery of the shoulder appears to improve sleep quality, and surgeons can expect functional outcomes, specifically the ASES score, SST score, NRS or VAS score, and CMS, to improve in line with sleep quality.

Disclosure

All authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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