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The relationship between sleep posture and subacromial impingement syndrome

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Abstract

Objective: Subacromial impingement syndrome is the most common cause of shoulder pain. One of the possible etiological factors of subacromial impingement syndrome is sleep posture. This study, it is aimed to evaluate the relationship between subacromial impingement syndrome and sleep posture.

Materials and Methods: This study received approval from the Institutional Clinical Research Ethics Committee. (No: 2021/04-54). It included 71 patients who underwent polysomnography at the Ear-Nose-Throat Sleep Laboratory between February and June 2021, meeting the study's inclusion and exclusion criteria. Patients were divided into two groups: 34 who met both diagnostic criteria for subacromial impingement syndrome and 37 who did not meet either criterion. The two groups were compared in terms of demographics, sleep postures, and polysomnography results. Additionally, the relationship between lateral decubitus posture and the affected shoulder was examined in the impingement group.

Results: No significant differences were found between the groups in terms of demographic data, except for smoking ($p=0.006$). The subacromial impingiment syndrome group spent significantly more time in the lateral decubitus posture than the control group ($p=0.003$), and they also spent significantly more of their sleep time in the lateral decubitusposition on the painful shoulder ($p<0.001$). Furthermore, the control group had a significantly higher number of posture changes during sleep ($p=0.002$).

Conclusion: This study objectively demonstrated the relationship between sleep posture and subacromial impingement syndrome using polysomnography. With this feature, it differs from the limited number of studies that have been done on this subject before. With this study, it has been shown that the lateral decubitus posture during sleeping is a risk factor for subacromial impingement syndrome, and the posture changes during sleep may also be a protective factor for subacromial impingement syndrome.

Keywords: subacromial impingement syndrome, sleep posture, shoulder, shoulder pain

Introduction

Shoulder pain is one of the most commonly encountered problems in orthopedic outpatient clinics. Studies have reported that shoulder pain accounts for up to 30% of all orthopedic outpatient visits [1-3]. In the United Kingdom, the lifetime probability of seeking medical attention for shoulder pain has been shown to range between 20% and 50% [4]. Subacromial impingement syndrome (SIS) is the most commonly encountered condition of the shoulder complex and accounts for 44% to 65% of shoulder pain [5].

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There is no consensus in the literature regarding the pathogenesis and risk factors of SIS. The known and widely accepted risk factors for SIS include advanced age, female gender, obesity, tobacco use, cardiovascular diseases, diabetes mellitus (DM), rheumatoid arthritis (RA), participation in sports involving repetitive overhead movements (e.g., throwing sports, swimming, tennis), working in physically demanding occupations (e.g., painting, electrical work), glenohumeral joint instability, scapular dyskinesis, stiffness in upper extremity joints, thoracic hyperkyphosis, spinal cord injury, history of stroke, Parkinson's disease, and psychosocial factors [6-11].

The most emphasized mechanism in the pathophysiology of SIS is overuse. However, patients with SIS do not always have a history of overuse, nor is the disease consistently observed on the dominant side, which is typically more exposed to stress from active and repetitive movements.

Another possible etiological factor that is less represented in the literature is sleeping posture. According to this theory, sleeping in the lateral decubitus (LD) position increases pressure in the shoulder's subacromial (SA) region on the side being slept on. Suppose this position is maintained for an extended period without movement during sleep. In that case, the high pressure in the SA region may lead to degeneration in the surrounding tissues, ultimately resulting in SIS [12,13].

Supporting this theory, some patients presenting to the clinic with shoulder pain report experiencing pain in the shoulder they sleep on, particularly upon waking up in the morning, which tends to subside after a while. Additionally, the increased prevalence of shoulder pain in patients with conditions such as stroke or spinal cord injury, which negatively affect mobility and the ability to change posture during sleep, suggests that prolonged immobility in the same position during sleep may be a risk factor for shoulder pain [14,15].

The number of studies in the literature investigating the relationship between sleeping posture and SIS is limited, and the data on sleeping posture in these studies are subjectively based on patient self-reports [12,16].

This study aimed to objectively evaluate the relationship between sleeping posture, frequency of posture changes during sleep, sleep quality, and their association with shoulder pain and SIS.

Materials and Methods

This study received approval from the Institutional Clinical Research Ethics Committee. (no: 2021/04-54). No financial support was received.

Within the scope of this study, patients who underwent polysomnography (PSG) at the Department of Ear-Nose-Throat (ENT) Sleep Laboratory between February 2021 and June 2021 were subsequently seen at their post-PSG ENT outpatient follow-up visit, during which an orthopaedic assessment was performed. The indication for the sleep study was either the diagnosis of a sleep disorder or the preoperative/postoperative evaluation of patients who had undergone, or were scheduled to undergo, surgery due to a sleep disorder. A total of 71 patients meeting the inclusion and exclusion criteria were included in the study (Table 1).

Table 1. Inclusion and exclusion criteria

Inclusion Criteria
1. Male gender
2. Age between 40 and 70 years
Exclusion Criteria
1. Working in occupations that involve repetitive shoulder movements, exposure to vibration, or heavy lifting, which are factors contributing to the etiology of SIS
2. Participating in professional or recreational sports known to be associated with SIS etiology, such as tennis, swimming, or javelin throwing
3. Receiving prior treatment for the painful shoulder
4. History of trauma affecting the painful shoulder
5. Bilateral shoulder pain
6. Having additional conditions that could affect sleep posture or movements during sleep (e.g., history of stroke, neurological diseases)
7. Having other conditions that could cause shoulder pain (e.g., cervical disc herniation, peripheral neuropathy, intrathoracic pathologies, rheumatological diseases)
8. Meeting only one of the SIS diagnostic criteria (Table 2).

To minimize confounding factors and ensure a homogenous study population, only male patients aged between 40 and 70 years were included, as age and sex are recognized risk factors for SIS and may influence musculoskeletal pain perception [6-8,17,18]. Patients with occupational or recreational exposures such as repetitive overhead activity, vibration, or heavy lifting, as well as those engaged in sports known to predispose to SIS (e.g., tennis, swimming, javelin throwing), were excluded to avoid overrepresentation of overuse-related etiologies [9,10]. Similarly, individuals with previous treatment or trauma to the painful shoulder, bilateral pain, or comorbid conditions that could alter sleep posture and shoulder mechanics (e.g., stroke, neurological disorders, cervical disc herniation, peripheral neuropathy, intrathoracic pathologies, or rheumatological diseases) were excluded to eliminate alternative causes of shoulder pain [11,14,15,19,20]. Finally, patients who met only one diagnostic criterion for SIS were excluded to ensure diagnostic accuracy and avoid misclassification bias.

Of the 71 patients, those meeting both diagnostic criteria for SIS were included in the SIS group (34 patients), while those not meeting either diagnostic criterion were included in the control group (37 patients). Patients meeting only one diagnostic criterion were excluded from the study (Table 2).

All patients included in the study also completed a questionnaire that inquired about demographic data and the characteristics of their shoulder pain.

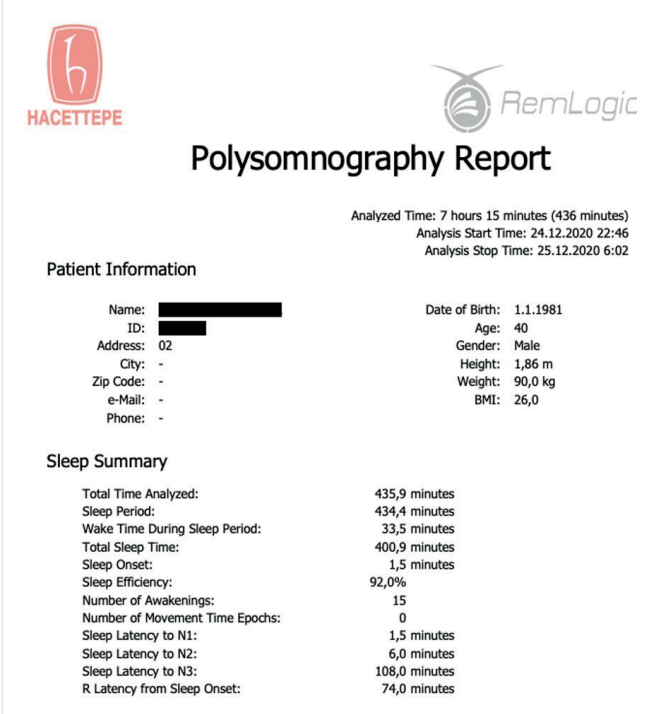
The sleep tests were conducted in the rooms that were soundproofed (<50 decibels), lightproof, maintained at a temperature of 18-20 °C through a ventilation system, and measured between 12-14 m^2 in size. Patients slept on standard medical beds measuring 198 cm in length and 113 cm in width.

Table 2. Diagnostic criteria for SIS

1. Shoulder pain persisting for at least 1 month
2. The positivity of at least 3 out of the 4 clinical diagnostic tests listed below.
a. Painful Arc Test
b. The Neer Impingement Test
c. Hawkins-Kennedy Test
d. Empty Can test

PSG was initiated between 23:00 and 00:00 according to the patients' sleep habits and terminated after a minimum of seven hours of testing. PSG data were recorded using the Embla S450® device. During PSG, the following parameters were recorded: electroencephalography (EEG), electrooculography (EOG), chin electromyography (EMG), leg EMG, airflow, respiratory effort, oxygen saturation, body posture, electrocardiography (ECG), video and audio recordings, and snoring.

Patients' EEG data were recorded using a 6-channel EEG (C4-A1, C3-A2, O2-A1, O1-A2, F4-A1, F3-A2) with probes placed according to the 10-20 system [21]. The data were interpreted by certified specialists trained in PSG. Embla® RemLogicTM software was used for data analysis. EEG waves were evaluated in 30-second epochs. Based on EEG recordings, the durations spent in REM, non-REM, N1, N2, N3, wake time, and sleep onset stages during the sleep period were calculated. Sections with alpha waves in the EEG were classified as wake time, and sections with beta waves were classified as sleep onset. The portions of the recording without alpha or beta waves, indicating the patient was "truly" asleep, were compared to the total sleep period to calculate and record sleep efficiency (Figure 1).


HACETTEPE

RemLogic

Polysomnography Report

Analyzed Time: 7 hours 15 minutes (436 minutes)
Analysis Start Time: 24.12.2020 22:46
Analysis Stop Time: 25.12.2020 6:02

Patient Information

Name:	[redacted]	Date of Birth:	1.1.1981
ID:	[redacted]	Age:	40
Address:	02	Gender:	Male
City:	-	Height:	1,86 m
Zip Code:	-	Weight:	90,0 kg
e-Mail:	-	BMI:	26,0
Phone:	-		

Sleep Summary

Total Time Analyzed:	435,9 minutes
Sleep Period:	434,4 minutes
Wake Time During Sleep Period:	33,5 minutes
Total Sleep Time:	400,9 minutes
Sleep Onset:	1,5 minutes
Sleep Efficiency:	92,0%
Number of Awakenings:	15
Number of Movement Time Epochs:	0
Sleep Latency to N1:	1,5 minutes
Sleep Latency to N2:	6,0 minutes
Sleep Latency to N3:	108,0 minutes
R Latency from Sleep Onset:	74,0 minutes

Figure 1. PSG report sample

The patients' sleep postures were recorded using the Embla S450® position sensor. The recorded data were processed with the Embla® RemLogicTM software to classify body postures during PSG as right LD, left LD, supine, or prone. The proportions of time spent in each posture were calculated relative to the total sleep duration. Additionally, the number of posture changes throughout the test was calculated and recorded.

Finally, the initial follow-up notes from the ENT department after PSG were reviewed to determine whether a treatment was recommended based on the PSG results.

The difference between the patients' self-reported daily sleep duration and their sleep duration recorded during PSG was evaluated for statistical significance. Since the sleep data calculated during PSG using EEG reflect the "actual sleep duration," a more accurate comparison was made by multiplying the patients' self-reported sleep duration by their average sleep efficiency (%) and re-evaluating the difference for statistical significance.

The posture laterality of the patients, specifically the ratios of right and left LD posture to the total LD posture, was calculated.

Posture laterality was calculated using both patient questionnaire data and PSG data. From the questionnaire, the posture laterality (%) of patients who preferred LD sleeping posture and specified a side preference was determined. In the PSG-based evaluation, posture laterality was calculated for both the entire population and the SIS group.

The relationship between the patients' self-reported sleep posture (supine, LD, prone) and their sleep posture during PSG was evaluated. For this, patients whose self-reported sleep posture matched the posture in which they spent the most time during PSG were coded as '1', while those whose self-reported posture differed from their predominant PSG posture were coded as '0'. The proportion of patients coded as '1' relative to the total population was calculated to assess the validity of posture self-reporting through the questionnaire.

The SIS and control groups were compared to evaluate whether there were significant differences in age, BMI, alcohol and tobacco use, and the presence of systemic comorbidities. Additionally, the two groups were compared in terms of the total LD ratio to assess the impact of LD posture on SIS.

In addition, the two groups were compared to evaluate whether there were significant differences in sleep duration during PSG, sleep efficiency, number of posture changes, and the rate of treatment recommendations by the ENT department after PSG. This analysis aimed to investigate potential etiological factors other than the LD posture ratio.

The most critical evaluation within the SIS group was to investigate the relationship between LD posture laterality and the laterality of the painful shoulder. For this calculation, the time spent in right or left LD posture was reclassified for each patient as "time spent on the painful shoulder" and "time spent on the non-painful shoulder", based on the side of the painful shoulder. The significance of the difference between these two values was assessed to determine whether the cause of pain was genuinely related to the increased time spent on the painful shoulder.

Additionally, the laterality of the painful shoulder was calculated by determining the ratio of patients with right shoulder pain and left shoulder pain to the total number of patients in the SIS group. To evaluate whether shoulder pain occurred more frequently on the dominant side, as suggested by the repetitive trauma theory, patients with shoulder pain on their dominant side were compared with those without pain on their dominant side.

In the SIS group, the proportions of the following were calculated relative to the total number of patients in the group: patients whose pain affected their daily life, patients who believed their pain was related to daily activities, patients who thought their pain was associated with their sleeping posture, and patients who experienced shoulder pain upon waking in the morning.

The normality of numerical data used to compare independent groups (SIS group and control group) was assessed with the Shapiro-Wilk test, and the homogeneity of group variances was evaluated using Levene's test. If data were normally distributed at a 95% confidence level and group variances were homogeneous (e.g., height data), parametric tests (Student's t-test) were used. When at least one of these assumptions was not met, non-parametric tests (Mann-Whitney U test) were applied.

For analyzing dependencies between categorical variables, Pearson's chi-square test was used as the assumptions for the test were met. Descriptive statistics for categorical variables were presented as counts and percentages.

For comparisons of numerical measurements within dependent groups (e.g., comparing the time spent on the painful shoulder to the non-painful shoulder in the SIS group), the paired t-test was used as parametric test assumptions were satisfied.

Since no previous studies had evaluated the relationship between time spent in different sleep postures and SIS, a pre-study power analysis could not be conducted. The primary hypothesis of this study was that the proportion of time spent in the LD posture relative to the total sleep duration would differ between the SIS and control groups. A post hoc power analysis of the Mann-Whitney U test used to evaluate this hypothesis indicated a power of 89% at a 95% confidence level for the given sample size (34 patients in the SIS group and 37 in the control group). A p-value of less than 0.05 was considered statistically significant.

Results

A significant difference was found between the patients' self-reported daily sleep duration (mean: 6.6 hours) and the sleep duration recorded via PSG (mean: 5.7 hours) ($p<0.001$). However, this comparison was based on the "actual sleep time" calculated during PSG, excluding periods identified as awake in the EEG recordings. Therefore, the self-reported sleep time was adjusted by multiplying it with the mean sleep efficiency (79.8%) to obtain a calculated value (mean: 5.2 hours). When this adjusted value was compared to the PSG-recorded time (5.7 hours), no significant difference was observed ($p=0.21$).

According to the questionnaire results, 58 patients (81.6%) reported LD, 12 patients (16.9%) reported supine, and only 1 patient (1.4%) reported prone as their preferred sleep posture. Based on PSG results, 56 patients (78.8%) spent the most time in LD posture, while 15 patients (21.2%) spent the most time in supine posture. None of the patients spent the most time in the prone posture during PSG (Table 3 and Table 4).

Among 58 patients who preferred LD sleeping posture on the questionarie, 15 did not indicate a side preference, while 43 specified a side preference. Of those who specified a preference, 24 preferred the right LD posture, and 19 preferred the left LD posture. According to the survey, the lateral preference for posture was calculated as 55.8% right. Based on PSG, the lateral preference for posture across the entire population was found to be 59% right. The survey and PSG results were observed to be consistent.

Among the 43 patients who indicated a side preference for LD posture in the questionnaire, 34 (79%) were found to have consistency between their reported preference and the side they predominantly used during PSG.

Most patients (56 patients, 78.8%) had the same sleep posture in the questionnaire as the posture in which they spent the most time during PSG. The number of patients whose preferred sleep posture matched their PSG sleep posture was significantly higher compared to those whose postures did not match ($p=0.015$).

A significant difference was found between the two patient groups regarding tobacco use ($p=0.006$), while no significant differences were observed for other

Table 3. Comparison of demographic data between patient groups

Demographic data	SIS group	Control Group	p value
Age (years)‡	50 (40-64)	46 (40-67)	0,791
Body mass index (kg/m^2)‡	27,7 (19,8-35,1)	28,4 (22,9-48,4)	0,363
Alcohol consumption (%)	10/34 (%29,4)	11/37 (%29,7)	0,977
Tobacco use (%)	17/34 (%50)	7/37 (%18,9)	0,006
Systemic comorbidity (%)	9/34 (%26,4)	6/37 (%16,2)	0,290
Receiving ENT treatment after PSG (%)	19/34 (%55,8)	19/37 (%51,3)	0,702

‡: Median (minimum-maximum)

Table 4. Comparison of posture and sleep data between patient groups

PSG Data	SIS group	Control Group	P value
PSG total sleep duration (minutes)‡	348,8 (201-422,2)	368,7 (150-420,5)	0,679
Sleep efficiency ((sleep duration / total PSG duration) x 100)‡	80,9 (61,8-95,3)	82,2 (51,4-91,9)	0,982
Total Time Spent in LD Posture (right + left) (%)‡	68,5 (25,3-100)	56,2 (0-86,4)	0,003
Time Spent in Supine Posture (%)‡	25,2 (0-62,8)	41,7 (9,6-100)	<0,001
Number of posture changes in PSG‡	9 (2-20)	14 (7-30)	0,002

‡: Median (minimum-maximum)

demographic variables, including age, BMI, alcohol use, and systemic comorbidities (p>0.05) (Table 3).

Calculations based on PSG data revealed that the SIS group spent significantly more total time in the LD posture compared to the control group (p=0.003). Additionally, the number of posture changes in the SIS group was significantly lower than in the control group (p=0.002) (Table 4).

The average sleep efficiency for the entire population was found to be 79.8%. Additionally, no significant differences were observed between the two groups in terms of sleep time and sleep efficiency (p=0.679 and p=0.982, respectively) (Table 4).

No significant difference was found between the patient groups in terms of the rate of treatment recommendations by the ENT department after PSG (p=0.702).

It was found that the proportion of time SIS patients spent in the LD posture on the painful shoulder (76.9%) was statistically significantly greater than the time spent on the non-painful shoulder (23.1%) (p<0.001).

The laterality of the painful shoulder in the SIS group was calculated as 50%, which was perfectly aligned with the laterality of the sleeping posture, also found to be 50% on the right side. Additionally, no statistically significant relationship was found between the dominant arm and the side of the painful shoulder (p=0.558).

Among the 34 patients in the SIS group, 16 (47%) reported experiencing shoulder pain upon waking in the morning, 19 (55.8%) believed their shoulder pain was related to sleeping posture, 15 (44.1%) thought their shoulder pain was associated with daily activities, and 12 (35.2%) stated that their shoulder pain affected their daily activities.

Discussion

The most implicated theory in the etiology of shoulder pain and SIS is degeneration caused by intrinsic or extrinsic mechanisms due to overuse. The literature suggests that shoulder pain is more common on the right side, as the dominant arm is often the right arm [22-24]. However, for the degeneration mechanism due to overuse to be valid, the individual must subject their active arm to stress, such as repetitive overhead movements. Additionally, studies have shown that pain is not always on the dominant side, regardless of whether there is a history of overuse [19,20].

In this study, the relationship between SIS and sleep posture was investigated. The number of studies addressing the relationship between sleep posture and shoulder pain in the literature is quite limited. In the English literature, the topic was mentioned in a few publications in the 1980s and 1990s [25,26]. In recent years, four studies examining the impact of sleeping posture on shoulder pain have gained prominence [12,13,16,27].

The first recent study on sleeping posture and shoulder pain was published by J. Zenian in 2010. Zenian focused on shoulder pain laterality and concluded that shoulder pain is not always on the same side as the dominant arm. He suggested that pain on the non-dominant side might be due to sleeping posture. Zenian proposed a theory that in the LD posture, increased pressure on the underlying shoulder could lead to degeneration in the structures of the SA region through an extrinsic mechanism [12].

To support his theory, Zenian compared shoulder pain laterality data from eight studies with sleeping posture laterality assessed verbally in two studies and with position sensors in six studies. He found similar results, with shoulder pain laterality at 61.9% right, verbal sleeping posture laterality at 63.2% right, and position sensor data at 61.3% right, suggesting LD posture as a risk factor for shoulder pain [12].

In our study, sleeping posture laterality calculated from the questionnaire (55.8% right) was similar to that calculated from PSG (59% right). Based on this result, the questionnaire appears to be a reliable method for assessing sleeping posture laterality.

In our study, self-reported sleep duration (6.6 hours) was significantly longer than PSG-measured sleep (5.7 hours) ($p<0.001$). Adjusting self-reported data using average sleep efficiency (79.8%) yielded no significant difference from PSG results ($p=0.21$).

The PSG and questionnaire methods were found to yield similar results for sleep posture laterality and sleep duration. Additionally, 78.8% of the population had the same preferred sleep posture (LD, supine, prone) in the questionnaire as the posture they spent the most time in during PSG. This indicates that verbal assessments of sleep posture are highly accurate.

Werner et al. used SA pressure catheters to investigate the effects of different body postures and arm positions on SA pressure in 20 healthy participants. They found that SA pressure was higher in the LD posture and during arm abduction [13]. This finding supported Zenian's theory for the first time [12]. However, since Werner et al.'s [13] study was conducted on healthy individuals, the increased pressure might represent a physiological change without causing pathology. Clinical studies are needed to determine whether this increase, and the LD posture, lead to pathology and pain.

In Kempf et al.'s 2012 study, the sleep posture laterality of 83 patients with shoulder pain was assessed through questionnaires completed by their partners, while shoulder pain laterality was determined through patient surveys. The results showed that a significant majority (67%, $p<0.001$) had shoulder pain on the same side as their LD posture [27].

A similar study by Holdaway et al. [16] in 2018 involved detailed shoulder examinations of 761 workers. Patients with positive Empty Can, painful arc, or Neer impingement tests were classified as having RC tears and grouped accordingly. Using a more detailed questionnaire than Kempf et al.'s [27] study, participants' preferred sleeping postures were identified. This study, however, found no significant relationship between sleeping posture and RC tears.

In Kempf and Holdaway's studies, sleeping posture was assessed solely based on self-reports, and the frequency of posture changes during sleep was not addressed.

The literature shows that shoulder pain is more common in patients with conditions like spinal cord injury, Parkinson's disease, or peripheral neuropathy, where activity levels during sleep and daily life are reduced [28-30]. However, no studies have evaluated the relationship between sleep posture change frequency and shoulder pain in individuals without comorbidities.

This study aimed to address a gap in the literature by objectively evaluating the relationship between sleeping posture preference, posture change frequency during sleep, and SIS using PSG data.

The study found that SIS patients spent significantly more time in the LD posture compared to the control group ($p=0.003$). Additionally, within the SIS group, 76.9% of the total LD posture time was spent on the painful shoulder, compared to 23.7% on the non-painful shoulder, a statistically significant difference ($p<0.001$).

The study found that the posture change frequency was significantly lower in the SIS group compared to the control group ($p=0.002$).

Werner et al. and Holdaway et al. noted in their studies that, in addition to sleeping posture, arm position might also influence shoulder pain. Werner et al. demonstrated that SA pressure increases during arm abduction [13,16]. One limitation of our study is the lack of evaluation of arm position.

Another limitation of the study is that it assessed patients' sleep patterns for only one night in the hospital, which might not fully reflect their habitual sleep behavior. However, this limitation is unlikely to have a significant impact, as sleep efficiency data support its validity. In sleep literature, healthy adults are expected to have an EEG-calculated sleep efficiency of over 80% [31]. Our study showed that, despite being

conducted in a population likely to have sleep problems, the average sleep efficiency was close to normal at 79.8%. Additionally, there was no significant difference in sleep efficiency between the study groups (p = 0.982). These findings suggest that while hospital sleep quality might be lower than at home, this difference is not large enough to affect the study results significantly.

During PSG, the numerous additional probes attached to patients, beyond the posture and EEG probes, may have influenced posture changes and sleep quality. However, the fact that sleep efficiency values remained close to normal suggests that these factors did not significantly impact the results.

In our study, the absence of imaging methods, injections, or diagnostic arthroscopy for confirming diagnoses could be seen as a limitation. However, SIS is primarily a clinical diagnosis [32]. Patients with shoulder pain lasting at least one month and who tested positive in three out of four highly specific and sensitive diagnostic tests (painful arc test, Neer impingement test, Hawkins-Kennedy test, and Empty Can test) were included in the SIS group.

The choice to include only male participants was based on the consideration that menopause or menstrual cycles in women could influence musculoskeletal problems and pain thresholds. This decision was made to eliminate these potential variables [17,18].

Conclusion

The etiology and pathophysiology of SIS remain controversial. Sleep posture has been proposed as a potential factor, but previous studies have been limited and largely based on subjective reports.

This study showed that sleeping in the lateral decubitus posture on the affected shoulder increases the risk of SIS, while frequent posture changes may be protective. It also demonstrated consistency between polysomnography and survey data, confirming the reliability of patient self-reporting for sleep posture.

Based on these findings, it is recommended to ask patients about their sleep posture during history-taking in outpatient clinics. Patients with shoulder pain who prefer sleeping in the LD posture can be advised to adjust their sleeping position. To reduce the time patients spend in the lateral decubitus posture, methods used in the positional treatment of obstructive sleep apnea may be utilized. Different devices such as tennis balls, vests, positional alarms, verbal instruction, and pillows have been used to modify sleep posture in obstructive sleep apnea [33-35].

Author contributions

Conception and design: A.Y.; Data acquisition: A.Y., C.D., A.E.S., O.A.A.; Data analysis: A.Y., O.A.A.; Data interpretation: A.Y., C.D., A.E.S., O.A.A.; Drafting of the manuscript: A.Y., C.D., A.E.S., O.A.A.; Critical revision of the manuscript: A.Y., C.D., A.E.S., O.A.A. All authors reviewed the results, approved the final version of the manuscript, and agreed to be accountable for all aspects of this study.

Ethical approval

This study was approved by the Hacettepe University Ethics Boards and Comissions (Date: Febuary 23, 2021, Decision/Protocol No: 2021/04-54). Informed consent was obtained from all participants involved in this study.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that this study was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Generative AI statement

The authors declare that no generative AI or AI-assisted technologies were used in the writing or preparation of this study.

References

[1] Armstrong A. Evaluation and management of adult shoulder pain: a focus on rotator cuff disorders, acromioclavicular joint arthritis, and glenohumeral arthritis. Med Clin North Am 2014;98(4):755-75, xii. **[Crossref]**

[2] Greving K, Dorrestijn O, Winters JC, et al. Incidence, prevalence, and consultation rates of shoulder complaints in general practice. Scand J Rheumatol 2012;41(2):150-5. **[Crossref]**

[3] Bruls VEJ, Bastiaenen CHG, de Bie RA. Non-traumatic arm, neck and shoulder complaints: prevalence, course and prognosis in a Dutch university population. BMC Musculoskelet Disord 2013;14:8. **[Crossref]**

[4] Linsell L, Dawson J, Zondervan K, et al. Prevalence and incidence of adults consulting for shoulder conditions in UK primary care; patterns of diagnosis and referral. Rheumatology (Oxford) 2006;45(2):215-21. **[Crossref]**

[5] Bhattacharyya R, Edwards K, Wallace AW. Does arthroscopic sub-acromial decompression really work for sub-acromial impingement syndrome: a cohort study. BMC Musculoskelet Disord 2014;15:324. **[Crossref]**

[6] Bishop JY, Santiago-Torres JE, Rimmke N, Flanigan DC. Smoking predisposes to rotator cuff pathology and shoulder dysfunction: a systematic review. Arthroscopy 2015;31(8):1598-605. **[Crossref]**

[7] Applegate KA, Thiese MS, Merryweather AS, et al. Association between cardiovascular disease risk factors and rotator cuff tendinopathy: a cross-sectional study. J Occup Environ Med 2017;59(2):154-160. **[Crossref]**

[8] Wendelboe AM, Hegmann KT, Gren LH, Alder SC, White GL, Lyon JL. Associations between body-mass index and surgery for rotator cuff tendinitis. J Bone Joint Surg Am 2004;86(4):743-7. **[Crossref]**

[9] Meister K. Internal impingement in the shoulder of the overhand athlete: pathophysiology, diagnosis, and treatment. Am J Orthop (Belle Mead NJ) 2000;29(6):433-8.

[10] Mehta S, Gimbel JA, Soslowsky LJ. Etiologic and pathogenetic factors for rotator cuff tendinopathy. Clin Sports Med 2003;22(4):791-812. **[Crossref]**

[11] Ratcliffe E, Pickering S, McLean S, Lewis J. Is there a relationship between subacromial impingement syndrome and scapular orientation? A systematic review. Br J Sports Med 2014;48(16):1251-6. **[Crossref]**

[12] Zenian J. Sleep position and shoulder pain. Med Hypotheses 2010;74(4):639-43. **[Crossref]**

[13] Werner CML, Ossendorf C, Meyer DC, Blumenthal S, Gerber C. Subacromial pressures vary with simulated sleep positions. J Shoulder Elbow Surg 2010;19(7):989-93. **[Crossref]**

[14] Gironda RJ, Clark ME, Neugaard B, Nelson A. Upper limb pain in a national sample of veterans with paraplegia. J Spinal Cord Med 2004;27(2):120-7. **[Crossref]**

[15] Van Ouwenaller C, Laplace PM, Chantraine A. Painful shoulder in hemiplegia. Arch Phys Med Rehabil 1986;67(1):23-6.

[16] Holdaway LA, Hegmann KT, Thiese MS, Kapellusch J. Is sleep position associated with glenohumeral shoulder pain and rotator cuff tendinopathy: a cross-sectional study. BMC Musculoskelet Disord 2018;19(1):408. **[Crossref]**

[17] Lee JW, Park HS. Relation of the factor to menstrual pain and musculoskeletal pain. J Exerc Rehabil 2015;11(2):108-11. **[Crossref]**

[18] Watt FE. Musculoskeletal pain and menopause. Post Reprod Health 2018;24(1):34-43. **[Crossref]**

[19] Silfverskiold J, Waters RL. Shoulder pain and functional disability in spinal cord injury patients. Clin Orthop Relat Res 1991;(272):141-5. **[Crossref]**

[20] Milgrom C, Schaffler M, Gilbert S, van Holsbeeck M. Rotator-cuff changes in asymptomatic adults. The effect of age, hand dominance and gender. J Bone Joint Surg Br 1995;77(2):296-8.

[21] American Electroencephalographic Society guidelines for standard electrode position nomenclature. Journal of Clinical Neurophysiology 1991;8(2):200-2. **[Crossref]**

[22] Seitz AL, McClure PW, Finucane S, Boardman ND, Michener LA. Mechanisms of rotator cuff tendinopathy: intrinsic, extrinsic, or both? Clin Biomech (Bristol) 2011;26(1):1-12. **[Crossref]**

[23] Uhthoff HK, Sarkar K. Classification and definition of tendinopathies. Clin Sports Med 1991;10(4):707-20. **[Crossref]**

[24] Yamaguchi K, Ditsios K, Middleton WD, Hildebolt CF, Galatz LM, Teefey SA. The demographic and morphological features of rotator cuff disease. A comparison of asymptomatic and symptomatic shoulders. J Bone Joint Surg Am 2006;88(8):1699-704. **[Crossref]**

[25] Belzer JP, Durkin RC. Common disorders of the shoulder. Prim Care 1996;23(2):365-88. **[Crossref]**

[26] Wehby CT, Wehby JH. Sleep shoulder syndrome. Ohio State Med J 1980;76(11):691-2.

[27] Kempf B, Kongsted A. Association between the side of unilateral shoulder pain and preferred sleeping position: a cross-sectional study of 83 Danish patients. J Manipulative Physiol Ther 2012;35(5):407-12. **[Crossref]**

[28] De Koninck J, Lorrain D, Gagnon P. Sleep positions and position shifts in five age groups: an ontogenetic picture. Sleep 1992;15(2):143-9. **[Crossref]**

[29] Lorrain D, De Koninck J, Dionne H, Goupil G. Sleep positions and postural shifts in elderly persons. Percept Mot Skills 1986;63(2 Pt 1):352-4. **[Crossref]**

[30] Ekblom B, Lövgren O, Alderin M, Fridström M, Sätterström G. Physical performance in patients with rheumatoid arthritis. Scand J Rheumatol 1974;3(3):121-5. **[Crossref]**

[31] Bin YS. Is sleep quality more important than sleep duration for public health? Sleep 2016;39(9):1629-1630. **[Crossref]**

[32] Park HB, Yokota A, Gill HS, El Rassi G, McFarland EG. Diagnostic accuracy of clinical tests for the different degrees of subacromial impingement syndrome. J Bone Joint Surg Am 2005;87(7):1446-55. **[Crossref]**

[33] Ravesloot MJL, van Maanen JP, Dun L, de Vries N. The undervalued potential of positional therapy in position-dependent snoring and obstructive sleep apnea-a review of the literature. Sleep Breath 2013;17(1):39-49. **[Crossref]**

[34] Permut I, Diaz-Abad M, Chatila W, et al. Comparison of positional therapy to CPAP in patients with positional obstructive sleep apnea. J Clin Sleep Med 2010;6(3):238-43. **[Crossref]**

[35] Randerath WJ, Verbraecken J, Andreas S, et al. Non-CPAP therapies in obstructive sleep apnoea. Eur Respir J 2011;37(5):1000-28. **[Crossref]**