Sleep quality in patients with rheumatic mitral stenosis and the effect of percutaneous mitral balloon valvuloplasty on sleep quality

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Abstract

Aim: Impaired sleep quality is common in patients with heart disease. However, data on the effects of mitral stenosis severity and percutaneous mitral balloon valvuloplasty on sleep quality are scarce.

Methods: 205 patients included in the study were divided into two groups as severe and non-severe (mild to moderate MS) rheumatic MS. 123 patients with mild to moderate MS and 82 patients with severe MS were analyzed. 82 patients with severe rheumatic MS who underwent percutaneous mitral balloon valvuloplasty were prospectively enrolled. Sleep quality was prospectively investigated immediately before and approximately six months after the percutaneous mitral balloon valvuloplasty procedure. The Pittsburgh Sleep Quality Index (PSQI) was used to evaluate sleep quality.

Results: The PSQI score was considerably higher in patients with severe MS compared to mild to moderate MS (3.7 ± 2.0 vs. 7.7 ± 2.9, p<0.001, respectively). A significant correlation was demonstrated between total PSQI scores and echocardiographic parameters [Left atrial diameter (r= 0.599, p=0.003), Mitral valve area (r= 0.837, p<0.001), Transmitral mean gradient (r=0.773, p<0.001), TR max velocity (r=0.593, p=0.004), Estimated PAP (r=0.530, p=0.01), TAPSE (r=-0.510, p=0.013)]. In addition, mitral valve area (QR=0.73; 95% CI: 0.54-0.92; p=0.011) and transmitral mean gradient (QR=1.78; 95% CI: 1.44-2.18; p <0.001) were found to be statistically significant in the multivariate regression analysis performed between echocardiographic parameters and total PSQI scores. Total PSQI scores at 6 months after the PMBV procedure were significantly lower than before the PMBV procedure (7.1 ± 2.7 vs. 3.9 ± 2.5; p < 0.001). There was an improvement in the PSQI score, a subjective measure of sleep quality.

Conclusions: A correlation was found between the PSQI score, which can subjectively assess sleep quality, and the severity of mitral valve stenosis. Sleep quality may deteriorate as the severity of mitral stenosis increases. An additional benefit of PMBV may be that it can ameliorate the underlying sleep disorder. Percutaneous mitral balloon valvuloplasty may be beneficial in improving sleep quality in adult patients with MS.

Keywords: *Rheumatic mitral stenosis; percutaneous mitral balloon valvuloplasty; Pittsburgh Sleep Quality Index; sleep quality*

1. Introduction

Mitral stenosis (MS) is characterized by the narrowing of the mitral valve orifice, which leads to obstruction of blood flow from the left atrium to the left ventricle. Mitral stenosis (MS) is a disease that limits the normal physical abilities of patients and is accepted as an important cause of hospitalization.[1] It cripples some of the patients eventually. The leading cause of MS globally is rheumatic heart disease, which continues to be prevalent in economically developing countries. It remains a major cause of morbidity and mortality. Mitral stenosis causes increased left atrial pressure. This pressure increase is transmitted to the pulmonary vessels, causing pulmonary hypertension. It may present with advanced mitral stenosis, signs of right heart failure, and pulmonary hypertension. Patients with MS often present with exertional dyspnea or increased fatigue mainly related to the severity of the stenosis.[2]

Severe MS is defined as a mitral valve area ≤1.5 cm^2. Symptomatic severe MS is also called Stage D MS. Patients with mitral valve area >1.5

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cm^2 are defined as moderate MS, and patients with mitral valve area >2.5 cm^2 are defined as mild MS.[2]

The main treatment for mitral stenosis was open heart surgery for many years. However, due to the development of an alternative minimally invasive procedure called PMBV, PMBV has now taken its place as a popular treatment for mitral stenosis.[3] Medications can treat MS symptoms, but they cannot cure the root cause of MS. For this reason, MS is considered a mechanical disease whose mortality can only be corrected by PMBV or mitral valve surgery .[1] PBMV is a safe and effective treatment modality for symptomatic severe MS (mitral valve area <1.5 cm^2), (Stage D) with appropriate valve morphology.[1,4]

Sleep, in which an average of one-third of human life is spent, is a cyclical, temporary, and functional state controlled by neurobiological processes.[5] Recent studies have also shown that sleep deprivation or poor quality sleep has a strong effect on the occurrence and prognosis of many important diseases, including cardiovascular diseases, cancer, depression, obesity, and immune system dysfunction.[6] One of the most important factors contributing to physical functionality, psychological well-being, and quality of life is good sleep quality. A good sleep can also play a protective role in terms of cardiovascular diseases that may develop later. Sleep quality is generally used to express a set of sleep measures such as total sleep time, sleep onset latency, sleep efficiency, wakefulness after sleep onset, and daytime sleepiness.[7,8] Sleep quality is affected by many variables such as diet, physical activity, genetics, environmental factors, and comorbidities.[7] The gold standard method for assessing sleep quality, duration, and structure is polysomnography (PSG). However, due to the cost and limited accessibility of PSG, questionnaires to assess sleep quality are often more easily implemented in larger populations.[9]

Data on the sleep quality of patients with MS are limited in the current literature. There is no data in the relevant literature on the sleep quality of a popular treatment option such as PMBV. The aim of this study was to evaluate the relationship between MS severity and sleep quality, as well as the effect of PMBV on sleep quality.

2. Materials and methods

2.1. Study design

In this study, patients with rheumatic MS who were examined Echocardiography Laboratory in Adana City Training and Research Hospital between January 2020 and February 2023 were evaluated. Patients with severe rheumatic MS and mild-to-moderate rheumatic MS who were eligible for PMBV were analyzed. Patients with atrial fibrillation or those scheduled for mitral valve surgery due to MS were excluded. In addition, patients with moderate to severe mitral valve regurgitation, moderate to severe aortic valve regurgitation, moderate to severe aortic valve stenosis, severe tricuspid valve regurgitation, and heart failure coinciding with mitral stenosis were excluded. Patients with significant asthma, chronic obstructive pulmonary disease, sleep apnea syndrome, restrictive lung disease, chest deformities, and extremely obese were also excluded. Patients with neurological and psychiatric problems that may affect sleep quality and those who use drugs and substances that may affect sleep quality were also excluded from the study. After excluding all these patients, two hundred and five patients included in the study were divided into two groups as severe and non-severe (mild to moderate MS) rheumatic MS. 123 patients with mild to moderate MS and 82 patients with severe MS were analyzed.

Transesophageal echocardiography was performed in all patients with severe MS among patients diagnosed with rheumatic MS by transthoracic echocardiography. Mitral valve structure, mitral valve area (measured planimetrically), transmitral valve gradient, left atrium parasternal long axis diameter, tricuspid valve regurgitation maximum velocity, inferior vena cava diameter and collapsibility, estimated systolic pulmonary artery pressure, tricuspid annular plane systolic excursion, right ventricle basal diameter, and right atrium major diameter were evaluated in transthoracic echocardiography. All measurements were calculated in accordance with the recommendations of the American Society of Echocardiography (ASE). MS severity was defined according to ASE recommendations.[10]

Sleep quality was prospectively studied in all patients with rheumatic MS, regardless of severity. Then, sleep quality was re-examined 6 months after the procedure in patients with severe rheumatic mitral stenosis who underwent PMBV procedure. The revised Turkish version of the Pittsburgh Sleep Quality Index questionnaire was used to assess sleep quality. The quantitative component of the study collected data from participants to determine self-rated sleep quality by completing a series of scales in this questionnaire. Causes that impair sleep quality before and after the procedure, such as depression, anxiety, another concomitant disease, a sedative drug used and discontinued, pain, etc. were excluded. This questionnaire was administered to all patients (two hundred and five) who participated in the study. Eighty-two patients who underwent the PMBV procedure were re-administered to the PSQI questionnaire in the 6th month after the procedure. A total of 287 surveys were conducted and 287 were actually recovered, resulting in a 100% recovery rate. After checking the validity and completeness of the questionnaire, it was found that the effectiveness and completeness of the questionnaire was 100%.

The Pittsburgh Sleep Quality Index (PSQI) is a questionnaire compiled mainly to evaluate the sleep quality of patients with sleep disorders and mental disorders.[7,8] Moreover, it is a suitable questionnaire for assessing the sleep quality of ordinary people. The survey consists of nine questions in total. The first four questions are fill-in-the-blank questions. The last fivequestions are multiple-choice questions. Also, the fifth question contains ten small questions. The eighteen self-assessment items consist of seven components: subjective sleep quality, sleep duration, sleep latency, sleep disturbance, habitual sleep efficiency, daytime dysfunction, and sleep medication use. Each of these components is scored on a scale from 0 to 3. The cumulative score of each component is the total PSQI score, and the total score ranges from 0 to 21 points. A high total score indicates poor sleep quality. The lower the score, the better the sleep quality.[7,8]

2.2. Ethical considerations

This study was approved by the Institutional Review Board of Adana City Training and Research Hospital. The principles of this study were in accordance with the Declaration of Helsinki, and detailed written informed consent was obtained from all participants.

2.3. Statistical Analysis

Analyzes were performed to test the hypothesis that sleep quality may be associated with stenosis severity in patients with rheumatic mitral valve stenosis and that PMBV treatment may improve sleep quality by reducing the severity of stenosis. All collected data were numerically coded. For statistical analysis, the SPSS 22.0 computer software package was entered, and the variable and recorded. Quantitative data were expressed as mean ± standard deviation. Qualitative data were compared between groups using the chi-square test. The independent student T-test was used to analyze the severity of mitral valve stenosis and sleep quality data. Paired T-test was used to analyze sleep quality data before and after the PMBV procedure. Correlation and regression analyzes were performed between total PSQI scores and some echocardiographic parameters before the PMBV procedure in all patients with mitral valve stenosis.

3. Results

The mean age of these patients was 48.9 ± 8.1 years, and 81 (65.9%) of these patients were women. The mean age of the patients with severe MS was 48.9 ± 8.1 years, and 81 (65.9%) of these patients were women. There were 82 patients with severe MS. The mean age of these patients was 46.9 ± 9.8 years, and 53 (64.6%) of these patients were women.

Baseline characteristics of all patients, such as age, gender, smoking, heart rate, blood pressure, and weight, are documented in Table 1. There was no statistically significant difference between the two groups in terms of many demographic, clinical, and laboratory parameters (Table 1). However, the PSQI score was considerably higher in the group with severe mitral valve stenosis and undergoing percutaneous mitral balloon valvuloplasty (severe MS) compared to the group with mild to moderate MS (3.7 ± 2.0 vs. 7.7 ± 2.9, p<0.001, respectively).

Table 1

Comparison of demographic, clinical, and laboratory data before PMBV procedure in patients with rheumatic mitral stenosis

Parameters	Mild to moderate MS (n:123)	Severe MS (n: 82)	p-value
Age, year	48.9 ± 8.1	46.9 ± 9.8	0.11
Sex, male, n (%)	81 (65.9%)	53 (64.6%)	0.85
Smoking, n (%)	43 (35%)	30 (36.6%)	0.81
BMI, kg/m2	27.1 ± 4.1	27.7 ± 3.8	0.42
Heart rate, bpm	82.9 ± 14.5	81.1 ± 11.1	0.5
Systolic blood pressure, mmHg	118.5 ± 17.6	118.9 ± 14.6	0.9
Diastolic blood pressure, mmHg	72.7 ±11.9	72.8 ± 10.6	0.95
C-reactive protein, mg/L	5.2 ±1.5	4.9 ± 1.3	0.74
Thyroid-stimulating hormone,mUI/L	4.1 ± 1.3	3.9 ± 1.6	0.78
Hemoglobin, gr/dL	13.1 ± 2.8	13.3 ± 2.7	0.71
Albumin, gr/dL	42 ± 3.7	39.8 ± 3.5	0.93
Total bilirubin, mg/dL	0.64 ± 0.44	0.65 ± 0.33	0.92
Alanine aminotransferaz, U/L	16.8 ± 7.4	18.2 ±8.6	0.39
Aspartat aminotransferaz, U/L	23.2 ±7.3	22.8 ±7.2	0.75
NT-proBNP, µg/L	246.2 ± 150.5	257.9 ±162.1	0.74
Total PSQI	3.7 ± 2.0	7.7 ± 2.9	<0.001

BMI: Body Mass Index; MS: mitral stenosis; NT-proBNP: N-Terminal Pro–Brain Natriuretic Peptide; PMBV: percutaneous mitral balloon valvuloplasty; PSQI: Pittsburgh Sleep Quality Index. * The difference was statistically significant (P < 0.05).

There were statistically significant differences in echocardiographic parameters (mitral valve area 2.19 ± 0.42 vs. 1.13 ± 0.23 cm^2, p <0.001; transmitral mean gradient 6.43 ± 2.07 vs. 15.02 ± 4.82 mmHg, p<0.001; estimated PAP 37.0 ± 9.1 vs. 49.5 ± 13.7 mmHg, p=0.001; right ventricular basal diameter 36.4 ± 3.5 vs. 38.8 ± 4.4 mm, p <0.001, respectively) between the two groups before PMBV procedure. A significant correlation was demonstrated between total PSQI scores and echocardiographic parameters [Left atrial diameter (r= 0.599, p=0.003*), Mitral valve area (r= 0.837, p<0.001*), Transmitral mean gradient (r=0.773, p<0.001*), TR max velocity (r=0.593, p=0.004), Estimated PAP (r=0.530, p=0.01*), TAPSE (r=-0.510, p=0.013*)] (Table 3).

A mitral valve area lower than 1.5cm^2 was associated with high total PSQI scores in patients with MS, with a sensitivity of 63 % and a specificity of 82 % (Cut-off value: 6.5; Area under the ROC curve=0.887; 95% CI 0.844–0.930; p<0.001). A transmitral mean gradient higher than 10 mmHg was associated with high total PSQI scores in patients with MS, with a sensitivity of 82 % and a specificity of 90 % (Cut-off value: 5.5; Area under the ROC curve=0.891; 95% CI 0.849–0.933; p<0.001).

In addition, mitral valve area (QR=0.73; 95% CI: 0.54-0.92; p=0.011) and transmitral mean gradient (QR=1.78; 95% CI: 1.44-2.18; p <0.001) were found to be statistically significant in the multivariate regression analysis performed between echocardiographic parameters and total PSQI scores (Table 3).

Total PSQI scores at 6 months after the PMBV procedure were statistically significantly lower than before the PMBV procedure (7.1 ± 2.7 vs. 3.9 ± 2.5 points, p < 0.001). There was an improvement in the PSQI score, a subjective measure of sleep quality.

4. Discussion

This study showed that patients with mitral valve stenosis had impaired sleep quality as assessed by the PSQI questionnaire in relation to the severity of valve stenosis. In patients who underwent PMBV for severe rheumatic mitral valve stenosis, a significant improvement in sleep quality was found beyond the 6th month after PMBV when compared to pre-PMBV procedure. The PSQI score was 3.7 ± 2.0 in patients with non-serious rheumatic mitral valve stenosis and 7.7 ± 2.9 in patients with severe rheumatic mitral valve stenosis. In patients with severe rheumatic mitral valve stenosis, the PSQI score was quite high (p < 0.001), in other words, the quality of sleep was severely impaired when compared to patients with non-serious rheumatic mitral valve stenosis.

In patients with severe rheumatic mitral valve stenosis, the PSQI score before PMBV was 7.1 ± 2.7, and the PSQI score beyond 6 months after PMBV was 3.9 ± 2.5. Beyond 6 months after PMBV, PSQI scores were statistically significantly decreased (p<0.001), namely, sleep quality improved compared to the pre-PMBV procedure.

Table 2

Comparison of echocardiographic data before PMBV procedure in patients with rheumatic mitral stenosis

Parameters	Mild to moderate MS	Severe MS	p-value
Left ventricular EF, %	59.9 ± 3.2	60.1 ± 2.9	0.62
Left atrial diameter, mm	44.2 ± 7.1	47.0 ± 7.5	0.036
Mitral valve area, cm2	2.19 ± 0.42	1.13 ± 0.23	<0.001
Transmitral mean gradient, mmHg	6.43 ± 2.07	15.02 ± 4.82	<0.001
Right ventricular diameter, mm	36.4 ± 3.5	38.8 ± 4.4	<0.001
Right atrial diameter, mm	41.3 ± 5.2	42.9 ± 5.6	0.051
TR degree			
• Mild, n (%)	84 (68.3)	37 (45)	0.026
• Moderate, n (%)	25 (20.7)	30 (37)	
• Severe, n (%)	14 (11)	15 (18)	
TR max velocity, m/s	2.72 ± 0.42	3.4 ± 0.67	<0.001
Estimated PAP, mmHg	37.0 ± 9.1	49.5 ± 13.7	0.001
TAPSE, mm	22.6 ± 2.5	22.2 ±2.3	0.34

EF: Ejection Fraction; MS: mitral stenosis; PAP: Pulmonary Artery Pressure; PMBV: percutaneous mitral balloon valvuloplasty; TAPSE: Tricuspid Annular Plane Systolic Excursion; TR: Tricuspid Valve Regurgitation * The difference was statistically significant (P < 0.05).

Table 3

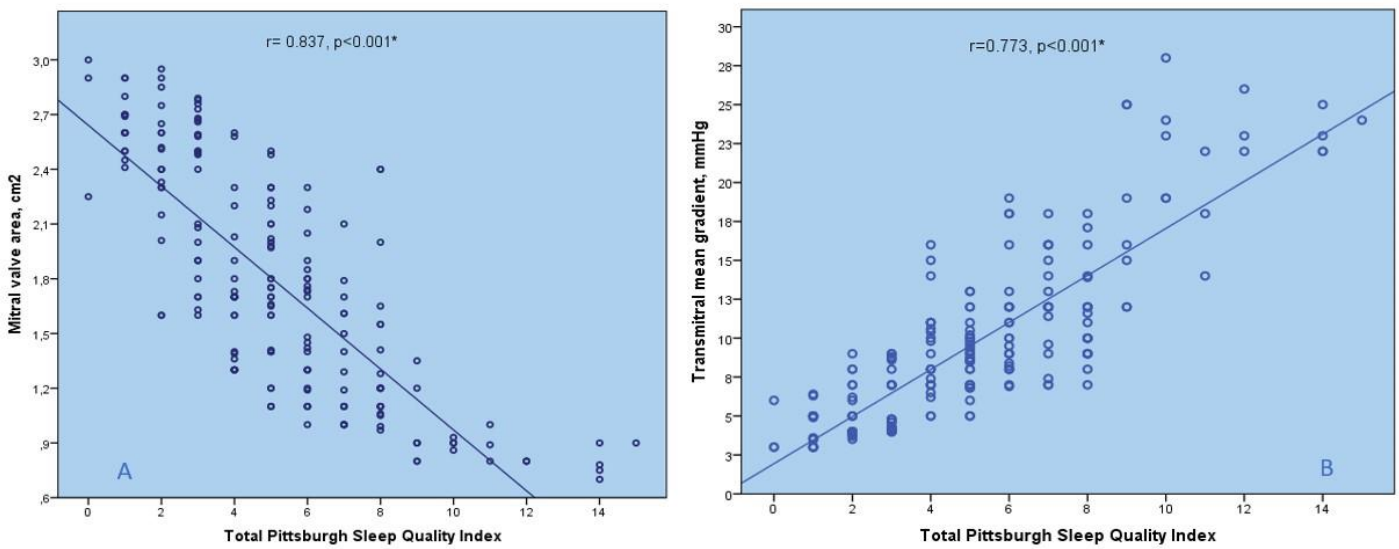
Univariate and multivariate analyses of echocardiographic parameters before PMBV procedure factors related to PSQI scores

	Univariate analysis		Multivariate analysis		
	r-value	p-value	QR	95% CI	p-value
Left ventricular EF	0.044	0.43	-		-
Left atrial diameter	0.599	0.003*	1.09	0.95-1.29	0.19
Mitral valve area	0.837	<0.001*	0.73	0.54-0.92	0.011*
Transmitral mean gradient	0.773	<0.001*	1.78	1.44-2.18	<0.001*
Right ventricular diameter	0.165	0.25	-		-
Right atrial diameter	0.358	0.066	-		-
TR max velocity	0.593	0.004	-		-
Estimated PAP	0.530	0.01*	1.58	0.92-2.35	0.19
TAPSE	-0.510	0.013*	1.05	0.96-1.15	0.42

EF: Ejection Fraction; PAP: Pulmonary Artery Pressure; PMBV: percutaneous mitral balloon valvuloplasty; PSQI: Pittsburgh Sleep Quality Index; TAPSE: Tricuspid Annular Plane Systolic Excursion; TR: Tricuspid Valve Regurgitation * The difference was statistically significant (P < 0.05).

Figure 1

Correlation graphs between mitral valve area, transmitral mean gradient and total PSQI before PMBV procedure in patients with rheumatic mitral stenosis. PMBV: percutaneous mitral balloon valvuloplasty; PSQI: Pittsburgh Sleep Quality Index. * The difference was statistically significant (p < 0.05).



In our study, a significant correlation was demonstrated between total PSQI scores and echocardiographic parameters such as left atrial diameter, mitral valve area, transmitral mean gradient, TRmax velocity, estimated PAP, and TAPSE (Table 3). In addition, multivariate regression analysis between total PSQI scores and some echocardiographic parameters showed that mitral valve area and transmitral mean gradient were statistically significant (Table 3).

These data may indicate that the increase in left atrial pressure load as a result of increased transmitral gradient and decreased mitral valve area and its reflection on the pulmonary veins and subsequently on the pulmonary capillary network may be associated with deterioration of sleep quality. In addition, due to the increased venous return at night, the right heart and pulmonary capillary volume load will increase somewhat, which may have an additional negative effect on sleep quality.

Sleep quality is significantly lower in patients with cardiovascular diseases compared to the general population. There are a few studies in the literature about a deterioration in sleep quality in patients with heart failure, coronary artery disease, and cardiac arrhythmia.[11-15]

Hajj J. and colleagues suggested that although there was no significant difference in sociodemographic and clinical characteristics in heart failure patients with NYHA class II and III symptoms, the increase in sleep quality disturbances in class III was likely due to clinical worsening in HF status. They found that the total PSQI score (6.72 versus 9.65) was lower in patients with NYHA class II heart failure compared with patients with NYHA class III heart failure. They explained that NYHA class II heart failure patients had better sleep quality compared to NYHA class III heart failure patients.[11]

Redeker NS. and colleagues showed that patients with heart failure had higher PSQI scores compared to the control group. They showed that sleep quality was worse in patients with heart failure. (7.17 ± 3.29 vs. 5.76 ± 3.03; p=0.017, respectively). Additionally, 67% of the patients with heart failure compared with 51% of to the

control group had poor global sleep quality (PSQI scores greater than 5).[12]

Kyoung Suk Lee, RN. and colleagues reported that 63% of patients had poor sleep quality. Those with poor sleep quality were 2.5 times more likely to have a shorter cardiac event-free survival (95% CI, 1.164-5.556) than those with good sleep quality after controlling for covariates. They found that impaired sleep quality in patients with heart failure was common and was associated with reduced cardiac event-free survival.[16]

Xiang Qian Lao and colleagues also stated that poor sleep quality is associated with the risk of coronary heart disease and may increase the risk of coronary heart disease in adults aged 40 and over. They also emphasized the importance of considering sleep quality when developing strategies to improve sleep for the prevention of cardiovascular diseases.[17]

Coşkun and colleagues found that poor sleep quality is common in patients with premature ventricular contractions, and sleep quality improved significantly after the radiofrequency catheter ablation procedure. They stated that poor sleep quality in patients with premature ventricular contractions is closely related to burden at nighttime.[15]

Rheumatic heart disease stands as the predominant worldwide cause of MS and continues to be a significant public health concern. There are almost no studies in the literature evaluating sleep quality in patients with MS.[18] In our study, we detected deterioration in sleep quality in patients with MS using the PSQI questionnaire. Furthermore, through this PSQI questionnaire, we found a statistically significant improvement in sleep quality after the PMBV procedure.

We showed that sleep quality deteriorates as the severity of stenosis increases in patients with mitral stenosis and that sleep quality may sometimes improve after PMBV. Questioning sleep-related parameters such as sleep quality may be considered in the clinical evaluation of patients with mitral stenosis.

4.1. Limitations

Because it is a small-scale, single-center study with limited follow-up, this study should be supported by studies with a larger population and longer follow-ups. Although atrial fibrillation was excluded from the study, undiagnosed paroxysmal atrial fibrillation could not be completely excluded from this study. In addition, the factors affecting sleep quality were not examined in detail in this study. Mitral valve replacement and PMBV procedure could not be compared due to the low number of patients undergoing mitral valve replacement due to severe MS and their demographic and echocardiographic differences from patients undergoing the PMBV procedure. Future studies are needed to examine sleep quality and sleep quality-related factors comparing mitral valve replacement and PMBV procedure in patients with MS, combining objective (polysomnography, etc.) and subjective (sleep-related questionnaires, etc.) sleep quality measures.

5. Conclusions

A correlation was found between the PSQI score, which can subjectively assess sleep quality, and the severity of mitral valve stenosis. Sleep quality may deteriorate as the severity of mitral stenosis increases. A decrease in the PSQI score was detected in the patients at 6 months after the PMBV procedure. In addition to its benefits, PMBV may increase sleep quality. The study needs to be supported by polysomnography, which can objectively assess sleep quality in a larger MS population.

Statement of ethics

This study was approved by the Institutional Review Board of Adana City Training and Research Hospital. The principles of this study were in accordance with the Declaration of Helsinki, and detailed written informed consent was obtained from all participants.

Conflict of interest statement

Author declare that they have no financial conflict of interest with regard to the content of this report.

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