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Research Article

Evaluation of Changes in Mental Health Parameters Following Ablation in Patients Treated with Pulmonary Vein Isolation

Pulmoner Ven İzolasyonu ile Tedavi Edilen Hastalarda Ablasyon Sonrası Ruh Sağlığı Parametrelerindeki Değişikliklerin Değerlendirilmesi

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Abstract

Aim: Atrial fibrillation (AF) is frequently associated with anxiety, depression, and impaired sleep quality. Pulmonary vein isolation (PVI) is an established ablation therapy for AF, yet its effects on mental health parameters remain less well explored. This study aimed to evaluate changes in anxiety, depression, and sleep quality before and after PVI.

Material and Methods: In this cross-sectional study, 117 patients undergoing PVI for AF were evaluated using validated questionnaires before and after ablation. Mental health parameters included the Beck Anxiety Inventory (BAI), Beck Depression Inventory (BDI), and Pittsburgh Sleep Quality Index (PSQI). Pre- and post-procedure scores were compared to assess changes in psychological well-being. Percentage change (Δ) in scores was calculated as [(post–pre)/pre] × 100. Associations between Δ values and baseline demographic, clinical, laboratory, and echocardiographic parameters were examined.

Results: The mean BAI score significantly decreased from 18.2 ± 5.1 at baseline to 15.0 ± 4.5 post-ablation, corresponding to a 20% reduction ($p < 0.001$). Similarly, a 19% decrease in BDI score was observed ($p < 0.01$). A 17% improvement in PSQI score was seen ($p < 0.05$). Greater improvements were noted in patients without coronary artery disease, while those with arrhythmia recurrence showed less benefit. In addition, patients with reduced baseline ejection fraction and enlarged ventricular dimensions experienced more pronounced psychological recovery.

Conclusion: PVI not only restores sinus rhythm but also improves psychological well-being and sleep quality in AF patients. The magnitude of benefit is influenced by comorbidities, arrhythmia recurrence, and baseline cardiac function, with the most pronounced improvements observed in patients with impaired ventricular function and without CAD.

Keywords: atrial fibrillation, pulmonary vein isolation, ablation, anxiety, depression, sleep quality

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Öz

Amaç: Atrial fibrilasyon (AF), sıklıkla anksiyete, depresyon ve uyku bozuklukları ile ilişkilidir. Pulmoner ven izolasyonu (PVI), AF tedavisinde standart ablasyon yöntemlerinden biridir; ancak mental sağlık parametreleri üzerindeki etkileri yeterince araştırılmamıştır. Bu çalışmada ablasyon öncesi ve sonrası anksiyete, depresyon ve uyku kalitesindeki değişiklikler incelendi.

Gereç ve Yöntem: Kesitsel tasarıma sahip bu çalışmada 117 AF nedeniyle PVI uygulanan hastalar, işlem öncesi ve sonrası validasyonlu ölçeklerle değerlendirildi. Mental sağlık parametreleri Beck Anksiyete Ölçeği (BAI), Beck Depresyon Ölçeği (BDI) ve Pittsburgh Uyku Kalitesi İndeksi (PSQI) ile ölçüldü. İşlem öncesi ve sonrası skorlar karşılaştırılarak psikolojik iyilik halindeki değişim belirlendi. Skorlardaki değişim yüzdesi $\Delta = [(\text{sonra} - \text{önce})/\text{önce}] \times 100$ formülü ile hesaplandı. Δ değerleri ile demografik, klinik, laboratuvar ve ekokardiyografik parametreler arasındaki ilişkiler incelendi.

Bulgular: Ortalama BAI skoru, başlangıçtaki 18,2 ± 5,1'den ablasyon sonrası 15,0 ± 4,5'e önemli ölçüde düştü; bu da %20 'lik bir azalmaya karşılık geliyor ($p < 0,001$). Benzer şekilde, BDI skoru %19'luk bir azalma gözlendi ($p < 0,01$). PSQI skorunda %17'lik bir iyileşme görüldü ($p < 0,05$). Koroner arter hastalığı olmayan hastalarda daha fazla iyileşme kaydedilirken, aritmi tekrarı olan hastalarda daha az fayda görüldü. Ayrıca, bazal ejeksiyon fraksiyonu azalmış ve ventrikül boyutları büyümüş hastalarda psikolojik iyileşme daha belirgindi.

Sonuç: PVI, AF hastalarında yalnızca ritim kontrolü sağlamaz, aynı zamanda ruh sağlığı ve uyku kalitesini de iyileştirir. İyileşme derecesi komorbiditeler, aritmi rekürrensi ve kardiyak fonksiyonla ilişkilidir; özellikle ventrikül fonksiyonu bozulmuş ve CAD olmayan hastalar en belirgin faydayı görmektedir.

Anahtar Kelimeler: atriyal fibrilasyon, pulmoner ven izolasyonu, ablasyon, anksiyete, depresyon, uyku kalitesi

Introduction

Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia, yet its impacts extend beyond cardiovascular morbidity [1]. Emerging evidence suggests a bidirectional relationship between AF and psychological health [2]. Patients with AF frequently experience significant mental health challenges: approximately one-third exhibit elevated symptoms of depression or anxiety [3]. Such psychological distress is not fleeting; in many cases symptoms persist over time and can meaningfully worsen patient-reported outcomes. Notably, depression in AF patients has been identified as a strong independent predictor of poorer future quality of life [4]. These observations underscore that AF and mental well-being are often intertwined, with emotional distress potentially amplifying the perceived burden of AF and vice versa.

Given this interplay, addressing mental health in AF management is critical. Pulmonary vein isolation (PVI) via catheter ablation has become a cornerstone therapy for symptomatic AF, targeting the arrhythmogenic triggers to restore and maintain sinus rhythm. Beyond reducing arrhythmia, successful PVI confers substantial benefits in terms of symptoms and overall patient well-being. In fact, catheter ablation has been shown to relieve AF-related symptoms and produce significant, sustained improvements in quality of life [5]. It stands to reason that reducing the burden of AF may also positively impact psychological outcomes. Initial studies support this rationale: patients often report marked reductions in anxiety and depression following successful AF ablation [6]. Moreover, a recent randomized trial confirmed that catheter ablation leads to significantly greater improvements in markers of psychological distress compared to medical management alone [7]. Despite these encouraging findings, the psychological outcomes of PVI remain relatively under-examined, especially when compared to traditional endpoints like arrhythmia recurrence [8]. This gap in knowledge highlights the need for further research focusing on mental health in AF care.

Sleep quality is another important yet frequently overlooked aspect of health in AF patients. Individuals with AF often suffer from poor sleep: for example, one cross-sectional study found that over 90% of AF patients had suboptimal sleep quality as measured by the Pittsburgh Sleep Quality Index (PSQI) [9]. AF symptoms (such as nocturnal palpitations), anxiety about the condition, and side effects of medications (e.g. beta-blockers causing insomnia) may all contribute to disrupted sleep patterns in this population. In turn, chronic sleep disturbances can exacerbate stress and negatively affect cardiovascular health, creating a vicious cycle. It is plausible that by reducing arrhythmia frequency and alleviating the associated anxiety, PVI could also lead to better sleep quality, though this possibility has not been well characterized in prior studies.

In light of the close interconnections between AF and mental health, the present study was designed to evaluate changes in key mental health parameters before and after PVI in patients with AF. PVI is an established ablation therapy for AF, yet its effects on mental health parameters remain less well explored. The objective of this study was to assess pre- and post-PVI changes in anxiety, depression, and sleep quality scores, as well as to determine the factors associated with these changes.

Material and Methods

This single-center prospectif study was conducted at the Mental Health and Illnesses Clinic of Bursa High Specialization Training and Research Hospital between August 2021 – August 2022. The study was performed in accordance with the Declaration of Helsinki, and was approved by the Bursa High Specialization Training and Research Hospital (2011-KAEK-25 2021/07-15). The study adhered to the principles of the Declaration of Helsinki. Consent was obtained from all patients.

Study Population

During the study period, consecutive adults who underwent first-time PVI for symptomatic AF and had complete pre- and post-ablation assessments of anxiety, depression, and sleep quality were eligible. Participants were eligible for inclusion if they were aged 18 years or older, had a confirmed diagnosis of atrial fibrillation of any pattern with a clinical indication for PVI, and had available paired mental health assessments conducted both before ablation and at 6-month follow-up. Patients were excluded if they had a history of prior AF ablation or a surgical maze procedure, incomplete mental health data at either assessment time point, or a documented major psychiatric disorder requiring hospitalization within the previous six months, to minimize the influence of unstable psychiatric baselines. Additional exclusion criteria included uncorrected thyroid dysfunction at baseline—defined as thyroid-stimulating hormone (TSH) levels outside the laboratory reference range without appropriate treatment—and hemodynamically unstable heart failure at baseline.

Study Protocol

All ablations were performed under conscious sedation or general anesthesia per operator preference using radiofrequency or cryoballoon systems. Electrical isolation of all pulmonary veins was confirmed by entrance/exit block. Periprocedural anticoagulation followed guideline-based practice. Antiarrhythmic medications were managed at the clinician's discretion.

Demographic and clinical variables included age, sex, body mass index (BMI), smoking status, hypertension, diabetes mellitus, coronary artery disease (CAD), prior stroke, chronic obstructive pulmonary disease (COPD), and medication use (antiarrhythmic drugs, anticoagulants, beta-blockers, calcium-channel blockers, ACE inhibitors/ARBs). Risk scores recorded at baseline: CHA_2DS_2-VASc, HAS-BLED, and C_2HEST [10-12].

Routine laboratory parameters obtained at baseline included white blood cell count, hemoglobin, neutrophils, lymphocytes, lipid profile, and thyroid-stimulating hormone. Standard hospital analyzers and reference intervals were used.

Transthoracic echocardiography was performed by experienced sonographers using guideline-concordant protocols. Measurements included interventricular septal thickness (IVS, mm), posterior wall thickness (PW, mm), LV end-diastolic and end-systolic diameters (LVEDD, LVESD, mm), LV end-diastolic and end-systolic volumes (LVEDV, LVESV, mL; biplane Simpson), LV ejection fraction (LVEF, %), isovolumic relaxation/contraction times (IVRT, IVCT, ms), E-deceleration time (EDT, ms), tissue Doppler e' /a' /s' velocities (cm/s; averaged where applicable), left atrial parasternal-short-axis diameter (LA ps-ax, mm), and LA volume index (LAVI, mL/m^2).

Beck Anxiety Inventory (BAI)

The BAI is a 21-item self-report scale designed to measure the severity of anxiety symptoms over the previous week. Each item is scored on a 4-point Likert scale ranging from 0 ("not at all") to 3 ("severely, I could barely stand it"), yielding a total score between 0 and 63. Higher scores indicate greater anxiety. The BAI has been validated in cardiovascular populations and demonstrates strong internal consistency and test–retest reliability [13].

Beck Depression Inventory (BDI)

The BDI is a 21-item questionnaire that evaluates the presence and severity of depressive symptoms. Each item is rated on a scale from 0 to 3, with a total score ranging from 0 to 63. Higher scores represent more severe depression. The BDI has long been recognized as a reliable and valid measure of depressive symptomatology in both clinical and research settings, including patients with cardiovascular disease [14].

Pittsburgh Sleep Quality Index (PSQI)

The PSQI is a 19-item instrument that assesses subjective sleep quality over the previous month. It yields seven component scores (sleep latency, duration, efficiency, disturbances, use of sleep medication, daytime dysfunction, and overall quality), each ranging from 0 to 3. These are summed to provide a global score from 0 to 21, with higher scores reflecting worse sleep quality [15].

Defination and outcomes

Arrhythmia recurrence was defined as any documented atrial tachyarrhythmia (AF/atrial flutter/atrial tachycardia) lasting ≥30 seconds on ECG, ambulatory monitoring, or device interrogation beyond a 90-day blanking period after ablation. Recurrence status (yes/no) during the 6-month interval was recorded.

Primary endpoint; within-subject change in BAI, BDI, and PSQI from baseline to 6 months (ΔBAI, ΔBDI, ΔPSQI). Secondary

endpoints; associations between ΔBAI/ΔBDI/ΔPSQI and (i) baseline demographics/clinical comorbidities (including CAD), (ii) laboratory parameters (including TSH and lipids), and (iii) echocardiographic indices (LVEF, LV dimensions/volumes, diastolic and tissue Doppler parameters). Recurrence subgroup comparisons (recurrence vs no recurrence) were prespecified.

Statistical analysis

Data analysis was conducted with IBM SPSS Statistics for Windows, version 20.0 (IBM Corp., Armonk, NY, USA). The normality of the data distribution was evaluated using the Shapiro–Wilk test. Descriptive statistics were presented as means ± standard deviations (SD) or medians with interquartile ranges (IQR) for continuous variables, and as frequencies and percentages for categorical variables. Pre- and post-ablation comparisons of mental health and sleep scores were performed with paired-samples t-tests for normally distributed data or Wilcoxon signed-rank tests for non-normal data. Percentage change (Δ) values for Beck Anxiety Inventory (BAI), Beck Depression Inventory (BDI), and Pittsburgh Sleep Quality Index (PSQI) were calculated as [(post – pre)/pre] × 100. Associations between ΔBAI, ΔBDI, and ΔPSQI and baseline demographic, clinical, laboratory, and echocardiographic parameters were explored using Pearson or Spearman correlation coefficients as appropriate. Group differences in Δ values (e.g., patients with vs without coronary artery disease or arrhythmia recurrence) were analyzed using independent t-tests or Mann–Whitney U tests for two groups and one-way ANOVA or Kruskal–Wallis tests for more than two groups, with post-hoc comparisons when required. All tests were two-tailed, with a significance threshold set at $p<0.05$.

Results

A total of 117 patients were included in the study, with a mean age of 60.4 ± 9.1 years and a mean BMI of 29.3 ± 4.5. The majority were female (59.0%), and 36.8% were smokers. Hypertension was present in 34.2% of patients, while 31.6% had diabetes mellitus. Coronary artery disease (CAD) was identified in 21.4%, and a history of stroke was reported in 5.1%. Chronic obstructive pulmonary disease (COPD) was seen in 6.0% of the cohort. The mean C2HEST, HAS-BLED, and CHA_2DS_2-VASc scores were 0.0 (0.0–2.0), 1.0 (0.0–2.0), and 2.0 (1.0–3.0), respectively. Atrial remodeling (AR) was absent in 81.2% of the patients. The most commonly used anti-arrhythmic drug was propafenone (65.8%), followed by amiodarone (23.9%). Most patients were on anticoagulant therapy (84.6%) and beta blockers (81.2%). Additionally, 55.6% of patients were using calcium channel blockers (CCB), and 44.4% were on ACE inhibitors or ARBs (Table 1).

When mental health parameters were evaluated before and after pulmonary vein isolation, a consistent improvement was observed across all scales (Figure 1). The mean Beck Anxiety Inventory (BAI) score significantly decreased from 18.2 ± 5.1 at baseline to 15.0 ± 4.5 post-ablation, corresponding to a 20% reduction ($p < 0.001$). Similarly, the Beck Depression Inventory (BDI) score declined from 16.2 ± 5.1 to 13.0 (10.0–15.0), representing a 19% reduction ($p < 0.01$). The Pittsburgh Sleep Quality Index (PSQI) score also improved, decreasing from 6.0 (4.0–9.0) to 5.0 (3.0–7.0), with a 17% improvement in subjective sleep quality ($p < 0.05$) (Figure 1).

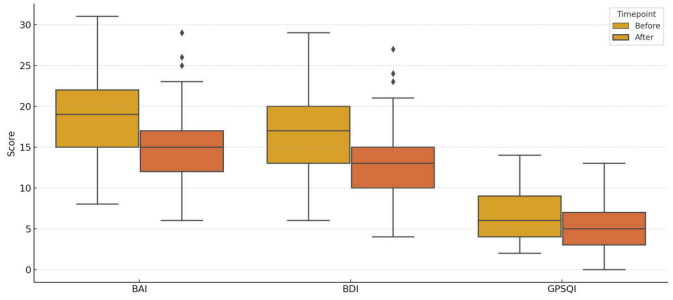

Figure 1. Change of mental health scores after ablation

Coronary artery disease (CAD) was significantly associated with changes in BAI ($p = 0.004$), BDI ($p < 0.001$), and GPSQ ($p = 0.003$). Patients with CAD demonstrated notably smaller reductions in BAI and BDI scores, and even an increase in GPSQ scores. C_2HEST score showed significant negative correlations with ΔBAI ($p = 0.002$), ΔBDI ($p < 0.001$), and ΔGPSQ ($p < 0.001$). CHA_2DS_2-VASc score was significantly negatively correlated with all three psychological outcome changes: ΔBAI ($p = 0.002$), ΔBDI ($p < 0.001$), and ΔGPSQ ($p = 0.002$). The presence of arrhythmia recurrence was also significantly correlated with ΔBAI ($p = 0.024$) and ΔGPSQ ($p = 0.036$) (Table 1).

There was no significant relationship between laboratory results and alterations in mental health scores following ablation (Table 2).

Several echocardiographic and Doppler variables demonstrated statistically significant correlations with changes in anxiety (ΔBAI), depression (ΔBDI), and sleep quality (ΔGPSQI) following ablation. Notably, ΔBAI was significantly associated with posterior wall thickness (PW, $r = 0.300$, $p = 0.011$), left ventricular end-diastolic diameter (LVEDD, $r = 0.303$, $p = 0.008$), left ventricular end-systolic diameter (LVESD, $r = 0.308$, $p < 0.001$), and left ventricular end-diastolic volume (LVEDV, $r = 0.314$, $p < 0.001$). Similarly, ΔBDI was significantly correlated with PW ($r = 0.299$, $p = 0.012$), LVEDD ($r = 0.304$, $p = 0.007$), LVESD ($r = 0.308$, $p = 0.024$), and LVEDV ($r = 0.309$, $p < 0.001$). For ΔGPSQI, significant correlations were found with PW ($r = 0.315$, $p = 0.008$), LVEDD ($r = 0.317$, $p < 0.001$), LVESD ($r = 0.310$, $p < 0.001$), and LVEDV ($r = 0.312$, $p < 0.001$) (Table 3).

Table 1. Demographic findings and their relationship with changes in mental health parameters after ablation.

Variables	All population n = 117	ΔBAI		ΔBDI		ΔGPSQ	
		r	p	r	p	r	p
		0.109	0.244	0.111	0.519	0.060	0.233
BMI	29.3 ± 4.5	-0.182	0.150	-0.190	0.056	-0.177	0.240
Gender, n (%)							
Female	69 (59.0)	-20.0%	0.166	-23.1%	0.423	-28.6%	0.157
Male	48 /41.0)	-15.0%		-16.7%		-28.6%	
Smoking, n (%)							
No	74 (63.2)	-16.0%	0.732	-17.6%	0.596	-28.6%	0.745
Yes	43 (36.8)	-20.0%		-22.2%		-28.6%	
Hypertension, n (%)							
No	77 (65.8)	-17.6%	0.459	-20.0%	0.167	-28.6%	0.456
Yes	40 (34.2)	-19.1%		-22.0%		-25.0%	
Diabetes mellitus, n (%)							
No	80 (68.4)	-17.2%	0.756	-19.1%	0.118	-28.6%	0.735
Yes	37 (31.6)	-20.0%		-22.2%		-25.0%	
CAD, n (%)							
No	92 (78.6)	-20.0%	0.004*	-22.2%	<0.001*	-33.3%	0.003*
Yes	25 (21.4)	-4.5%		-5.0%		20.0%	
Stroke, n (%)							
No	111 (94.9)	-18.2%	0.153	-20.7%	0.440	-28.6%	0.154
Yes	6 (5.1)	-7.9%		-8.8%		-19.4%	
COPD, n (%)							
No	110 (94.0)	-18.2%	0.168	-20.3%	0.601	-28.6%	0.182
Yes	7 (6.0)	0%		0%		-33.3%	
C2HEST score	0.0 (0.0-2.0)	-0.318	0.002*	-0.314	<0.001*	-0.446	<0.001*
HAS-BLED score	1.0 (0.0-2.0)	0.008	0.932	0.005	0.382	0.082	0.956
CHA_2DS_2-VASc score	2.0 (1.0-2.0)	-0.312	0.002*	-0.311	<0.001*	-0.385	0.002*
AR, n (%)							
No	95 (81.2)	-20.0%	0.024*	-22.2%	0.001	-28.6%	0.036*
Yes	22 (18.8)	-9.5%		-10.5%		5.0%	
Anti-arrhythmic drug, n (%)							
Amiodarone	28 (23.9)	-11.5%	0.131	-12.7%	0.189	-19.1%	0.122
Propafenone	77 (65.8)	-20.0%		-22.2%		-33.3%	
Sotalol	5 (4.3)	-9.1%		-11.1%		-25.0%	
Flecainide	7 (6.0)	-23.8%		-26.3%		-33.3%	
Anticoagulant, n (%)							
No	18 (15.4)	-15.0%	0.727	-16.7%	0.998	-28.6%	0.688
Yes	99 (84.6)	-18.2%		-20.7%		-28.6%	
Beta blocker, n (%)							
No	22 (18.8)	-16.7%	0.626	-18.8%	0.658	-25.0%	0.579
Yes	95 (81.2)	-18.2%		-21.7%		-28.6%	
CCB, n (%)							
No	81 (69.2)	-16.7%	0.586	-18.2%	0.402	-28.6%	0.617
Yes	36 (30.8)	-18.8%		-21.2%		-33.3%	
ACEi/ARB, n (%)							
No	65 (55.6)	-16.7%	0.501	-18.2%	0.457	-28.6%	0.464
Yes	52 (44.4)	-20.0%		-22.2%		-26.8%	

BAI, Beck Anxiety Inventory; BDI, Beck Depression Inventory; GPSQ, General Psychopathology Symptom Questionnaire; BMI, Body Mass Index; CAD, Coronary Artery Disease; COPD, Chronic Obstructive Pulmonary Disease; AR, arrhythmia recurrence; CCB, Calcium Channel Blocker; ACEi/ARB, Angiotensin-Converting Enzyme inhibitor / Angiotensin Receptor Blocker. The delta symbol (Δ) denotes change over time.

Table 2. Demographic findings and their relationship with changes in mental health parameters after ablation.

Variables	All population n = 117	ΔBAI		ΔBDI		ΔGPSQ	
		r	p	r	p	r	p
Leukocytes, $\times 10^3/\mu L$	7.7 ± 2.0	0.069	0.459	0.074	0.431	0.154	0.206
Hemoglobin	13.6 (12.5-14.8)	0.127	0.174	0.126	0.176	0.129	0.113
Neutrophils, $\times 10^3/\mu L$	4.4 (3.6-5.6)	0.012	0.898	0.018	0.847	0.192	0.238
Lymphocytes, $\times 10^3/\mu L$	2.3 ± 0.8	0.132	0.154	0.128	0.170	0.152	0.103
Total Cholesterol, mg/dL	182.4 ± 38.0	0.171	0.165	0.163	0.178	0.032	0.729
LDL-C, mg/dL	99.0 (78.0-127.7)	0.210	0.123	0.202	0.129	0.076	0.415
HDL-C, mg/dL	45.9 ± 10.8	-0.180	0.152	-0.169	0.169	-0.091	0.327

BAI, Beck Anxiety Inventory; BDI, Beck Depression Inventory; GPSQ, General Psychopathology Symptom Questionnaire; LDL-C, Low-Density Lipoprotein Cholesterol; HDL-C, High-Density Lipoprotein Cholesterol. The delta symbol (Δ) denotes change over time.

Table 3. Correlation between echocardiographic and Doppler parameters and changes in anxiety, depression, and sleep quality scores following ablation.

Variables	All population n = 117	ΔBAI		ΔBDI		ΔGPSQ	
		r	p	r	p	r	p
LVEF, %	1.0 ± 0.2	0.140	0.135	0.138	0.140	0.038	0.688
IVS, cm	0.9 ± 0.2	0.140	0.136	0.140	0.135	0.074	0.435
PW, cm	48.9 ± 4.2	0.300	0.011*	0.299	0.012*	0.315	0.008*
LVEDD, mm	33.8 ± 5.1	0.303	0.008*	0.304	0.007*	0.317	<0.001*
LVESD, mm	102.7 ± 15.8	0.305	<0.001*	0.308	0.024*	0.310	<0.001*
LVEDV	49.8 ± 13.1	0.314	<0.001*	0.309	<0.001*	0.312	<0.001*
LVESV	74.9 ± 21.9	0.054	0.572	0.053	0.572	-0.069	0.468
IVRT	54.8 ± 14.8	-0.132	0.162	-0.139	0.140	-0.122	0.195
IVCT	204.4 ± 45.9	-0.052	0.588	-0.059	0.536	-0.074	0.439
EDT	10.0 ± 2.3	-0.078	0.403	-0.081	0.387	-0.002	0.984
Lateral E'	8.9 ± 1.8	-0.039	0.674	-0.040	0.665	0.011	0.907
E'	7.7 ± 1.9	0.001	0.990	0.003	0.977	-0.001	0.995
Septal e'	10.2 ± 2.8	-0.057	0.543	-0.055	0.554	-0.049	0.596
E/E' ratio	41.8 ± 3.8	0.013	0.890	0.011	0.906	0.142	0.127
LA, mm	25.9 ± 4.2	0.125	0.178	0.123	0.188	0.051	0.584

LVEF, left ventricular ejection fraction; IVS, interventricular septum thickness; PW, posterior wall thickness; LVEDD, left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; LVEDV, left ventricular end-diastolic volume; LVESV, left ventricular end-systolic volume; IVRT, isovolumetric relaxation time; IVCT, isovolumetric contraction time; EDT, E-wave deceleration time; Lateral e' , lateral mitral annular early diastolic velocity; Septal e' , septal mitral annular early diastolic velocity; E/e' ratio, transmitral E-wave to e' velocity ratio; LA, left atrial diameter.

Discussion

Pulmonary vein isolation (PVI) – a common ablation therapy for atrial fibrillation (AF) – is associated with significant improvements in patients' mental well-being. Multiple studies have documented marked reductions in anxiety and depressive symptoms following AF ablation [8]. Randomized trial data indicate that catheter ablation leads to clear relief of psychological distress (anxiety and depression) compared to medical therapy, underscoring mental health benefits beyond arrhythmia suppression [7]. In the STOP-AF Post-Approval Study, cryoablation was associated with a 5-point improvement in the physical component and a 4-point improvement in the mental component of the SF-12 at six months [5]. In practical terms, restoring sinus rhythm appears to alleviate the constant worry, fear of palpitations, and mood disturbances that often accompany chronic AF [8]. Patients frequently describe feeling more in control of their health and less anxious about unpredictable heart rhythm episodes once their arrhythmia is treated, which likely contributes to the improved Beck Anxiety and Depression Inventory scores observed.

Sleep quality also improves after successful AF ablation. AF can disrupt sleep through nocturnal palpitations, dyspnea, or anxiety about symptoms, leading to poor sleep quality in many patients. After PVI, patients experience better sleep – as reflected by a decrease in Pittsburgh Sleep Quality Index (PSQI) scores – without requiring exact numbers to appreciate the trend. In one longitudinal study, overall sleep quality improved within the first few months post-ablation [16]. Notably, patients had poor sleep at baseline (a common issue in AF), but reported more restful, uninterrupted sleep after their heart rhythm was stabilized [17, 18]. This improvement may result from both physiological and psychological factors: the elimination of arrhythmia-related awakenings and symptoms, reduced nighttime surges of adrenaline or palpitations, and peace of mind knowing their AF is being controlled. Improved sleep, in turn, can further enhance mood and cognitive function, creating a positive cycle of recovery. These enhancements in mental health and sleep collectively point to ablation's holistic benefits, beyond the primary goal of rhythm control.

Our findings suggest that patients without CAD experience more pronounced improvements in anxiety, depression, and sleep quality after AF ablation compared to those with CAD. AF patients with additional illnesses (hypertension, CAD, lung disease, etc.) tend to have a lower baseline quality of life and may show smaller increments in well-being after interventions, compared to otherwise healthy AF patients [19]. CAD itself is associated with higher rates of depression and anxiety in cardiac patients [20, 21], so it is plausible that in our cohort those with CAD remained somewhat anxious or downcast even after their AF was treated. They might continue to worry about their overall heart health or experience limitations from coronary ischemia that overshadow the relief from ablation.

In our analysis, individuals with post-ablation recurrence had only minimal decreases (or even a rebound) in BAI and BDI scores compared to the substantial drops seen in patients without recurrence. Raine et al. demonstrated that quality of life improvements were significant in patients maintaining sinus rhythm, but no improvement was seen in those with recurrent AF. This aligns with the intuitive expectation that if AF returns (even intermittently), it can erode the confidence and relief a patient felt after the procedure. Raine et al. demonstrated that quality of life improvements were significant in patients maintaining sinus rhythm, but no improvement was seen in those with recurrent AF [22]. Another recent studies on heart-focused anxiety found that patients with AF recurrence did not experience any reduction in their cardiac-related fear and worry after ablation, whereas those without recurrence had marked relief [8, 23]. Mechanistically, recurrence means the underlying problem is not fully solved – patients may feel the procedure "failed" or worry about needing additional interventions. This can perpetuate anxiety ("When will the next episode strike?") and discourage the improvements in mood and sleep that would accompany a durable sinus rhythm.

An intriguing finding in our study was the inverse relationship between baseline cardiac function (and dimensions) and improvements in mental health metrics. Patients with poorer baseline LV function – reflected by LVEF – tended to exhibit greater reductions in anxiety, depression, and sleep disturbances after ablation. Likewise, those with enlarged baseline LV size (higher end-diastolic/systolic diameters and volumes) showed larger psychological improvements (i.e. greater drops in BAI, BDI, PSQI scores) compared to patients with normal cardiac dimensions. In simpler terms, the more compromised the heart was before ablation, the more the patient's mental well-being seemed to rebound afterward. This trend can be explained by considering the concept of tachycardia-induced cardiomyopathy and symptom burden. Many AF patients with low LVEF or dilated ventricles are in that state because uncontrolled rapid AF has impaired their cardiac function over time. For these individuals, a successful ablation can substantially improve cardiac output and symptoms – sometimes even normalizing the ejection fraction – by eliminating the arrhythmia that was weakening their heart. The relief from heart failure symptoms (fatigue, breathlessness) and the objective recovery of heart function likely translate into significant uplift in mood and outlook. Patients feel physically stronger and less limited, which reduces feelings of depression and anxiety. Moreover, those with severely symptomatic AF (often the case when LVEF is low or the heart is structurally affected) have the most to gain; eliminating the arrhythmia removes a huge burden from their

daily life. This is consistent with reports that greater baseline disease severity or symptom burden is associated with the largest post-ablation improvements in both symptoms and quality of life [24]. Essentially, when the starting point is very impaired, even a partial return toward normalcy yields a big psychological payoff.

Interestingly, one earlier study did not find baseline clinical parameters to predict quality-of-life changes after ablation[8]. However, that study population may have been different (e.g. excluding severe heart failure patients), or it focused on generic quality of life rather than specific mental health indices. It has been reported that, among patients treated with radiofrequency catheter ablation for premature ventricular complex-induced cardiomyopathy (PVC-CMP), marked improvement occurred in both systolic and diastolic cardiac function, as well as in psychological and psychiatric health parameters [25]. Another study demonstrated that a slight enhancement in parasympathetic response to stress was correlated with a decrease in anxiety, indicating that cardiac autonomic modulation plays a role in psychological recovery following catheter ablation for atrial fibrillation [26]. Our results highlight that baseline cardiac status can influence psychological outcomes: AF patients with concomitant heart failure or significant cardiac remodeling derive especially large mental health benefits when sinus rhythm is restored [22].

This study has some important limitations. First, it was a single-center, cross-sectional analysis with a relatively modest sample size, which may restrict the generalizability of the findings. Second, psychological status was evaluated exclusively with self-reported questionnaires (BAI, BDI, PSQI); although these are validated tools, subjective assessments can be influenced by patient expectations, recall bias, or unmeasured psychosocial factors. Third, follow-up was limited to six months, so longer-term trajectories of anxiety, depression, and sleep quality after pulmonary vein isolation could not be determined. Fourth, the absence of a medically treated control group means that improvements cannot be attributed solely to ablation and may partly reflect placebo effects or natural disease variation. Finally, potential confounders such as concomitant psychiatric treatment, lifestyle modifications, or residual AF burden were not systematically recorded, which could have affected the observed outcomes.

In conclusion, pulmonary vein isolation was associated with consistent improvements in anxiety, depression, and sleep quality among patients with atrial fibrillation. These benefits were more pronounced in patients without coronary artery disease and in those who remained arrhythmia-free, whereas improvements were attenuated in patients with arrhythmia recurrence. Moreover, greater psychological gains were observed in individuals with lower baseline ejection fraction and enlarged left ventricular dimensions, suggesting that patients with impaired cardiac function may experience the most marked mental health recovery. Overall, our findings are in line with prior reports and highlight that ablation offers not only rhythm control but also meaningful improvements in psychological well-being.

Ethical Approval

The study was performed in accordance with the Declaration of Helsinki, and was approved by the Bursa High Specialization Training and Research Hospital (2011-KAEK-25 2021/07-15).

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Conflicts of Interest

Authors declare that they have no conflicts of interest.

Informed Consent

Consent was obtained from all patients.

Authors' Contribution

Concept – BBK and SK, Design- BBK, Data collection and/or processing – BBK and SK, Analysis and/or interpretation - BBK and SK, Writing – BBK, Critical review – SK. All authors read and approved the final version of the manuscript.

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