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Comparison of Propofol and Ketamine for Sedation in Patients Undergoing Radiofrequency Ablation for Atrial Fibrillation

Propofol ve Ketamin'in Atriyal Fibrilasyon için Radyofrekans Ablasyonu Geçiren Hastalarda Sedasyon için Karşılaştırılması

ABSTRACT

Objective: Catheter-based ablation is now widely recognized as a beneficial therapeutic option for managing atrial fibrillation (AF). However, the extended duration and pain associated with the procedure may cause patient movements, potentially leading to disruptions in electro-anatomical mapping systems. Sedative and analgesic agents are used to prevent body movements and manage pain. This study aimed to compare the safety and effects of ketamine and propofol for deep sedation on outcomes in AF patients undergoing radiofrequency ablation.

Method: This retrospective, single-center study included 108 patients who underwent radiofrequency AF ablation under deep sedation (without intubation) in our hospital. The patients were categorized into two groups based on the anesthetic agent administered for deep sedation: the propofol group and the ketamine group. Procedure duration, success rates, and recovery times were compared.

Results: Of the 108 patients, 54 were in the propofol group and 54 were in the ketamine group. The procedure durations were similar in both groups (propofol group: 135 min (120–145) vs. ketamine group: 140 min (120–155), P = 0.803). The eye-opening time after the procedure was 275 seconds in the propofol group and 266 seconds in the ketamine group (P = 0.530). Additionally, no significant variation was detected in the initial measurements of systolic and diastolic blood pressure or heart rate.

Conclusion: There was no significant difference between the propofol group and the ketamine group in terms of outcomes. To the best of our knowledge, this is the first study to assess the efficacy of ketamine and propofol in the radiofrequency AF ablation patient group.

Keywords: Atrial fibrillation, ketamine, propofol, radiofrequency ablation

ÖZET

Amaç: Kateter bazlı ablasyon, atriyal fibrilasyonun (AF) yönetiminde faydalı bir tedavi seçeneği olarak günümüzde yaygın şekilde kabul görmektedir. Ancak, işlemin uzun sürmesi ve ağrılı olması, hastaların hareket etmesine neden olabilir; bu da elektro-anatomik haritalama sistemlerinde bozulmalara yol açabilir. Vücut hareketlerini önlemek ve ağrıyı kontrol altına almak için sedatif ve analjezik ajanlar kullanılmaktadır. Bu çalışmada, AF nedeniyle radyofrekans ablasyon uygulanan hastalarda derin sedasyon için ketamin ve propofolün güvenliği ve etkileri açısından karşılaştırılması amaçlanmıştır.

Yöntem: Bu retrospektif ve tek merkezli çalışmaya, hastanemizde derin sedasyon (entübasyon yapılmaksızın) altında radyofrekans AF ablasyonu uygulanan 108 hasta dahil edilmiştir. Hastalar, derin sedasyon için uygulanan anestezik ajana göre iki gruba ayrılmıştır: propofol grubu ve ketamin grubu. İşlem süresi, başarı oranları ve iyileşme süreleri karşılaştırılmıştır.

Bulgular: Toplam 108 hastanın 54'ü propofol grubunda, 54'ü ise ketamin grubunda yer almıştır. İşlem süreleri her iki grupta da benzer bulunmuştur (propofol grubu: 135 dk (120–145) vs. ketamin grubu: 140 dk (120–155), P = 0.803). İşlem sonrası göz açma süresi, propofol grubunda 275 saniye, ketamin grubunda ise 266 saniye olarak ölçülmüştür (P = 0.530). Ayrıca, sistolik ve diyastolik kan basıncı ile kalp atım hızının başlangıç ölçümlerinde anlamlı bir fark tespit edilmemiştir.

Sonuç: Sonuç olarak, propofol grubu ile ketamin grubu arasında sonuçlar açısından anlamlı bir fark bulunmamıştır. Bildiğimiz kadarıyla, bu çalışma ketamin ve propofolün radyofrekans AF ablasyonu uygulanan hasta grubundaki etkinliğini değerlendiren ilk çalışmadır.

Anahtar Kelimeler: Atriyal fibrilasyon, ketamin, propofol, radyofrekans ablasyon

ORIGINAL ARTICLE
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Atrial fibrillation (AF) represents the most prevalent form of atrial arrhythmia and constitutes a significant cardiovascular disease burden worldwide.[1] AF initially presents as a primary electrical disturbance, often initiated by rapid discharges originating from the pulmonary veins.[2] Radiofrequency ablation has been demonstrated to effectively treat AF by suppressing ectopic electrical impulses originating from the pulmonary veins.[3] According to the latest recommendations by the European Society of Cardiology, catheter ablation is advised as a primary therapeutic approach for rhythm management in patients presenting with paroxysmal AF.[4]

Atrial fibrillation ablation can be lengthy and painful. Therefore, administration of sedation or general anesthesia may be considered to prevent involuntary movements and manage pain.[5] A survey conducted by the European Heart Rhythm Association showed that 66% of patients undergoing pulmonary vein isolation were conscious or deeply sedated.[6] This approach may allow procedures to be performed comfortably without the need for intubation or general anesthesia. Although deep sedation with propofol is widely used in AF catheter ablation,[7] there is insufficient information in the literature regarding the use of ketamine.

Our objective was to compare the relative safety of ketamine and propofol for achieving deep sedation in patients undergoing radiofrequency ablation for atrial fibrillation.

Materials and Methods

Data Collection

This retrospective study included 108 patients who underwent radiofrequency AF ablation under deep sedation (without intubation) in our tertiary heart center. To ensure patient homogeneity, only patients who underwent pulmonary vein isolation were included, while those who received additional lesions were excluded.

The study population was divided into two groups according to the deep sedation anesthetic received: the propofol group and the ketamine group. The choice of sedative agent (propofol or ketamine) was determined according to institutional routine practice and at the discretion of the attending anesthesiologist. No randomization or predefined selection criteria were applied. Procedure duration, success rates, and recovery times were compared, ensuring that the patient groups were matched as closely as possible.

Transesophageal echocardiography was performed on all patients to exclude the presence of intracardiac thrombus, and anticoagulation therapy was continued until the day of the procedure. Regardless of the CHA_2DS_2-VASc score (Congestive heart failure, Hypertension, Age ≥ 75 years, Diabetes mellitus, prior Stroke/transient ischemic attack/systemic embolism, Vascular disease, Age 65–74 years, Sex category), all patients were administered anticoagulation therapy for a minimum of three weeks prior to and three months following the procedure. Additionally, patients fasted for at least 12 hours before the intervention. As part of standard pre-procedural screening, patients with significantly elevated liver enzymes or known hepatic dysfunction were excluded from the study.

ABBREVIATIONS

AF	Atrial fibrillation
CI	Confidence interval
DAS	Deep analgosedation
DC	Direct current
ECG	Electrocardiogram
NOAC	Noval oral anticoagulant
RF	Radiofrequency
SaO_2	Arterial oxygen saturation
TIVA	Total intravenous anesthesia

The sedation protocol commenced 15 minutes before the intervention with intravenous doses of 2 mg midazolam and 4 mg ondansetron. The drug was administered to the propofol group as a continuous infusion with a syringe pump at a dose of 4 mg/kg/hour from the beginning of the procedure. In the ketamine group, the drug was administered as an intravenous bolus at a dose of 1 mg/kg at the beginning of the procedure. Additional ketamine boluses of 0.5 mg/kg were administered as needed throughout the procedure based on patient response and vital signs. No continuous infusion was used. The dose was titrated according to the patient's condition, anesthetic response, and changes in vital signs in both groups. All sedation procedures were administered and continuously monitored by a certified anesthesiologist throughout the intervention.

Mapping was performed in sinus rhythm. If patients were in AF at baseline, sinus rhythm was restored by direct current (DC) cardioversion. After septal puncture, the ablation catheter was introduced into the left atrium via the atrial septal puncture sheath, and three-dimensional mapping was performed. Electroanatomic mapping was obtained using the Ensite X software (Abbott Laboratories, Chicago, IL, USA) system. A radiofrequency ablation device (TactiCath by Abbott, Little Canada, Minnesota, USA) was used for the procedure. AF ablation consisted of standard techniques, including circumferential pulmonary vein isolation.[8] Radiofrequency ablation at 35 W and 45°C was performed on the antral regions of ipsilateral pulmonary vein pairs. Circumferential lesions were created until electrical isolation of each pulmonary vein from the left atrium was achieved, indicated by bidirectional conduction block. Patients who received additional left atrial lesions were excluded from the analysis.

During the procedure, anticoagulation was provided with heparin sodium to keep the patients' activated clotting time between 250–350 seconds. Oxygen was administered via a nasal cannula throughout the procedure to maintain target SaO_2 (arterial oxygen saturation) levels above 95%. Arterial blood gas levels were assessed right before and at the end of the procedure. After the procedure, patients were taken to a post-anesthesia care unit where they were monitored for electrocardiogram (ECG), blood pressure, and oxygen saturation until they regained consciousness. Procedure duration was measured from the moment of femoral puncture until the removal of the catheter.

The left ventricular ejection fraction was assessed using the modified Simpson's method, which involved measuring both the left ventricular end-diastolic volume and end-systolic volume. The clinical characteristics, comorbidities, medications used,

Table 1. Clinical baseline features of all patients categorized based on the sedative agent used: propofol or ketamine

	Propofol group (n=54)	Ketamine group (n=54)	P
Baseline characteristics			
Age, years	62 (58–68)	60 (51–68)	0.475
Male	29 (53.7)	25 (46.3)	0.441
Height (cm)	173 (165–178)	170 (163–175)	0.150
Weight (kg)	80 (75–89)	80 (75–94)	0.594
Body mass index (kg/m^2)	27.6 (24.9–30.7)	27.8 (26.0–31.5)	0.296
Smoking	14 (25.9)	17 (31.5)	0.523
Comorbidities			
Hypertension	31 (57.4)	24 (44.4)	0.178
Diabetes mellitus	13 (24.1)	12 (22.2)	0.820
Hyperlipidaemia	17 (31.5)	10 (18.5)	0.118
Coronary artery disease	6 (11.1)	9 (16.7)	0.402
Cerebrovascular accident	2 (3.7)	5 (9.3)	0.437
Congestive heart failure	6 (11.1)	8 (14.8)	0.566
Cardiac implantable electronic device	2 (3.7)	5 (9.4)	0.270
Chronic renal failure	6 (11.1)	12 (22.2)	0.118
Current medication			
Aspirin	6 (11.1)	9 (16.7)	0.402
NOAC			
Apixaban	17 (31.5)	22 (40.7)	0.316
Dabigatran	4 (7.4)	3 (5.6)	1.000
Edoxaban	10 (18.5)	8 (14.8)	0.605
Rivaroxaban	22 (40.7)	21 (38.9)	0.844
Beta-blockers	30 (55.6)	22 (40.7)	0.123
Calcium channel blocker	14 (25.9)	17 (31.5)	0.523
Ace inhibitors	31 (57.4)	24 (44.4)	0.178
Diuretics	13 (24.1)	7 (13.0)	0.135
Anti-arrhythmic agents			
Amiodarone	24 (44.4)	19 (35.2)	0.325
Dronedarone	5 (9.3)	6 (11.1)	0.750
Propafenone	14 (25.9)	9 (16.7)	0.238
Preoperative laboratory and echo findings			
Haemoglobin	13.7 (13.3–14.6)	14.1 (12.8–15.1)	0.671
Creatinine	0.86 (0.80–1.02)	0.92 (0.77–1.12)	0.518
LVEF (%)	61 (60–63)	60 (59–62)	0.111

NOAC, Non-vitamin K oral anticoagulant; LVEF, Left ventricular ejection fraction; ACE, Angiotensin-converting enzyme inhibitors.

and echocardiographic parameters of all patients were collected from patient records and electronic medical records. The study was approved by Health Sciences University Hamidiye Scientific Research Ethics Committee (Approval Number: 11/24, Date: 20.09.2024), and was conducted in full compliance with the Declaration of Helsinki.

Statistical Analysis

The participants were classified into two groups based on whether ketamine or propofol was administered during the procedure. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as medians with interquartile ranges. The Kolmogorov–Smirnov test was employed to assess the normality of continuous data distribution. Comparisons of categorical variables were performed using either the Chi-square test or Fisher's exact test, as appropriate. For continuous variables, the Mann-Whitney U test or independent samples t-test was applied depending on data distribution.

Results

A total of 108 AF patients undergoing radiofrequency ablation were divided into two groups: those receiving propofol (n = 54) and those receiving ketamine (n = 54) for deep sedation at

Table 2. Comparison of catheter ablation procedure data with the use of propofol or ketamine for sedation

	Propofol group (n = 54)	Ketamine group (n = 54)	P
Duration of procedure (min)	135 (120–145)	140 (120–155)	0.803
Fluoroscopy time (min)	22 (19–27)	25 (20–30)	0.192
Total amount of propofol, mg	470 (400–550)		
Total amount of ketamine, mg		150 (100–300)	
Midazolam (mg)	2 (2–2)	2 (2–2)	0.304
Heparin dose (IU)	10000 (10000–12500)	12500 (10000–12500)	0.207
Time to eye opening after procedure (s)	275 (244–312)	266 (244–301)	0.530
Initial systolic blood pressure, mmHg	140 (125–154)	139 (114–146)	0.235
Initial diastolic blood pressure, mmHg	65 (57–76)	65 (58–76)	0.815
Initial heart rate, beat/minute	96 (84–110)	101 (89–114)	0.166
Initial SO_2, %	99 (99–99)	99 (99–99)	0.265
Arterial blood gas in the beginning			
pH	7.38 (7.35–7.39)	7.36 (7.36–7.38)	0.158
SO_2	99 (99–99)	99 (99–99)	0.294
PO_2	99 (89–110)	101 (96–109)	0.328
PCO_2	37 (35–37)	37 (36–38)	0.167
Lactate	1.19 (1.12–1.26)	1.14 (1.10–1.18)	0.844
Arterial blood gas in the end			
pH	7.38 (7.37–7.40)	7.38 (7.37–7.39)	0.467
SO_2	99 (99–99)	99 (99–99)	0.313
PO_2	143 (130–167)	157 (140–160)	0.071
PCO_2	39 (37–39)	39 (38–39)	0.476
Lactate	1.19 (1.12–1.26)	1.18 (1.14–1.20)	0.294

SO_2, Sulfur dioxide; pH, Potential of hydrogen; pO_2, Partial pressure of oxygen; PCO_2, Partial pressure of carbon dioxide.

the start of the procedure. The prevalence of comorbidities did not differ significantly between the groups. The patient groups showed similarity in terms of non–vitamin K antagonist oral anticoagulant (NOAC) and antiarrhythmic drug use. The left ventricular ejection fraction was 61% (60–63) in the propofol group and 60% (59–62) in the ketamine group (P = 0.111). Table 1 summarizes the baseline clinical characteristics of all patients according to use of propofol or ketamine for sedation.

The mean procedure duration was 135 (120–145) minutes in the propofol group and 140 (120–155) minutes in the ketamine group (P = 0.803) (Figure 1). The fluoroscopy durations were similar between the groups (propofol group: 22 (19–27) minutes vs. ketamine group: 25 (20–30) minutes, P = 0.192). A total of 470 (400–550) mg of propofol was used in the propofol group, while 150 (100–300) mg of ketamine was administered in the ketamine group. Following the procedure, there was no meaningful difference in eye-opening times between the groups (propofol group: 275 s (244–312) vs. ketamine group: 266 s (244–301), P = 0.530). Initial measurements of systolic and diastolic blood pressure, heart rate, and oxygen saturation showed no significant variation between the groups. Table 2 summarizes the comparison of catheter ablation procedure data with the use of propofol or ketamine for sedation. The comparison of propofol and ketamine administration based on time to eye opening is shown in Figure 2. In addition to p-values,

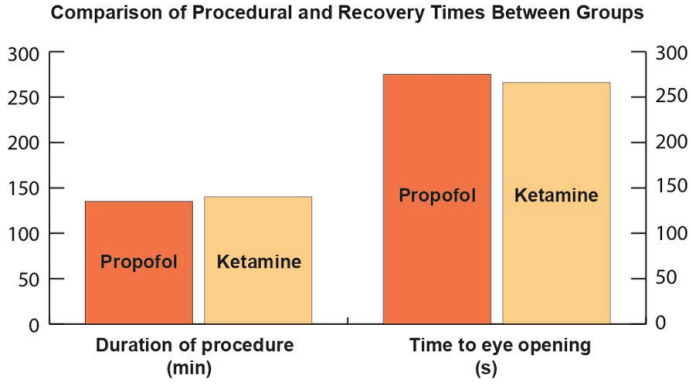

Figure 1. Comparison of procedural and recovery times in the propofol and ketamine groups.

effect sizes and confidence intervals (CI) offer deeper insight into the clinical relevance of the results. The median time to eye opening after the procedure was slightly shorter in the ketamine group (266 seconds, IQR: 244–301) compared to the propofol group (275 seconds, IQR: 244–312). Although this difference was not statistically significant (P = 0.530), the estimated effect size was small (Cohen's d ≈ 0.15), and the 95% CI for the difference ranged from –18 to +25 seconds. Similarly, the duration of the procedure was marginally longer in the ketamine

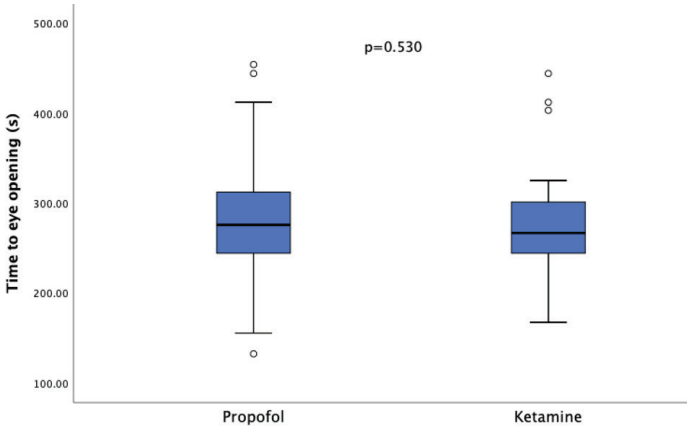

Figure 2. Comparison of propofol and ketamine administration based on time to eye opening.

group (140 minutes, IQR: 120–155) than in the propofol group (135 minutes, IQR: 120–145), with a p-value of 0.803. The effect size was negligible (Cohen's d ≈ 0.05), and the 95% CI for the median difference was -10 to +15 minutes.

Discussion

This study supports the notion that ketamine offers comparable safety and feasibility to propofol when employed for deep sedation in the context of AF ablation. To our knowledge, this is the first study in the literature to show that ketamine is safe in radiofrequency AF ablation.

While antiarrhythmic drugs are beneficial, AF ablation has now become the primary treatment approach. The electrical isolation of triggers originating from the pulmonary vein ostia or antra has become the cornerstone of AF ablation.[2] Catheter ablation is often accompanied by analgesia and sedation to manage procedural pain. Such interventions promote patient stillness, which is a critical factor for achieving catheter stability and optimal tissue contact. Currently, ablation procedures are carried out using one of three methods: general anesthesia, deep sedation, or conscious sedation. Nonetheless, a universally accepted sedation protocol has yet to be established.[9,10]

The combination of propofol with benzodiazepines is widely used for deep sedation in emergency and gastroenterological procedures.[11,12] The need for positive pressure ventilation and intubation with propofol is relatively low.[13] However, propofol's effects on hemodynamics and electrophysiology, such as hypotension and bradyarrhythmia, may limit its use during ablation procedures.[14,15] Additionally, the literature has shown that supraventricular tachycardia can be suppressed and may not be inducible during propofol anesthesia.[16,17] Heart rate and blood pressure are augmented due to ketamine-induced sympathetic nervous system stimulation.[18] Through this mechanism, ketamine has been proven effective in electrophysiological procedures performed on patients with hypotension and bradycardia.[19] Therefore, ketamine presents a viable alternative for managing patients prone to hemodynamic fluctuations and during key ablation procedures aimed at arrhythmia induction. Although not statistically significant, the slightly shorter eye-opening time observed in the ketamine group may suggest faster recovery in some patients. In high-throughput electrophysiology units, even modest improvements in recovery time may enhance procedural efficiency and patient turnover, especially in settings with limited post-anesthesia care resources.

Evidence supports the safe use of ketamine in the context of pulmonary vein isolation procedures involving pulsed field ablation.[20] However, information on the safety of ketamine use in pulmonary vein isolation with radiofrequency ablation is limited. Our study demonstrates that ketamine use may be a potential and reliable alternative in AF ablation, with similar procedure times and hemodynamic properties to propofol use. Based on the study's results, we can suggest using ketamine as an alternative medication for deep sedation in patients undergoing radiofrequency AF ablation, provided that there are no contradictions. However, we believe that our results must be confirmed in randomized controlled studies. From a clinical perspective, ketamine may offer several practical advantages in selected patients. Unlike propofol, ketamine preserves respiratory drive and cardiovascular stability, which may reduce the need for airway interventions or intensive hemodynamic monitoring. Furthermore, ketamine does not require continuous infusion equipment, potentially simplifying workflow and decreasing setup time in busy electrophysiology laboratories. In institutions where anesthesia resources are limited, ketamine may provide a cost-effective and operationally efficient alternative for deep sedation. However, its psychiatric side effects should be considered, and patient selection remains crucial.

Recent randomized data comparing sedation regimens in pulsed-field ablation procedures for AF highlight the advantages of ketamine-based deep analgosedation (DAS) over propofol-opioid protocols. A study evaluating remimazolam-ketamine DAS versus propofol-opioid DAS and total intravenous anesthesia (TIVA) demonstrated a significantly lower incidence of hypoxemia and hypotensive events in the ketamine group, underscoring its superior safety profile specifically in the context of pulsed-field ablation.[21] Although our retrospective study focused on ketamine versus propofol without opioid co-administration and found no significant difference in procedural outcomes or recovery times during radiofrequency ablation, these findings support the potential benefits of ketamine-containing sedation strategies in reducing sedation-related adverse events. Future prospective studies incorporating opioid use and airway management protocols may further clarify optimal sedation approaches to improve patient safety and comfort during various AF ablation techniques.

Our study has limitations that need to be addressed. First, the fact that our study was single-center, included a relatively small patient group, and was retrospective, limits the generalizability of our results. Unfortunately, we were not able to compare ketamine efficacy with placebo because of the design of the study. Additionally, due to the retrospective nature of the study, adverse effects—particularly psychiatric side effects associated with ketamine such as dissociation or visual disturbances—were not systematically recorded in medical files and could not be assessed. Due to the retrospective design, specific data on intra-procedural apnea episodes could not be collected or analyzed systematically. However, no advanced airway management was reported in any case based on available records.

Conclusion

The use of ketamine for deep sedation in AF ablation procedures showed no increase in sedation complications and comparable results to propofol. To the best of our knowledge, this is the first study to directly compare these two sedatives in radiofrequency AF ablation.

Ethics Committee Approval: Ethics committee approval was obtained from Health Sciences University Hamidiye Scientific Research Ethics Committee (Approval Number: 11/24, Date: 20.09.2024).

Informed Consent: Informed consent was not required due to the retrospective nature of this study.

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