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Ideal Anesthetic Agent for Cardiac Electrophysiology Study and Catheter Ablation – A Pilot Study

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ABSTRACT

Objectives: Patients suffering from supraventricular tachycardia (SVT) require diagnostic or therapeutic intervention in a cardiac electrophysiology (EP) laboratory. Some anesthetic medications may adversely affect cardiac EP and conduction, altering the ability to induce the arrhythmia, and may have a negative impact on the ablation treatment. This prospective, randomized, pilot study was conducted in the cardiac EP laboratory of a tertiary care hospital with the aim to identify the ideal anesthetic agent for cardiac EP study and catheter ablation of SVT. The primary objective was to compare the effects of anesthetic agents on cardiac electrophysiological parameters and arrhythmia inducibility. The secondary objective was to compare the patient, anesthesiologist, and cardiologist satisfaction scores with respect to the anesthetic agent used.

Materials and Methods: Thirty adult patients with SVT for EP study and radiofrequency catheter ablation were administered either of the anesthetic agents: midazolam, fentanyl, propofol, ketamine, or sevoflurane titrated to produce conscious sedation corresponding to bispectral index (BIS) values between 71 and 90. Electrophysiological parameters were recorded before and after administering the anesthetic agent.

Results: Arrhythmia could be induced in all patients. Although electrophysiological parameters remained stable with ketamine administration; higher values of the Richmond Agitation Sedation Scale score and BIS were recorded. Propofol and sevoflurane administration was associated with deviation in electrophysiological parameters more than fentanyl and midazolam. The highest values of patient, anesthesiologist, and cardiologist satisfaction scores were obtained in the fentanyl group and the lowest in the ketamine group ($P < 0.002$).

Conclusion: In doses used to provide conscious sedation, fentanyl provided ideal conditions, and midazolam, propofol, sevoflurane, and ketamine provided satisfactory conditions for conducting EP study and catheter ablation for supraventricular tachyarrhythmias. The potential of propofol to impede cardiac conduction needs to be explored further.

Keywords: Ideal anesthetic, Arrhythmia, Catheter ablation, Radiofrequency ablation, Electrophysiology study

INTRODUCTION

There has been growing interest in cardiac electrophysiology (EP) study and catheter ablation procedures over the years and anesthesiologists are increasingly becoming an integral part of these procedures.[1-3] EP study and catheter ablation procedure may be painful and of prolonged duration.[4,5] Movement of the patient during the procedure may reduce catheter stability, cause catheter dislocation, and increase the probability of complications during the delivery of

radiofrequency energy. Therefore, anesthesia services are required during catheter ablation of cardiac arrhythmias to provide analgesia, patient comfort, and immobilization while maintaining adequate airway, and ventilation.[6,7] EP studies conducted for the treatment of supraventricular tachycardia (SVT) create a distinct scenario where it is necessary to induce arrhythmias to accurately diagnose and effectively treat them. The choice of the anesthetic agent is crucial, just as important as the treatment plan, as these agents can impact cardiac electrophysiology and conduction. They have the potential to modify the ability to induce an abnormal rhythm, which could ultimately have adverse effects on the ablation procedure.[8] When selecting an appropriate anesthetic agent, factors such as the patient's age, comorbidities, and length of the procedure should be taken into consideration. In addition, the provider's experience and consultation with the electrophysiologist are also important, in addition to the agent's potential to induce arrhythmias.

MATERIAL AND METHODS

This prospective and interventional study was conducted in the Cardiac EP Laboratory of our institute. After obtaining Institutional Ethics Committee approval, 30 adult patients with SVT scheduled for elective diagnostic EP study and radiofrequency catheter ablation were enrolled for the study with the aim to identify the ideal anesthetic agent for cardiac EP study and catheter ablation. The primary objective of the study was to compare the effects of anesthetic agents on cardiac electrophysiological parameters and arrhythmia inducibility. The secondary objective was to compare the patient, anesthesiologist, and cardiologist satisfaction scores with respect to the anesthetic agent used. Written informed consent was taken from the patients a day before the day of the procedure. The patients were assigned to one of the following groups according to the anesthetic agent to be used – midazolam (Group M), fentanyl (Group F), propofol (Group P), ketamine (Group K), or sevoflurane (Group S) by using computer-generated random number table with a block size of 15. Patients with liver or kidney dysfunction, severe heart failure (New York Heart Association Class III and Class IV), any psychiatric or neurological disorder, history of adverse reaction to study medications, history of obstructive sleep apnea, or having an anticipated difficult airway were excluded from the study.

A resting 12-lead electrocardiogram, transthoracic echocardiography, and standard laboratory tests were performed before the study as per the institutional protocol. Pre-procedure visit by the anesthesiologist was done a day before and the patients were explained the entire protocol of the study. The patient was assessed for difficult airway and all preoperative investigations were noted. All antiarrhythmic drugs were stopped. No premedication was prescribed to the patients and all patients were kept fasting overnight. Demographic data comprising name, age, gender, height, weight, body mass index, left ventricular ejection fraction, and comorbid conditions (hypertension, structural heart disease, coronary artery disease, diabetes mellitus, hypothyroidism, etc.) were noted. In the EP laboratory, electrocardiography, arterial oxygen saturation (SpO_2), non-invasive blood pressure, end-tidal carbon dioxide, and surface temperature monitoring were initiated. A 20 G peripheral intravenous (IV) access was secured in the upper limb in all patients. The depth of anesthesia was monitored using a bispectral index (BIS) monitor (BIS™ Monitoring System: Covidien, Medtronic) and Richmond Agitation Sedation Scale (RASS). External defibrillation pads were applied before the start of the procedure. Oxygen was supplemented through the face mask. Basic and advanced airway management equipment was kept in readiness for tackling respiratory depression and airway emergencies. Maintenance IV fluid in the form of a balanced salt solution at 2 mL/kg/h was administered throughout the procedure and in the post-procedure period till the time the patient resumed oral intake. Patients were kept warm by maintaining the ambient temperature, using warming blankets and an in-line IV fluid warming system.

EP study

Femoral venous access was obtained by the cardiologist under local anesthesia using up to 10 mL solution of 0.25% ropivacaine in all patients. After obtaining venous access, EP catheters were positioned, with standard placements in the high right atrium near the sinus node, His-bundle, coronary sinus, and the apex of the right ventricle under fluoroscopic guidance. Every diagnostic catheter had two or more electrodes, and a distinct intracardiac electrogram was recorded for each pair of consecutive electrodes. Additional diagnostic catheters, if required, were used for further diagnosis. Surface ECG and intracardiac electrogram recordings were displayed and recorded on a standard multichannel recording system. A standard electro-stimulator (St Jude Medical, EP-4 TM: The Computerized EP Stimulator) was used for stimulation.

Following intervals and refractory periods: RR interval, PQ/PR interval, QRS interval, QT interval, cycle length, atrial-His interval (AH, atrioventricular [AV] node conduction time), His-ventricle interval (HV, conduction time between bundle of His and the right ventricle), AV node effective refractory period (AVNERP, longest interval between two impulses that fail to conduct through the AV node), accessory pathway effective refractory period (APERP), and ventriculoatrial effective refractory period (VAERP) were noted before (pre) and 5 min after (post) administering the anesthetic agent.

The number, type, and mechanism of induction (spontaneous or in response to stimulation) of arrhythmias

were documented. The stimulation protocol was performed at baseline and repeated after the administration of individual sedative agents. Stimulation was also performed in the end toward the termination of the procedure to assess the success of ablation. Use of any drug administered to induce arrhythmia (isoproterenol and atropine) was noted.

Drug administration and monitoring

After performing the baseline measurements, patients were administered either of the sedative agents – midazolam (30 μg/kg IV) or fentanyl (1 μg/kg IV) or propofol (1 mg/kg IV), or ketamine (1 mg/kg IV) or sevoflurane (0.8 minimum alveolar concentration, 1–2% concentration in 50% air-oxygen mixture delivered through the face mask. The exhaled gases were vented passively through corrugated tubing from the anesthesia machine exhaust port to the atmosphere). This was followed by an infusion of the same drug, that is, either midazolam (100 μg/kg/h) or fentanyl (1 μg/kg/h) or propofol (50 μg/kg/min) or ketamine (0.5 mg/kg/h) or sevoflurane (as above) to produce conscious (moderate) sedation.

Conscious (moderate) sedation has been defined by the American Society of Anesthesiologists (ASA) as a drug-induced depression of consciousness during which a patient responds purposefully to verbal commands, either alone or accompanied by light tactile stimulation, no interventions are required to maintain a patent airway, spontaneous ventilation is adequate and the cardiovascular function is usually maintained. Further adjustments were made to maintain BIS values between 71 and 90 throughout the procedure.

Respiratory depression was defined as SpO_2 < 90% at any time during the study. Hypotension was defined as a decrease in mean arterial pressure of more than 20% from baseline or a systolic blood pressure <90 mmHg. Bradycardia was defined as a heart rate <60/min. These criteria were considered to be present if they occurred at any time during the procedure, regardless of their duration. Respiratory depression, if occurred, was managed using basic airway maneuvers such as chin-lift, jaw-thrust, or use of an oropharyngeal or nasopharyngeal airway and by increasing the inspired-oxygen concentration. Hypotension was managed by increasing the rate of the IV fluid.

All anesthetic and procedural complications occurring during or immediately after the procedure were noted; till the time, the patient was discharged from the EP laboratory. Overall patient, anesthesiologist, and cardiologist satisfaction scores were noted at the end of the procedure on a scale of 1–10, where 1 signified absolute dissatisfaction and 10 signified total satisfaction with the anesthetic agent used.

Statistical analysis

Data were analyzed using the statistical software Stata 14.0 (StataCorp LLC, TX, US). Quantitative variables were expressed as median (minimum - maximum) and categorical variables were expressed as frequency and percentage. Kruskal–Wallis test followed by Dunn's test was applied to compare the quantitative variables among the groups. The signed-Rank test was used for comparing pre- to post-change in a variable. Fisher's exact test was used to compare categorical variables between the groups. $P < 0.05$ was considered statistically significant.

RESULTS

The median age of the study population was 39 years (18–66 years) with male to female ratio of 1:1 and ASA physical status I or II. The patients were diagnosed with AV node re-entrant tachycardia (AVNRT) ($n = 23$, 76.7%), paroxysmal SVT ($n = 4$), orthodromic AV reciprocating tachycardia ($n = 2$), and Wolff-Parkinson-White (WPW) syndrome ($n = 1$). The patients were comparable with respect to demographic parameters recorded in all the groups, namely, age, gender, height, weight, body mass index, hemoglobin levels, serum creatinine, and serum electrolytes [Table 1].

EP parameters remained stable with ketamine administration. Sevoflurane and propofol administration was associated with deviation in EP parameters (RR interval, PQ/PR interval, QRS interval, QT interval, cycle length, atrioventricular Wenckebach cycle length [AVWCL], and APERP) more than fentanyl and midazolam. Clinically, arrhythmia could not be induced electrically in one patient in the propofol group but could be induced with isoprenaline [Table 2].

The average duration of the procedure was 51 min. One patient each in the propofol and sevoflurane group suffered hypotension, which was managed by increasing the rate of IV fluid administration. No patient required administration of atropine for symptomatic bradycardia or injection mephentermine for severe hypotension.

Higher RASS scores were observed in the ketamine group at all-time points [Figure 1]. BIS values were found to be comparable at baseline. Thereafter, higher values of BIS were observed in the ketamine group as compared to other groups [Figure 2].

The highest patient, anesthesiologist, and cardiologist satisfaction scores were observed in the fentanyl group, while the lowest scores were observed in the ketamine group. Based on the composite average satisfaction scores (average of all three satisfaction scores), overall scores were found to be the highest in the fentanyl group. The order of composite average satisfaction scores can be summarized as group F > group M > group P = group S > group K [Table 3].

Table 1: Demographic data and baseline characteristics.

Variable Median (Min–Max)	Group M	Group F	Group P	Group K	Group S
Age (years)	48.5 (19–63)	47.5 (21–59)	50 (36–62)	25.5 (20–66)	25 (18–38)
Height (cm)	163.5 (151–168)	165.5 (158–172)	167.5 (164–172)	168.5 (164–178)	168 (164–176)
Weight (kg)	60 (55–70)	55.5 (48–65)	56 (50–92)	61 (48–70)	56 (45–73)
Body mass index (kg/m^2)	23.5 (21.5–25.1)	20.8 (17.6–30.0)	20.3 (17.9–31.1)	21.2 (17.8–22.5)	19.2 (16.3–24.7)
Hemoglobin (g%)	11.9 (11.3–14.6)	12.5 (11.6–14.2)	13.2 (12.7–15)	14.8 (10.8–16)	13.5 (11.8–17.5)
Serum creatinine (mg/dL)	0.75 (0.6–0.9)	0.65 (0.6–0.8)	0.60 (0.5–0.8)	0.55 (0.2–0.8)	0.60 (0.5–0.7)
Serum K^+ (mEq/L)	4.2 (3.7–4.8)	4.1 (3.7–4.7)	4.2 (3.6–4.4)	4.5 (3.6–4.8)	4.1 (3.6–4.9)
Serum Na^+ (mEq/L)	138 (133–145)	138 (133–142)	139 (137–140)	138.5 (135–146)	139 (133–142)
Gender (M/F) (*n*)	2/4	2/4	4/2	4/2	3/3
Hypertension (*n*)	2	2	1	0	0
Diabetes mellitus (*n*)	1	0	0	1	0
Hypothyroidism (*n*)	1	0	0	0	0
ASA physical status (*n*)					
1	3	5	5	5	6
2	3	1	1	1	0

P-value not significant. ASA: American Society of Anesthesiologists

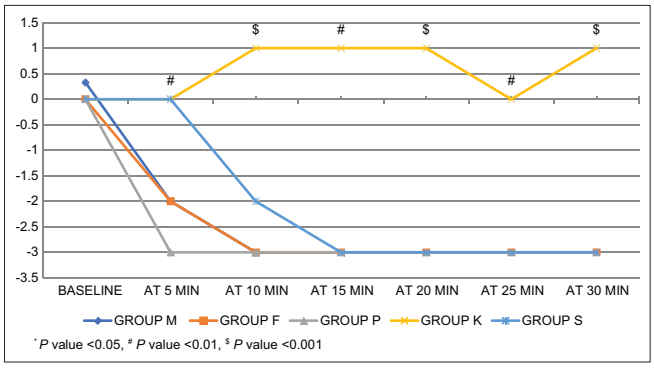

Figure 1: Comparison of Richmond agitation sedation scores among the groups. *$P < 0.05$, #$P < 0.01$, $$P < 0.001$.

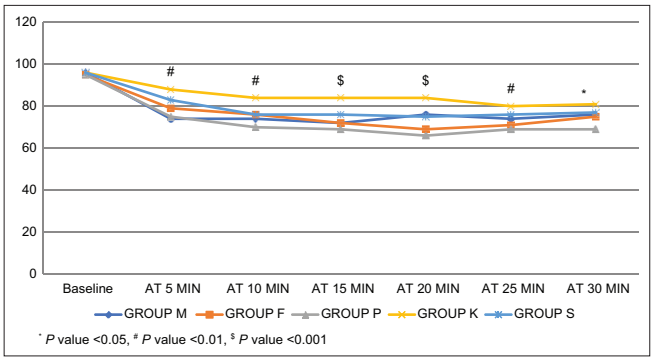

Figure 2: Comparison of Bispectral index values among the groups. *$P < 0.05$, #$P < 0.01$, $$P < 0.001$.

DISCUSSION

Drugs such as dexmedetomidine, ketamine, fentanyl, remifentanil, midazolam, and propofol have been used for providing sedation during EP studies and SVT ablations procedures.[1,9] Induction of arrhythmia during the procedure is crucial for confirming the diagnosis and ensuring the success of the procedure. Hence, diagnosis, ablation, or success becomes limited if the anesthetic used during the procedure inherently has antiarrhythmic properties and by itself hinders the induction of tachycardia.

The most common approach for sedation and pain relief during cardiac procedures is the use of benzodiazepines and narcotics either alone or in combination. The combination of these drugs provides analgesia, sedation, and amnesia. The combination of fentanyl and midazolam may be administered either as a continuous infusion[10] or intermittently[11] for a wide range of EP procedures. Selvaraj *et al.* studied the effects of conscious sedation on tachycardia inducibility and patient comfort during ablation of SVT using intermittent doses of midazolam and fentanyl. They concluded that conscious sedation with intermittent midazolam and fentanyl reduced patient discomfort during the EP study and ablation of SVT without affecting the tachycardia inducibility.[12]

Midazolam is frequently used for sedation because of its shorter half-life and minimal effects on hemodynamics and the cardiac conduction system at therapeutic doses.[13-16] Studies have shown that midazolam has no effect on the normal AV node or accessory pathways, sinoatrial (SA) node activity, or the inducibility of re-entrant tachycardias in intermittent doses up to 5 mg.[17]

Fentanyl is one of the most commonly used opioids for sedation in EP laboratories, its analgesic action being the primary therapeutic effect. IV fentanyl boluses of 10–50 mcg and infusion rates ranging from 0.5 to 2.0 mcg/kg/h showed no significant adverse effects on arrhythmia inducibility. Schaffer *et al.* demonstrated that fentanyl had no effect on the atrial effective refractory period. They also found no significant difference between fentanyl or desflurane

Table 2: Comparison of electrophysiology parameters.

Variable (ms) Median (Min–Max)	Group M	Group F	Group P	Group K	Group S
RR interval Pre	500 (496–780)	742 (700–950)	780 (500–1032)	745 (500–860)	740 (698–780)
RR interval Post	515 (500–660)	660# (600–1090)	660*,# (520–783)	630 (600–780)	630* (598–660)
PQ/PR interval Pre	124 (121–127)	124 (120–147)	128.5 (121–147)	122.5 (101–130)	128 (121–130)
PQ/PR interval Post	127.5 (122–136)	136* (131–140)	130.5 (125–140)	130 (106–140)	134.5* (130–141)
QRS interval Pre	84 (64–98)	82.5 (64–92)	68 (64–76)	79 (66–90)	79 (64–90)
QRS interval Post	98 (78–108)	86 (81–97)	97* (86–103)	91.5 (78–103)	96.5 (78–103)
QT interval Pre	340 (336–386)	382.5 (269–386)	382 (380–386)	379.5 (260–384)	382 (380–386)
QT interval Post	310.5 (300–379)	351 (280–379)	380 (319–460)	320 (280–380)	329* (319–379)
Cycle length Pre	685 (480–780)	742 (700–950)	780 (740–1032)	700 (490–780)	740 (690–780)
Cycle length Post	590 (420–660)	660 (600–1090)	680*,# (360–783)	600 (330–660)	475* (270–660)
AH interval Pre	64.5 (62–66)	61 (60–79)	64 (62–72)	63 (60–70)	63 (58–68)
AH Interval Post	69 (67–70)	65 (53–94)	66 (58–70)	59 (53–70)	65 (50–74)
HV interval Pre	44 (40–47)	43.5 (40–47)	41 (40–47)	41 (23–45)	43 (40–45)
HV interval Post	46 (36–55)	44 (36–53)	42 (36–53)	40 (33–53)	44 (36–53)
AVWCL Pre	310 (300–340)	330 (310–370)	320 (310–360)	320 (300–330)	320 (310–340)
AVWCL Post	350 (240–360)	240* (220–370)	300 (240–360)	275 (230–360)	240* (230–320)
APERP Pre	260 (220–460)	230 (220–270)	220 (210–260)	240 (220–260)	230 (220–240)
APERP Post	205* (200–220)	240 (220–270)	220 (210–290)	240# (220–290)	270# (220–290)
VAERP Pre	200 (180–210)	205 (190–220)	210 (200–220)	215 (210–260)	200 (190–220)
VAERP Post	190 (180–200)	210 (200–220)	200 (190–210)	190 (180–210)	205 (190–210)

AH: Atrial–His, HV: His-ventricle, AVWCL: Atrio-ventricular Wenckebach cycle length, APERP: Accessory pathway effective refractory period, VAERP: Ventriculo-atrial effective refractory period. *P<0.05 for within-group differences, #P<0.05 for intergroup differences

techniques in terms of EP measurements and SVT was inducible with both drugs.[18]

Propofol has minimal or no direct effect on SA node activity, intra-atrial conduction, accessory pathways, and the atrioventricular conduction systems.[19-21] Lai *et al*. examined the feasibility of using propofol anesthesia for radiofrequency catheter ablation of various tachyarrhythmias in 150 patients. They were able to induce tachyarrhythmias, however ectopic atrial tachycardia remained uninducible even with isoprenaline infusion in four out of seven children.[22] Wutzler *et al*. compared the effects of propofol/midazolam, ketamine/midazolam, and midazolam alone on the atrial physiology in 31 patients undergoing an EP study for SVT ablation. They reported that SVT induction rates before and after administration of anesthetic agents did not differ significantly between the groups, nor was there any instance wherein the

Table 3: Comparison of patient, anesthesiologist, and cardiologist satisfaction scores.

Variable Median (Min-Max)	Group M	Group F	Group P	Group K	Group S
Patient satisfaction score	8 (7–8)	9 (8–10)	8 (7–9)	6 (5–7)[$]	8 (7–9)
Anesthesiologist satisfaction score	8 (8–10)	9 (9–10)	8 (7–8)[$]	7 (5–8)[$]	8 (7–9)
Cardiologist satisfaction score	8 (8–8)	10 (9–10)	7 (6–8)[$]	6 (1–8)[$]	7 (7–8)[$]
Composite average score (rounded off)	8 (8)	9.33 (9)	7.67 (8)	6.33 (6)	7.67 (8)

[$]$P<0.001$

arrhythmia could not be induced after administration of the anesthetic drug.[23]

Ketamine as an anesthetic is unique, with sedative, analgesic, and sympathomimetic properties. In clinically relevant concentrations of ketamine, experimental studies have revealed a shortening of action potential duration, with minimal effect on AV node conduction and atrial refractoriness. Significant shortening of atrial conduction time after the administration of ketamine and midazolam, compared to propofol and midazolam, was reported by Wutzler *et al*.[23] In their study in the pediatric population, Char *et al*. observed that the concurrent use of ketamine may mitigate the negative chronotropic effects of dexmedetomidine with an increase in heart rate, decrease in sinus node recovery time, decrease in QT interval, and AVNERP.[24] At clinically relevant concentrations, ketamine shortens the action potential duration by inhibiting L-type Ca+2 currents.[25]

Much of the data on general anesthesia for catheter ablations is from pediatric studies because of the need for ensuring immobility in these patients. All modern inhaled anesthetics have been used successfully in children undergoing SVT catheter ablations. When used in combination with alfentanil and midazolam in patients undergoing ablative procedures, sevoflurane was found to have no effect on the electrophysiological properties of the SA node, normal AV conduction system, and accessory pathways in patients with WPW syndrome.[26] In a study by Pérez *et al*. on the EP effects of sevoflurane in children with WPW syndrome undergoing radiofrequency ablation, it was found that sevoflurane partially modified the properties of the accessory pathway but did not prevent ablation.[27] Caldwell *et al*. noted significant prolongation of APERP under general anesthesia with sevoflurane and cautioned regarding its use in patients with WPW syndrome and coexisting mitochondrial myopathy.[28]

RASS scores were found to be significantly different among the groups at all time points. Higher mean scores were observed in the ketamine group and lower mean scores were noted in the fentanyl and propofol groups. Similarly, higher BIS values were observed at all-time points in the ketamine group. In our study, two patients in the ketamine group demonstrated restlessness and agitation toward the end of the procedure but could be pacified with the injection of midazolam 1 mg IV. However, one of them subsequently developed apnea, and the airway was managed using basic airway maneuvers-head tilt and chin lift. Sevoflurane also demonstrates emergence delirium which is a complex of perceptual disturbances and psychomotor agitation.[29-31] One patient in the sevoflurane group demonstrated agitation after 5 min of commencing administration. It was managed by reducing the inspired concentration of the inhalational agent for some time. These episodes may have contributed to dissatisfaction with the use of these drugs.

EP parameters

EP study and radiofrequency ablation could be accomplished successfully in all the patients regardless of the anesthetic agent used. The tachycardia was inducible in all but one patient in the propofol group, in whom it could be induced after starting an isoprenaline infusion. All patients were tested again for arrhythmia inducibility with pacing as well as with isoprenaline infusion at the end of the procedure to confirm the success of the ablation treatment.

A statistically significant increase in PQ/PR interval was observed within the fentanyl and sevoflurane groups when compared with baseline values. However, the observed increase was clinically insignificant and arrhythmias could be induced in either of the groups. In a previous study, Sharpe *et al*. observed that sevoflurane has no effect on SA node function or normal AV and accessory pathway conduction in WPW syndrome during alfentanil/midazolam anesthesia.[26]

There was a statistically significant increase observed in the QRS duration in the propofol group; however, all the values were within the normal range. An abnormally prolonged QRS duration is an independent predictor of the risk of sudden cardiac death.[32]

The QT interval was found to be either unchanged or shortened in our study in all the groups. Statistically significant shortening was observed in the midazolam and sevoflurane groups. Previously, sevoflurane has been shown to increase corrected QT interval (QTc) in a dose-dependent manner; however, the increase in QTc which is caused by

sevoflurane alone seemed modest. Most of the studies on sevoflurane have been conducted under anesthesia, wherein other anesthetics and non-anesthetic drugs have also been used. Perhaps, more important than the effect of sevoflurane was the effect of the entire anesthetic milieu. The cumulative effects of underlying disease, electrolyte abnormalities, adrenergic tone, temperature, circadian variation, and other drugs that were administered either acutely or chronically may have resulted in QTc prolongation.[33]

Significant prolongation of cycle length (time between two successive heartbeats) was observed in the propofol group. Increased pre-procedural Wenckebach cycle length (WCL) was associated with a high risk for AV block after catheter ablation treatment for AVNRT.[34]

AH intervals were comparable in all the groups and also at pre- and post-drug measurements. Similarly, HV intervals were also comparable for both pre-and post-drug time points as well as among the groups.

For the assessment of refractory periods, the pacing was initiated at a rate slightly faster than the patient's intrinsic spontaneous rate and then the pacing cycle length was decreased in a step-wise fashion to the point of block or to a minimum cycle of 200–300 ms. We assessed the presence or absence of any retrograde atrial activation, and, if present, the atrial activation sequence (i.e., concentric or eccentric). If a block was detected, the site of the block, that is, AH or HV was determined. The groups were comparable for AVWCL in both pre-and post-drug time periods; however, a statistically significant difference was observed in fentanyl and sevoflurane groups. Prolongation of AVWCL was observed only in the midazolam group. This shortening of WCL was clinically insignificant as pacing could be achieved in all the patients. Our findings were in contrast to other studies where anesthetic agents have been found to increase the WCL.[35]

APERP decreased significantly in the midazolam group, whereas a significant increase was observed in the sevoflurane group. A short APERP is one of the risk factors for WPW syndrome.[36] Khan and Shah demonstrated that the ablation of the AV nodal slow pathway for AVNRT led to changes in the effective refractory period of the fast pathway.[37] Enhanced AV nodal conduction and changes in adrenergic tone because of the use of anesthetic agents may also affect the accessory pathway's effective refractory period.

Fentanyl sedation was associated with an increase in VAERP. For VAERP measurement, incremental ventricular pacing was performed at a rate slightly faster than the cycle length and increased until a ventriculo-atrial conduction block appeared. During the conduct of an EP study, arrhythmia (AVNRT) inducibility is dependent on the cardiac autonomic tone and changes dramatically according to the level of patient sedation or the use of isoproterenol, or prolonged periods of rapid pacing.

In summary, significantly higher satisfaction scores (patient, anesthesiologist, and cardiologist) were observed in the fentanyl group. This may be due to better tolerability by the patient, hemodynamic stability, ease of administration, no major complications, and most importantly ease of arrhythmia inducibility, without clinically significant effect on EP parameters. Midazolam provided satisfactory conditions for EP study and catheter ablation. The cardiologists expressed dissatisfaction toward propofol as it impeded cardiac conduction and arrhythmia could not be induced electrically in one patient. In certain instances, propofol and sevoflurane administration affected hemodynamic stability, altered EP parameters, and necessitated active airway intervention due to cardiovascular and central nervous system depressant properties contributing to anesthesiologists' and cardiologists' dissatisfaction. The patients experienced agitation with sevoflurane (occasionally) and ketamine sedation. Despite no major effects on EP parameters, the ketamine group showed the lowest satisfaction scores in all three categories by virtue of its central nervous system stimulant property.

Limitations of the study

We acknowledge that the results obtained from the pilot study need to be confirmed by a larger study. The results of the present study may not be reproduced due to its limited sample size. The potential of propofol to impede cardiac conduction needs to be further explored. Access for the procedure was obtained after local anesthetic infiltration (up to 10 mL solution of 0.25% ropivacaine) in all the patients. The effects of local anesthetic on the cardiovascular and central nervous system, and hence, the arrhythmia inducibility and conduction were not studied. The effects of systemically absorbed local anesthetic cannot be negated. Furthermore, the long-term outcomes after catheter ablation were not studied.

CONCLUSION

In doses used to provide conscious sedation, fentanyl provided ideal conditions, and midazolam, propofol, sevoflurane, and ketamine provided satisfactory conditions for conducting EP study and catheter ablation for supraventricular tachyarrhythmias. The potential of propofol to impede cardiac conduction needs to be explored further.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

Suruchi Hasija and Sandeep Chauhan are the members of the Editorial Board.

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