

Conversion of supraventricular arrhythmia to normal rhythm by propofol and remifentanyl -three cases report-

Eun-Kyung Choi and Dae-Lim Jee

Department of Anesthesiology and Pain Medicine, Yeungnam University College of Medicine, Daegu, Korea

We experienced conversion of supraventricular arrhythmia to normal sinus rhythm in three patients during general anesthesia using propofol and remifentanyl. This may be related to direct inhibition of the cardiac conduction system or activation of the parasympathetic system. The literature review suggests that propofol and remifentanyl have antiarrhythmic potential, reverting supraventricular arrhythmia during anesthesia. (Korean J Anesthesiol 2014; 66: 244-247)

Key Words: Propofol, Remifentanyl, Supraventricular arrhythmia.

Supraventricular arrhythmia can be spontaneously converted to normal sinus rhythm (NSR) occasionally and the conversion rate of chronic atrial fibrillation to a normal rhythm is reported to be as high as 7.6% [1]. Supraventricular arrhythmia can also be reverted spontaneously during surgery; however, the patients at risk may be more prone to develop supraventricular arrhythmia related systemic inflammation or the excessive production of catecholamines resulting from surgery [2].

We recently experienced 3 patients with conversion of supraventricular arrhythmia to NSR during anesthesia using propofol and remifentanyl. Cardiac electrophysiologic studies have suggested that propofol and remifentanyl induce antiarrhythmic activity. The cardiac electrophysiologic effects of propofol and remifentanyl may play a role in this conversion. We report on this with literature review.

Case Reports

Case 1

A 52-year-old woman (height 160 cm, weight 47 kg) with a history of hyperthyroidism was scheduled for total radical thyroidectomy because of a gradual increase in the size of the thyroid nodules. The patient's previous medical history was unremarkable. Preoperative laboratory tests, including thyroid function test, and chest x-ray were unremarkable. An electrocardiogram (ECG) taken 1 month prior to surgery showed atrial fibrillation, and transthoracic echocardiography revealed normal left ventricular ejection fraction without regional wall motion abnormalities. She was not given premedication before surgery. In the operating room, non-invasive blood pressure

Received: November 8, 2012. Revised: 1st, January 11, 2013; 2nd, February 8, 2013. Accepted: February 15, 2013.

Corresponding author: Dae-Lim Jee, M.D., Department of Anesthesiology and Pain Medicine, Yeungnam University Medical Center, Daemyeong 5-dong, Nam-gu, Daegu 705-717, Korea. Tel: 82-53-620-3367, Fax: 82-53-626-5275, E-mail: adjee@medical.yeungnam.ac.kr

©This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0/>), which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

monitoring, ECG (lead II) and a pulse oximetry monitoring were placed. Pre-anesthetic blood pressure was 120/70 mmHg, heart rate was 70 beats/min, and oxygen saturation was 95%. The ECG rhythm was same as preoperative state, suggesting atrial fibrillation is chronic. After preoxygenation, anesthesia was induced with propofol (3.5 µg/ml) and remifentanyl (0.1 µg/kg/min) using target controlled infusion (TCI) pump (Orchestra[®] Base Primea, Fresenius Vial, Brezins, France) and she was intravenously given rocuronium 50 mg. After tracheal intubation, anesthesia was maintained using propofol and remifentanyl TCI in an oxygen-air mixture (FiO₂ = 0.5). After about 40 minutes, atrial fibrillation converted to the NSR (heart rate, 70 or so), which persisted. On postoperative day 4, the patient was discharged with NSR. One month later, the patient was still having NSR. The patient was lost to follow-up afterwards.

Case 2

A 79-year-old male (weight 50 kg) was scheduled for clipping of aneurysm of subarachnoid hemorrhage. The patient was stuporous and had a tracheostomy. ECG taken immediately before surgery revealed atrial fibrillation and T wave inversion. The precise medical history was unobtainable; the patient's family was unaware of atrial fibrillation. A chest X-ray was consistent with emphysema. Preoperative laboratory results were unremarkable except for low serum potassium (3.2 mEq/L). No premedication was given before surgery. On arrival at the operating room, blood pressure, heart rate, oxygen saturation were 130/70 mmHg, 99 beats/min, and 92%, respectively. Anesthesia was induced with TCI of propofol (2.5 µg/ml) and remifentanyl (0.1 µg/kg/min). Rocuronium 50 mg was administered intravenously, and endotracheal intubation was performed. Anesthesia was maintained with TCI of propofol and remifentanyl in an oxygen-air mixture (FiO₂ = 0.5). About 10 minutes after tracheal intubation, the rhythm changed to NSR, which reverted to atrial fibrillation on postoperative day 2 and persisted.

Case 3

A 71-year-old male with a history of hydrocephalus was admitted to the hospital for surgery of ventriculoperitoneal shunt. The patient had a history of hypertension, arrhythmia, cerebral infarction 10 years previously and was taking oral medications for hypertension (the name of medication was unknown). The patient had a history of unidentified arrhythmia, but he did not have cardiac symptoms; the patient was not taking antiarrhythmic drugs. A preoperative ECG showed frequent (70–80 /min) premature atrial contractions. Transthoracic echocardiographic findings were not remarkable. Laboratory results including electrolytes and cardiac enzymes were also normal. The patient was

not premedicated. Prior to anesthetic induction, the patient's blood pressure was 100/60 mmHg, heart rate was 65 beats/min, and standard ECG lead II showed the same arrhythmia. Anesthesia was induced and maintained with propofol and remifentanyl using TCI, and an oxygen-air mixture (FiO₂ = 0.5). Rocuronium 40 mg was administered intravenously, and trachea was intubated. Ten minutes later, the patient's ECG converted to NSR, which was persistent on postoperative day 1. However, the NSR reverted to his preoperative cardiac rhythm thereafter.

Discussion

Spontaneous conversion of chronic atrial fibrillation to NSR is a well-known phenomenon, although rare and transient. It has been suggested that the fibrotic change of atrial tissue causing electrical inactivity suppresses the ectopic firing, thereby converting the arrhythmia to NSR, but this conversion does not mean a clinical or hemodynamic recovery [3].

It was reported that propofol had a direct inhibitory effect on the cardiac conduction system (CCS) in a dose-dependent manner and this eventually prolonged an atrioventricular conduction interval in rabbits [4]. Alphin et al. [5] reported that propofol delayed the conduction of the atrioventricular node and lowered the atrial rate in guinea pigs. These authors also noted that propofol had a negative dromotropic and an antiarrhythmic effect analogous to adenosine and diltiazem. On the other hand, some studies did not find that propofol affects the CCS directly [6]. Propofol induces bradycardia originating from an intense reduction of the sympathetic tone [7]. Ikeno et al. [8] reported that propofol did not affect the CCS when the autonomous nervous system (ANS) was blocked with atropine prior to the administration of propofol in dogs. These reports support the assumption that propofol affects the ANS, suppressing tachycardia and triggering bradycardia. We therefore assume that propofol can revert supraventricular arrhythmia via activation of vagal tone besides the direct actions on the CCS.

Remifentanyl may also revert supraventricular arrhythmia to NSR. There are several reports of remifentanyl-induced bradycardia [9], suggesting that remifentanyl may have cardioelectrophysiologic effects like propofol. A study examining the cardiac electrophysiological effect of remifentanyl found that it suppressed both sinus node and atrioventricular nodal functions and then prolonged the ventricular refractoriness [10]. Another study also showed that remifentanyl suppressed the calcium and potassium cardiac ion channel and thereby increased the action potential, implying a direct antiarrhythmic activity [11]. In addition, the increased vagal tone of remifentanyl might also be involved in reverting supraventricular arrhythmia to NSR. Fattorini et al. [12] reported on the reversal of remifentanyl-induced bradycardia by atropine, indicating that increased parasym-

thetic tone may be involved.

Given the direct and indirect effects of propofol and remifentanil on CCS, some may argue that the synergic or additive effect of both anesthetics on the cardiac rhythm might also be considered. Zaballos et al. [10] reported that the electrophysiologic synergic interaction between propofol and remifentanil could be excluded. However, both drugs can change the autonomic nervous system tone [7,8,12]. Thus it is plausible that both drugs may affect the tone additively or synergistically. Unfortunately, no one can presently advocate or oppose the additive or synergistic effect. Further research on the cardiac effect of propofol alone, remifentanil alone, and both anesthetics combined, is needed.

Sedation from anesthesia, irrespective of anesthetics used, also decreases sympathetic tone and increases vagal activity, modulating ANS to convert the arrhythmias to NSR. However, Herman and Vettermann [13] reported that volatile anesthetics did not revert supraventricular arrhythmia during general anesthesia. This report might imply that volatile anesthetics are not enough to produce ANS modulation to convert supraventricular arrhythmia to NSR, and propofol exerts relatively stronger vagal stimulation and/or sympathetic depression than volatile anesthetics, playing an anti-arrhythmic role.

Two major pathophysiological mechanisms for supraventricular arrhythmia include the increased automaticity and occurrence of reentry. Warpechowski et al. [14] reported that propofol was effective in suppressing the occurrence of automatic

supraventricular arrhythmia but not in reentry tachyarrhythmia. In our patients, however, conversion to NSR occurred irrespective of pathophysiological mechanisms. This agrees Fujii et al. [15] that reentrant mechanisms of supraventricular arrhythmia are sensitive to enhanced vagal tone by propofol. We speculate that propofol and/or remifentanil might revert the reentry mechanism.

Surgical stress and anxiety-related emotional stress may provoke perioperative supraventricular arrhythmias in patients at risk (such as having the history of the arrhythmias), leading to hemodynamic disturbances and acute heart failure. Avoiding such provocation, if possible, is reasonable. The combined use of propofol and remifentanil was associated with conversion of the supraventricular arrhythmias, which would also suppress the development of the arrhythmias. We believe that the antiarrhythmic effects of these drugs may play some role in the management of anesthesia for patients who have supraventricular arrhythmias or prophylactically for patients at risk, although the antiarrhythmic effects are not invariably apparent. As a result, compared to other anesthetic drugs, these drugs seem to be the affordable anesthetic option.

In summary, we observed that propofol and/or remifentanil converted supraventricular arrhythmia to NSR during general anesthesia. The direct and indirect effects of propofol and remifentanil seemed to play a role in reverting to NSR. In patients with supraventricular arrhythmia, propofol and remifentanil may be helpful in reverting to NSR during anesthesia.

References

1. Deedwania PC, Singh BN, Ellenbogen K, Fisher S, Fletcher R, Singh SN. Spontaneous conversion and maintenance of sinus rhythm by amiodarone in patients with heart failure and atrial fibrillation: observations from the veterans affairs congestive heart failure survival trial of antiarrhythmic therapy (CHF-STAT). *Circulation* 1998; 98: 2574-9.
2. Sohn GH, Shin DH, Byun KM, Han HJ, Cho SJ, Song YB, et al. The incidence and predictors of postoperative atrial fibrillation after noncardiothoracic Surgery. *Korean Circ J* 2009; 39: 100-4.
3. Zimmerman TJ, Basta LL, January LE. Spontaneous return of sinus rhythm in older patients with chronic atrial fibrillation and rheumatic mitral valve disease. Description of three patients. *Am Heart J* 1973; 86: 676-80.
4. Wu MH, Su MJ, Sun SS. Age-related propofol effects on electrophysiological properties of isolated hearts. *Anesth Analg* 1997; 84: 964-71.
5. Alphin RS, Martens JR, Dennis DM. Frequency-dependent effects of propofol on atrioventricular nodal conduction in guinea pig isolated heart. Mechanism and potential antidysrhythmic properties. *Anesthesiology* 1995; 83: 382-94.
6. Sharpe MD, Dobkowski WB, Murkin JM, Klein G, Yee R. Propofol has no direct effect on sinoatrial node function or on normal atrioventricular and accessory pathway conduction in Wolf-Parkinson-White syndrome during alfentanil/midazolam anesthesia. *Anesthesiology* 1995; 82: 888-95.
7. Deutschman CS, Harris AP, Fleisher LA. Changes in heart rate variability under propofol anesthesia: a possible explanation for propofol induced bradycardia. *Anesth Analg* 1994; 79: 373-7.
8. Ikeno S, Akazawa S, Shimizu R, Nakaigawa Y, Ishii R, Inoue S, et al. Propofol does not affect the canine cardiac conduction system under autonomic blockade. *Can J Anaesth* 1999; 46: 148-53.
9. Reid JE, Mirakhur RK. Bradycardia after administration of remifentanil. *Br J Anaesth* 2000; 84: 422-3.
10. Zaballos M, Jimeno C, Almendral J, Atienza F, Patiño D, Valdes E, et al. Cardiac electrophysiological effects of remifentanil: study in a closed-chest porcine model. *Br J Anaesth* 2009; 103: 191-8.
11. Estafanous FG. *Opioids in Anesthesia*. Boston, Butterworth-Heinemann. 1991, pp 61-71.

12. Fattorini F, Romano R, Ciccaglioni A, Pascarella MA, Rocco A, Mariani V, et al. Effects of remifentanyl on human electrical system. A transesophageal pacing electrophysiological study. *Minerva Anesthesiol* 2003; 69: 673-7, 677-9.
13. Hermann R, Vettermann J. Change of ectopic supraventricular tachycardia to sinus rhythm during administration of propofol. *Anesth Analg* 1992; 75: 1030-2.
14. Warpechowski P, dos Santos AT, Pereira PJ, de Lima GG. Effects of propofol on the cardiac conduction system. *Rev Bras Anesthesiol* 2010; 60: 438-44.
15. Fujii K, Iranami H, Nakamura Y, Hatano Y. Fentanyl added to propofol anesthesia elongates sinus node recovery time in pediatric patients with paroxysmal supraventricular tachycardia. *Anesth Analg* 2009; 108: 456-60.