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Original article

Feasibility of total intravenous anesthesia by cardiologists with the support of anesthesiologists during catheter ablation of atrial fibrillation

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ABSTRACT

Background: The optimal methodology for sedation and anesthesia during atrial fibrillation (AF) ablation has not been well established. We assessed the feasibility of total intravenous anesthesia (TIVA) by cardiologists with support from anesthesiologists during AF ablation and quality of pulmonary vein isolation (PVI) and single procedure success rate at 12 months.

Methods: TIVA was performed by cardiologists using IV propofol and fentanyl under controlled ventilation via i-gel™ without neuromuscular blocking drugs in 160 consecutive patients (80 non-paroxysmal) with no anticipated difficult airway or other severe diseases. Anesthesiologists were requested to be on standby during the procedure. The incidence of anesthesia-associated complications and ablation-associated complications were assessed. To evaluate the quality of PVI, the prevalence of acute adenosine triphosphate (ATP)-provoked PV reconnections and late PV reconnections among those requiring a redo procedure was analyzed.

Results: TIVA was successfully completed in 152 patients (95%). In five (3%), we requested help from anesthesiologists, and in three (2%), TIVA was abandoned. No major anesthesia-associated complications were observed. Ablation-associated complications were observed in seven patients (4%). ATP provocation test was performed in 141 patients, and no acute PV reconnections were observed in 134 (95%). Success rates at 12 months were 85% of patients off antiarrhythmic drugs. Twenty-one of 24 patients with recurrence underwent a redo session, and 18 (86%) had no PV reconnections.

Conclusions: TIVA by cardiologists with support from anesthesiologists during AF ablation may be feasible. The success rate at 12 months was high, and prevalence of acute and late PV reconnection was very low.

Introduction

Catheter ablation of atrial fibrillation (AF) is an important treatment for symptomatic AF, and pulmonary vein isolation (PVI) is a cornerstone treatment for AF ablation [1–4]. Catheter ablation for AF is an unpleasant procedure with intolerable pain, and the patient must remain motionless for a long time. General anesthesia is widely used during AF ablation in many centers [5], but in Japan, the vast majority of patients undergo AF ablation under conscious sedation (56%) or deep sedation (41%), and only 0.5% of patients undergo general anesthesia [6]. Minimum to conscious sedation cannot provide sufficient control of the patient's pain, discomfort, and movement, which causes disturbance of the electroanatomical mapping system, including map shifts. Deep sedation is an alternative method during AF ablation [7–9]. However, during deep sedation, airway obstruction and impaired ventilator function are major concerns that should be rapidly recognized

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and appropriately managed to prevent hypoxic brain damage, cardiac arrest, or death [10]. Instrumental airway management such as using oropharyngeal airway is often necessary to maintain a patent airway, but it may cause gag reflex and coughing when the depth of sedation becomes shallow. Because sedation is a continuum, the level of sedation can deepen to the level of general anesthesia [10], especially when sedatives and analgesics are additionally administered to prevent the patient's movement or elicitation of the gag reflex by instruments. This causes severe airway obstruction, severe respiratory depression, and unstable respiratory rhythm caused by apnea and subsequent deep breathing, which results in unstable navigation of the electroanatomical mapping system and increases the risk of serious complications such as cardiac tamponade and air embolisms [6,11]. Conversely, inadequate sedation may result in patient discomfort or unexpected physical movements because of lack of cooperation [10].

General anesthesia provides sufficient control of pain and physical movement, and mandatory ventilation during general anesthesia provides stable respiration and stable electroanatomical navigation, which may facilitate durable and continuous lesion creation [12]. One randomized clinical trial comparing general anesthesia with conscious sedation reported that the use of general anesthesia improved the single procedure success rate and decreased the prevalence of pulmonary vein (PV) reconnection [13]. General anesthesia seems to be the optimal method for AF ablation; however, in Japan, it is not practical to request general anesthesia from anesthesiologists for all AF ablations, mainly because of the shortage of anesthesiologists [14].

Total intravenous anesthesia (TIVA) is defined as a technique of general anesthesia using a combination of sedatives such as propofol and fentanyl given solely by the intravenous route without any inhalational agents and a closed circuit anesthetic machine. To secure a stable airway, a supraglottic airway device (i-gel™, Intersurgical, Wokingham, UK) is available. The device can be easily and rapidly inserted without using neuromuscular blocking drugs and is well tolerated throughout anesthesia with a very low rate of complications [15,16]. Since August 2015, cardiologists in our institute have used TIVA with i-gel, with anesthesiologists on standby, for patients without high risk factors for general anesthesia. The aim of this study was to assess the feasibility of TIVA performed by cardiologists with the support of anesthesiologists during AF ablation and to assess the quality of PVI and the single procedure success rate at 12 months.

Methods

Patient population

This was a single-center retrospective study. We analyzed 173 consecutive patients with symptomatic AF who underwent the first AF ablation at our institute between August 2015 and August 2016. In our institute, patients with high risks of general anesthesia, such as anticipated difficult airway; obesity (body mass index $\geq$35); disease of the neck, upper respiratory tract, or upper alimentary tract; severe lung disease, including uncontrolled bronchial asthma and moderate/severe chronic obstructive pulmonary disease; severe left ventricular dysfunction (ejection fraction <30%); and American Society of Anesthesiologists (ASA) physical status grading of 3 or more, underwent AF ablation under general anesthesia by anesthesiologists. Thirteen patients with high risk factors were excluded from the study. The remaining 160 patients underwent AF ablation under TIVA by cardiologists, and their data were analyzed. Written informed consent was obtained from all patients before undergoing the ablation procedure and anesthesia. In our institute, the usage of propofol by non-anesthesiologists is restriced by the institutional safety management committee. The following method of TIVA using propofol by the cardiologists with the support of anesthesiologists was approved by the committee, and this study was approved by the institutional ethical committee.

Induction of TIVA

We requested an anesthesiologist to be on standby during ablation in case of anesthesia-associated problems. AF ablation under TIVA was performed at a catheter laboratory located 2 min away from an anesthesiologist. The cardiologists who administered TIVA (TY, AF, TO, YT, and TT) had intensively learned the following skills for at least 2 months at a department of anesthesiology and/or intensive care unit: obtaining the patient's medical history and performing a physical examination to assess risk and comorbidities suggestive of high risk of difficult airway management; pharmacology of the anesthetic drugs; recognition of adequacy of ventilator function and airway patency, including usage of capnography; evaluation of sedation depth, including bispectral index (BIS) monitoring; and airway and respiratory management, including bag-valve-mask ventilation, mechanical ventilation, i-gel insertion, and endotracheal intubation. One of the cardiologists was exclusively engaged in management of anesthesia during the procedure.

The patients were carried into the catheter laboratory in at least 6 h post-absorptive state. All patients were preoxygenated with 5 L/min of oxygen via a facemask, and routine monitoring, including electrocardiography, oxygen saturation (SpO_2), end-tidal CO_2 ($ETCO_2$), BIS, and noninvasive and invasive blood pressure, was performed. Following restraint of limbs and sedation with intravenous diazepam 10 mg, fentanyl 0.05 mg, and atropine 0.5 mg, anesthesia was induced with a bolus of propofol 1% 1–2 mg/kg via a sheath inserted from the right jugular vein. After the patient had become unresponsive and lost the eyelash reflex, with BIS dropping <50, the i-gel with water-based lubricant was inserted. The size of the i-gel was selected according to body weight (<50 kg, size 3; 50–90 kg, size 4; and >90 kg, size 5), but another size could be used if the initial size did not fit well. If there was difficulty in mouth opening, coughing, gagging, or body movement, bolus administration of propofol 30 mg was added and repeated when necessary. Neuromuscular blocking drugs were not used.

The i-gel was connected to a standard respirator (Vela™ Type D Model CareFusion, Yorba Linda, CA, USA), and synchronized intermittent mandatory ventilation was started. The settings of the respirator are described in Fig. 1. The high peak inspiratory pressure (PIP) alarm was set at >40 cm H_2O, and high PIP was displayed with an audible alarm whenever the high PIP threshold was exceeded. When it exceeded the threshold, mandatory inspiration was automatically terminated until the circuit pressure returned to the baseline pressure +5 cm H_2O. Exhaled minute volume was also continuously monitored. When the exhaled minute volume did not reach or dropped to <70% of the preset minute volume during the procedure, we regarded it as a significant leakage from the i-gel. An effective airway and stable respiration were confirmed by bilaterally symmetrical diaphragm movements by fluoroscopy, square wave form on capnography, range of $ETCO_2$ (35–45), normal SpO_2 (>96%), and no audible and significant leakage. When an effective airway was not achieved, the following manipulations were done: neck extension or flexion, gentle pushing or pulling of the device, and, finally, changing the size of the device. If these attempts were unsuccessful, we asked for help from the anesthesiologist or abandoned TIVA. When the systolic blood pressure dropped to <80 mmHg and persisted as low, a vasopressor was administered. Then, a

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