Chapter 11
Procedural Sedation for Atrial Fibrillation Patients

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Definitions and Goals of Procedural Sedation and Analgesia

Procedural sedation and analgesia, previously referred to as conscious sedation, is the process of administering sedatives or dissociative medications simultaneously with analgesics, as needed, to produce an altered state of consciousness which permits the patient to undergo unpleasant and/or painful procedures while preserving cardiovascular function [1]. Analgesia is defined as pain relief without intentional alteration of mental status. Anxiolysis refers to the condition in which the patient experiences decreased apprehension without affecting their level of awareness. Sedation occurs along a continuum that ranges from minimal to moderate, followed by deep sedation and finally general anesthesia [2]. Dissociative sedation is a trance-like cataleptic state in which spontaneous ventilation, airway, and cardiopulmonary function are maintained, while the patient is unresponsive to all stimuli [3]. The classic and most widely used dissociative agent is ketamine.

Eliminating or at least minimizing the anxiety, suffering, and pain that may occur during diagnostic or therapeutic procedures is the avowed purpose of procedural sedation and analgesia [2].

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Considerations in the Selection of Sedatives and Analgesics for Procedural Sedation: Patient Factors

The selection of an appropriate sedation and analgesic regimen for any patient undergoing a medical procedure, including a patient with atrial fibrillation, is dependent upon multiple variables incorporating patient considerations, the properties of the specific sedative and or analgesics, and other factors, including the practitioner's knowledge base and the site or location where the procedural sedation is to occur [4].

Obviously, the specific properties of the sedative(s) and analgesic(s), and particularly their effect on the various organ systems, especially the cardiovascular, respiratory, and neurologic systems, are key items for consideration [4].

Patients need to be assessed regarding their risk for procedural sedation and analgesia in order to determine the potential for adverse effects when undergoing procedural sedation and analgesia. This allows the practitioner to anticipate potential problems and ideally avoid or minimize any adverse events related to the procedural sedation and analgesia [4].

Patients presenting with atrial fibrillation range in complexity from essentially healthy young patients with a structurally normal hearts to hemodynamically unstable geriatric patients with end-stage heart failure and multiple comorbidities. Patients range in age from the newborn or infant with congenital heart disease to the geriatric patient with multiple comorbidities and New York Heart Association (NYHA) class IV [5, 6]. Providing procedural sedation and analgesia to a patient with atrial fibrillation may create additional difficulties or problems and often requires additional consideration and usually adds another layer of complexity to the process.

Patients at Risk for Adverse Events During Procedural Sedation

Who is at increased risk for adverse events during procedural sedation? Various factors have been linked with an increased incidence of adverse events during procedural sedation and analgesia. Patients with significant comorbidity such as cardiovascular disease, respiratory disorders, or neurologic disease have a higher incidence of adverse events or complications than patients without any comorbidities [7, 8]. Moreover, patients whose comorbid condition is well controlled have a lower occurrence of adverse events than patients whose comorbid condition is poorly controlled.

Obviously, a patient with asthma who is experiencing an acute exacerbation of their asthma and is wheezing and hypoxic would pose more problems for sedation than an asthmatic who is well controlled, not experiencing an acute asthmatic attack, is not wheezing, and is not hypoxic. Similarly, a patient with atrial fibrillation who

is rate controlled, with stable vital signs, and is asymptomatic is different from a patient with symptomatic atrial fibrillation who is having chest pain or shortness of breath, has a heart rate of 180, and is hypotensive. The symptomatic, hypotensive, tachycardic atrial fibrillation patient whose heart rate is not well controlled would be more likely to experience a complication from procedural sedation and analgesia than the stable, asymptomatic patient.

This is reflected in the American Society of Anesthesiology (ASA) physical status classification [4] (Table 11.1). Patients with a higher ASA physical status classification, especially 3 or above, are at greater risk than lower physical status classification, with the greatest risk in the highest ASA physical status classification (Table 11.2). ASA 1 is a normal healthy patient with no medical illnesses or diseases. ASA 2 is a patient with mild disease. An ASA 2 patient has no functional limitations and has well-controlled disease of one body system. An example of an ASA 2 patient would be a well-controlled asthmatic with mild, intermittent asthma who is not having an asthmatic attack. A hypertensive patient on antihypertensive medications whose blood pressure is well controlled and in the normal range would be an ASA category 2 (Table 11.1).

For the young healthy atrial fibrillation patient with no structural heart disease and no other comorbidities who is asymptomatic with stable vital signs whose heart rate is rate controlled (e.g., within the normal range), he/she might be deemed as

Table 11.1 American Society of Anesthesiology (ASA) physical status classification

ASA 1: Normal healthy patient. No organic, physiologic, or psychiatric disease
ASA 2: Patients with mild disease: No functional limitations. Well-controlled disease of one body system. Examples: well-controlled asthma, well-controlled hypertension
ASA 3: Patients with severe systemic disease: Some functional limitation. Controlled disease of ≥ 2 body systems with no immediate danger of death
ASA4: Patients with severe systemic disease that is a constant threat to life: ≥ 1 poorly controlled or end-stage disease with possible risk of death. Examples: unstable angina, symptomatic congestive heart failure, symptomatic chronic obstructive pulmonary disease, symptomatic atrial fibrillation
ASA 5: Moribund patients who are not expected to survive without an operation and/or other immediate intensive care. Patients are not expected to survive > 24 h without surgery. Patients are at imminent risk of death, have multiorgan failure, and/or are hemodynamically unstable. An example would be a sepsis patient who is anuric with kidney failure on dialysis, has liver failure, and is in respiratory distress for which he/she is intubated and on a ventilator
ASA 6: Declared brain-dead patient whose organs are being removed for donor purposes

Table 11.2 Factors associated with adverse events during procedural sedation

Comorbidity: especially patients with significant cardiovascular or respiratory or neurologic disorders
High ASA physical status
Extremes of age: elderly or very young – neonates and infants
Other *possible* factors: multiple sedatives and/or analgesics, high doses of medications, the procedure being done, the location

Table 11.3 Commonly used sedatives for procedural sedation

Sedative	CV effects	Use with caution if	Other side effects	Contraindications
Etomidate	Minimal CV depression	Adrenal insufficiency	Pain on injection, myoclonic movements, ↓adrenal steroid production	Adrenal insufficiency
Ketamine	CV stability Sympathomimetic Effects: ↑ HR, ↑BP	Hypertension Tachycardia	Emergence reactions, ↑ Intraocular pressure[a]	Thyrotoxicosis or other conditions with marked sympathetic activity, psychiatric conditions
Midazolam	Mild CV effects unless volume depleted	Hypotension shock	Paradoxical agitation vomiting, coughing, hiccups	Shock or significantly low BP (consider IVF bolus)
Barbiturates: methohexital, pentobarbital	Can cause CV depression	Hypotension shock, impaired cardiac function	Vomiting, coughing, hiccups; extravasation can cause tissue necrosis; intra-arterial injection can cause gangrene	Porphyria
Propofol	CV depression is dose/rate of administration dependent, negative inotrope (↓ CO) ↓ SVR (vasodilatation) ↑ Vagal tone (↑ risk of bradyarrhythmias when given with certain drugs)	Shock, low BP, impaired cardiac function	Respiratory depression, apnea	Egg, soybean, or EDTA allergy

CV cardiovascular, *HR* heart rate, *BP* blood pressure, *IVF* intravenous fluids, *CO* cardiac output, *SVR* systemic vascular resistance, ↑ increase, ↓ decrease

[a]↑ intracranial pressure was previously thought to be a contraindication, but recent reports suggest that ketamine may be safe and effective in patients with head injuries or CNS disorders

ASA 2. The patient with atrial fibrillation with good heart rate control and stable vital signs, who also has COPD or CHF, has well-controlled disease of two body systems and might be classified as ASA 3. The atrial fibrillation patient with CHF who is dyspneic, tachycardic with a heart rate of 160, and hypotensive with a blood pressure of 90 and with rales, peripheral edema, and jugular venous distention could be classified as ASA 4.

There are other variables that may lead to an increased incidence of complications during procedural sedation and analgesia. The evidence indicates that age may be a significant factor. Patients at the extremes of age have a higher incidence of adverse events during procedural sedation. Being an infant, e.g., age <1 year, is a predictor of increased risk of sedation adverse events in some pediatric studies [7]. The elderly have been reported to have significantly higher complication rates than their nongeriatric adult counterparts [8–10]. This difference for age remains even when other factors such as comorbidity or ASA class are taken into consideration [9]. The geriatric patient with atrial fibrillation is more likely to suffer an adverse event during procedural sedation and analgesia than their younger counterpart, an adult <65 years old (Table 11.2).

Procedural factors that may be associated with a higher incidence of adverse events in some studies include multiple sedatives and analgesics (e.g., opioids), high doses of sedatives and/or opioids, and specific sedatives and/or analgesics [10–14]. However, other studies have reported different conclusions. The location where the procedure is performed may affect the incidence of complications during procedural sedation and analgesia. The highest incidence of complications during procedural sedation has been in dental offices according to some reports [15] (Table 11.2).

Procedural Sedation and Analgesia in the Emergency Department

It is recommended that there be at least one practitioner skilled in airway management, venous access, and resuscitation present during the procedure in case any untoward events occur [15]. Emergency physicians as part of their training and certification are required to be competent in airway management, the use of critical care medications including advanced cardiac life support (ACLS) drugs, resuscitation, and procedural sedation. This knowledge and these skills are especially important in unstable or critically ill atrial fibrillation patients who may be in need of emergent cardioversion. There is abundant evidence-based literature to suggest that procedural sedation can be effectively and safely performed in the emergency department (ED) in patients of all ages and with all types of conditions and diseases [1, 16].

Cardioversion in the Emergency Department

Moreover, a recent study found that cardioversion in emergency department (ED) patients with dysrhythmias, most commonly atrial dysrhythmias, specifically atrial fibrillation, can be effective and safe even in critically ill patients with multiple comorbidities and high ASA physical status classifications (e.g., ASA 4 or 5) [17]. Another study found that four sedation regimens (propofol, etomidate, midazolam, and midazolam/flumazenil) were similarly effective in hemodynamically stable adults undergoing cardioversion in the ED [18].

Considerations in the Selection of Sedatives and Analgesics for Procedural Sedation: Sedatives

There is a wide range of procedures for which patients may undergo procedural sedation and analgesia including orthopedic procedures (reduction of fractures and dislocations), lumbar puncture, incision and drainage of abscesses, removal of foreign bodies, wound care including suturing, insertion of various tubes (chest tubes, feeding tubes, nasogastric tubes), and radiologic procedures. In addition to these procedures, patients with atrial fibrillation may need to undergo cardioversion to treat their underlying rhythm disorder.

Sedatives frequently used for procedural sedation and analgesia include etomidate, ketamine, midazolam, methohexital, pentobarbital, and propofol. There are advantages and disadvantages associated with every sedative. The ideal sedative would have no side effects, have a rapid onset and rapid offset, and be applicable for every patient and every procedure. Unfortunately, there is no ideal sedative. The commonly used sedatives have varying effects on cardiovascular function (Table 11.3).

Since patients with atrial fibrillation may have congestive heart failure, poor cardiac function with an impaired ejection fraction, an abnormal heart rate (more commonly tachycardia than bradycardia), or may be hypovolemic or in shock, the effects of the sedative on cardiovascular function must be considered prior to procedural sedation and analgesia.

Propofol can cause cardiovascular and respiratory depression. Therefore, it should be used with caution in any patient with shock, hypotension, or impaired cardiac function [8, 19, 20].

The barbital class of sedatives includes the commonly used sedatives methohexital and pentobarbital. Cardiovascular and respiratory depression can occur with both methohexital and pentobarbital [21].

The sedative, midazolam, belongs to the benzodiazepine class of sedative drugs. Midazolam has mild cardiovascular effects unless the patient is hypovolemic so midazolam could be used in patients who are euvolemic or volume overloaded. Midazolam decreases left ventricular (LV) filling pressure so it may be useful in patients with a high LV pressure, as seen in many heart failure patients. Respiratory depression and apnea can occur with midazolam, especially in high doses given as

a rapid intravenous (V) bolus [22]. In cardiac patients who also have coexisting respiratory disease, such as chronic obstructive pulmonary disease (COPD), and are at risk for loss of respiratory drive, midazolam may not be a good choice [2, 23].

Ketamine has remarkable cardiovascular stability and is known as the battlefield drug since it can be used in situations where hemodynamic monitoring is difficult or impossible. Ketamine does not lower blood pressure unlike propofol, methohexital, or pentobarbital. However, ketamine has sympathomimetic effects, which generally result in an increase in heart rate and blood pressure, so it would not be the ideal drug of choice in patients who are tachycardic and/or hypertensive [24].

Etomidate has minimal cardiovascular and respiratory depression so it can be used in patients who are hypotensive, hypertensive or normotensive, and/or tachycardic or bradycardic. Etomidate does, however, cause adrenal suppression and should be avoided in patients with adrenal insufficiency. However, the evidence suggests that a one-time dose of etomidate does not have any lasting untoward side effects as regards to adrenal suppression [25].

There are other relatively new agents that might be used for procedural sedation and analgesia including dexmedetomidine (sedative) [26–28], alfentanil (an opioid, an analogue of fentanyl) [29, 30], and remifentanil (synthetic opioid) [31, 32]. Dexmedetomidine is usually administered as a loading dose over 10 min followed by a maintenance infusion [26]. The need for a loading dose might be a disadvantage if there is a need for an emergent sedation. Dexmedetomidine has mainly been used as a sedative for radiology procedures with mixed results [27] although there is a case report from the ED [28]. In one ED study in which alfentanil was given, it was safe and effective; however, recovery rates were longer when alfentanil was coadministered with propofol, and the authors concluded that there was no benefit of alfentanil with propofol re-hypoventilation [29]. Remifentanil use in the ED has been also reported [31, 32]. Without any large studies or randomized controlled trials of these agents in an ED setting, it is problematic to make recommendations for their use in the ED.

In summary, for cardiac patients including those with atrial fibrillation, the cardiovascular (and other) side effects of the sedative must be considered. Etomidate has minimal cardiovascular depression. This is also true for midazolam unless the patient is hypovolemic. Replacement of volume with a bolus of a crystalloid, such as normal saline, could be considered when using midazolam in a volume-depleted patient. The barbitals methohexital and pentobarbital can cause cardiovascular (and respiratory) depression, so they would not be the drug of choice in patients with impaired cardiac function. Ketamine does not cause cardiovascular depression but instead raises the heart rate and blood pressure so it would not be ideal in a patient who is already hypertensive or tachycardic (Table 11.3).

Steps in Procedural Sedation

Successful procedural sedation and analgesia encompasses several elements: patient assessment, personnel and monitoring equipment, discharge criteria, and quality improvement. Preprocedural assessment involves an evaluation of the patient,

beginning with a detailed history and physical examination emphasizing the cardiovascular, airway, pulmonary, and neurologic systems in order to identify any problems or abnormalities that could make the patient high risk for complications. Cardiac medications needed to manage any dysrhythmias or other cardiac events, including ACLS resuscitation medications, defibrillators, respiratory supplies, oxygen, suction, and even intubation equipment should be immediately available [2, 4].

Qualified and trained individual(s) who are able to manage any potential cardiovascular or pulmonary problems or other adverse events that may occur should be present during the procedure [16]. Monitoring, at a minimum, entails obtaining and recording vital signs and the depth of sedation at regular intervals along with continuous monitoring of heart rate, pulse oximetry, and ideally capnography. In addition, for patients with any preexisting cardiovascular disease, including atrial fibrillation, continuous cardiac rhythm strip monitoring is recommended. Monitoring should be ongoing, even after the procedure has been completed, since the patient is still vulnerable, and adverse events are possible after the stimuli and pain of the procedure has ended. Only after patients are fully awake, have returned to their preprocedural mental and physical status baseline, and have normalized vital signs should they be discharged [2].

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