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Review Article

Anesthesia for Cardiac Ablation

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As the complexity and duration of cardiac ablation procedures increase, there is a growing demand for anesthesiologist involvement in the electrophysiology suites for sedation and anesthesia provision, hemodynamic and neuromonitoring, and procedural guidance through transesophageal echocardiography. To deliver high-quality perioperative care, it is important that the anesthesiologist is intimately familiar with the evolving techniques and technologies, the anesthetic options and ventilation strategies, and the anticipated postprocedural complications.

Key Words: electrophysiology; catheter ablation; anesthesia; ventilation; complications

THE FIELD OF electrophysiology (EP) and cardiac ablation is undergoing rapid growth and unique changes. The multitude of catheters, approaches, and anticoagulation management is ever changing. The increasing complexity of EP ablations creates a growing demand for anesthesiologist involvement in the EP suite. The anesthesiologist's role includes provision of sedation or general anesthesia, monitoring of hemodynamics and neurologic status, maintenance of procedural anticoagulation, and performing transesophageal echocardiography to rule out intracardiac thrombus and guide catheter positioning. The rapid evolution of interventional EP can overwhelm the casual anesthesia provider.

It remains controversial whether cardiac anesthesiologists are best suited to manage anesthesia in the EP lab. To our knowledge, there are no studies on patient outcomes that compare the care provided by cardiac anesthesiologists with that of general anesthesiologists. A debate discussing the merits of general versus subspecialty-trained cardiovascular/thoracic anesthesiologist providing care for EP procedures was recently published. Proponents for general anesthesiologists argue that all anesthesiologists are familiar with cardiac disease, hemodynamic management, and EP procedures. Additionally, many procedures require expertise with sedation and natural airway maintenance or high-frequency jet ventilation, skills that may not be routinely practiced by cardiothoracic anesthesiologists.[1]

The alternative opinion that only cardiothoracic anesthesiologists should provide care for EP procedures is based partially on the increasing demand for intraprocedural transesophageal echocardiography (TEE) for ruling out intracardiac thrombus, guiding septal puncture, and monitoring for complications such as tamponade. Additionally, greater familiarity with multiple inotropic infusions, ventricular assist devices (VADs), intra-aortic balloon pumps, and life-threatening clinical presentations implies cardiac anesthesiologists are the ideal provider for the moribund EP patient. Finally, many postablation complications may require emergent surgical management with cardiopulmonary bypass, and only cardiac anesthesiologists can provide continuity of care during the transition from interventional suite to cardiac operating room.[2]

Although there is a growing trend for cardiac anesthesiologists to provide care for the unstable EP patient, a small dedicated team of anesthesiologists who have great familiarity and experience with the EP procedures, environment, and special considerations will likely have the biggest benefit to patient care outcomes. Some centers still predominantly employ a proceduralist-directed, nurse-administered sedation

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model. This often is driven by the lack of anesthesiologist availability.[3,4] Anesthesia departments should increase support for electrophysiologic procedures to maintain a high quality of care for an inevitably growing field and increasingly complex patient population.

Epidemiology

Atrial fibrillation (AF) is the most prevalent arrhythmia, affecting >5 million patients in the United States and a reported incidence of 0.4% to 1% worldwide.[5,6] Atrial flutter affects approximately 0.1% of the US general population,[7,8] while there are approximately 35 cases of supraventricular tachycardia (SVT, excluding AF and atrial flutter), per 100,000 persons.[9] Of the subtypes of SVT, atrioventricular nodal reentrant tachycardia (AVNRT) is more common than atrioventricular reentrant tachycardia and atrial tachycardia.[10]

The prevalence of ventricular tachycardia (VT) is not well studied; however, VT is most commonly observed after myocardial infarction and results in 300,000 hospital deaths per year in the United States, resulting in a cost of approximately $26 billion.[6,11] In the United Kingdom, VTs account for >1% of the National Health Services budget.

Principles of EP Procedures

The purpose of catheter ablation is to cauterize the endocardium at areas of re-entry to render it electrically inert.[12] The choice of catheters and equipment will change depending on the intent of the procedure, as outlined in Table 1.[13] The mechanisms of arrhythmias are well described in previous review articles.[12,14] Figure 1 depicts the mechanisms of common arrhythmias.

Before ablation, 12-lead electrocardiograms (ECG) of all arrhythmias are reviewed to determine the diagnosis, localize the arrhythmia exit sites, and identify potential ablation targets. Preprocedural assessment also should include biventricular function for procedural tolerance, aortic valve pathology for retrograde left ventricular (LV) access, and coronary anatomy if ischemic heart disease is a concern.[15] Significant structural heart diseases, such as mitral regurgitation and ischemic heart disease, may be treated surgically or via catheter-based procedures before ablation. Cardiac magnetic resonance imaging also may help in procedural planning by locating the extent of scar tissue.[16,17]

Frequently, tachycardia is not well captured on a 12-lead ECG; the diagnosis or location also may not be clear from the ECG, therefore, a full diagnostic study is commonly performed to confirm the diagnosis and rule out other causes. A diagnostic study is performed by incremental ventricular pacing, followed by ventricular extrastimulus pacing, atrial extrastimulus pacing, and atrial incremental pacing. Finally, entrainment mapping is performed to identify sites vital to maintaining the arrhythmia circuits. Entrainment mapping is performed 10 to 20 ms faster than the tachycardia cycle. In the setting of unstable VT, entrainment mapping may be unfeasible and empiric ablation lines may be required.

Patients with paroxysmal AF who are in sinus rhythm will require an extensive diagnostic study, whereas for persistent AF, the diagnostic study is minimal.[18] An atrial flutter study will focus on confirming typical cavotricuspid isthmus dependence.[13] The purpose of VT pace mapping is to locate the anatomic arrhythmia origin by pacing areas of abnormal electrical signals to recreate clinical VT morphology.[15] Abnormal or slow conduction are tagged during mapping and usually correspond with scar tissue. Occasionally, patients presenting with one diagnosis can have substrate for a different arrhythmia.[13]

VT ablation therapy is generally reserved for chronic and stable VT due to either old myocardial infarction or arrhythmogenic right ventricle cardiomyopathy. For acute VT secondary to acute myocardial infarction, coronary revascularization may be preferred.

Postablation, programmed stimulation to reinduce the arrhythmia is performed during waiting periods. The end goal of any ablation procedure is clinical noninducibility. In some patients, a detailed remapping is performed to ensure complete elimination of arrhythmogenic substrate. Occasionally, epicardial or endocardial tissue next to the burn lesions may still be able to conduct the arrhythmia. Inadequate ablation may initially appear successful because tissue edema forms between 2 lesions and leads to temporary block. The arrhythmia recurs when the edema subsides.[19]

Table 1
Type of Arrhythmia Determines the Number, Type, and Position of Catheters Required

	Catheter positions*						
Procedure	RA	His	CS	RV	Multipolar RA (eg, Halo)	Circular multipolar (eg, Lasso)	Multispline (eg, PentaRay)
Diagnostic study	+	+	+	+			
Atrial fibrillation			+	+		+	±
Atrial flutter			+	+	+		
AVNRT	+	+	+	+			
AVRT	+	+	+	+			
VT	+		±	+			+

Abbreviations: AVNRT, atrioventricular nodal reentrant tachycardia; AVRT, atrioventricular reentrant tachycardia; CS, coronary sinus; His, bundle of His; RA, right atrium; VT, ventricular tachycardia.

*Choice of catheter positions is variable depending on the institution and clinician. This table is based on the author's institution.

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