Lesson 312: Assessment and Management of the Patient With Atrial Fibrillation for Ablation

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Read this article, reflect on the information presented, then go online and complete the lesson post-test and course evaluation before the termination date below. (CME credit is not valid past this date.) You must achieve a score of 80% or better to earn CME credit.

TIME TO COMPLETE ACTIVITY: 2 hours
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Professional Gaps

Most anesthesiologists are conversant with the pharmacologic therapy of atrial fibrillation. New theories attempt to identify the cause of this dysrhythmia and indicate that only a few foci are responsible for generating the fibrillatory activity, and, if precisely localized, they can be ablated, resulting in a cure. As medical management has many, sometimes prohibitive side effects, new developments have centered on ablation techniques performed at off-site locations, areas which may not be familiar to the anesthesiologist.

Learning Objectives

At the completion of the activity, the reader will be able to:

1. Differentiate between paroxysmal, persistent, and permanent atrial fibrillation (AF).
2. State the pathophysiology of AF.
3. List risk factors that contribute to morbidity and mortality in patients with AF.
4. List appropriate tests for a patient about to undergo an ablation procedure.
5. Identify the complications/caveats that may accompany procedures for AF.
6. Recognize the signs of cardiac tamponade under general anesthesia.
7. Outline the anesthetic management for an ablation procedure.
8. List the problems encountered in provision of off-site anesthetic care.
9. Name the two electroanatomical technologies used for ablation.
10. Prescribe a plan for postanesthetic care of the patient who has had an ablation procedure.

Case

A 72-year-old man presented to the emergency department complaining of dizziness, shortness of breath, and palpitations that began approximately 24 hours previously while he was playing with his
grandson. He had noticed these symptoms on and off for more than 2 months. He had hoped that his usual dose of dronedarone would resolve the palpitations. He had a history of hypertension, diabetes, and AF, for which he was therapeutically anticoagulated with warfarin. During a previous hospitalization for his irregular heartbeat he was treated with “electricity.” He was anxious, dyspneic, and complained of fluttering in his chest. Vital signs included blood pressure, 158/82 mm Hg; pulse, 135 beats per minute and irregular; respiratory rate, 28 breaths per minute; and SpO2 on room air, 95%. Oxygen via nasal cannula was administered at 3 L per minute and a 12-lead electrocardiogram revealed narrow complex tachycardia with an irregular rhythm and no discernible P waves. A cardiac monitor displayed AF. Laboratory tests included a complete blood count, comprehensive metabolic panel, thyroid-stimulating hormone, troponin, and coagulation studies. Chest radiography showed cardiomegaly with bilateral pleural effusions consistent with congestive heart failure (CHF). A transthoracic echocardiography showed an ejection fraction of 35%, decreased from 55% 1 year previously, with mild left atrial remodeling but no evidence of left atrial thrombus. After cardiac and electrophysiology consultation, the decision was made to proceed with radiofrequency catheter ablation under general anesthesia.

Atrial fibrillation is the most commonly encountered and clinically significant cardiac dysrhythmia today. Incidence increases significantly with age, and nearly 1 in 25 individuals over the age of 60 and 1 in 10 over the age of 80 are affected. The number of people with AF in the United States alone is estimated to be more than 2 million and projected to increase 3- to 5-fold by 2050, perhaps exceeding 10 million.1,2 Furthermore, AF is a significant contributor to morbidity and mortality in the elderly. It is associated with an increased incidence of cardiomyopathies, dementia, and cognitive dysfunction, and stroke.3,4

One classification system used to define AF is based on the duration of the dysrhythmia and response to medical and electrical treatments. The system categorizes AF as paroxysmal, recurrent, persistent, or permanent and defines overall treatment strategy (Table 1).3,5

Medical therapy involves the use of pharmacologic agents that enable rhythm or rate control. Multiple studies have examined the effectiveness of rate versus rhythm control in the treatment of AF and have indicated similar outcomes.6,7 Traditionally, treatment consists of rate or rhythm control in addition to anticoagulation therapy. The CHAD2 (Congestive heart failure, Hypertension, Age ≥75 years, Diabetes mellitus, Stroke) score is a new stroke-risk stratification system that has been shown to have significant predictive value in facilitating the selection of anticoagulation and antiplatelet therapy (Table 2). A high score indicates a greater risk for stroke.8

However, despite numerous options, treatment of AF is difficult and controversial because of lack of efficacy, risk for side effects, and/or other limitations. A newer theory centers on the idea of a single or few foci located in the proximity of
the pulmonary veins that generate the abnormal rhythm. This theory provides the basis for catheter ablation therapy being an effective treatment.\textsuperscript{9,10}

**Ablative Therapy**

Ablative therapy has received significant attention as an alternative therapy for restoration of sinus rhythm. Several studies have shown ablative therapy to be more effective than medical treatment, with a significant decrease in overall morbidity and mortality.\textsuperscript{11} The 2010 European Society of Cardiology Atrial Fibrillation Guidelines even recommend considering ablation as an initial therapy for paroxysmal AF in selected uncomplicated patients with minimal or no heart disease.\textsuperscript{12} The recommendation was recently adopted in the 2014 American Heart Association/American College of Cardiology/Heart Rhythm Society (HRS) Guidelines for the Management of Patients with Atrial Fibrillation.\textsuperscript{13}

The foundation for ablative therapy is the belief that AF is the result of a single or few electric foci rapidly discharging through the atria leading to fibrillatory activity. Identifying and ablating these foci, namely the pulmonary veins, enables restoration of sinus rhythm.\textsuperscript{9} The pulmonary veins are thought to play a key role in the generation of AF. The cardiomyocytes found in the pulmonary veins have pacemaker-type activity; through the mechanism of automaticity and triggering potential they result in spontaneous electrical activity. Typically, 2 catheters, a mapping/ablation and multielectrode, are placed trans-septally in the left atrium via a femoral puncture, which allows the electrophysiologist to record multiple electrical signals from the left atrium and deliver radiofrequency ablation (RFA) lesions. Systemic anticoagulation is accomplished with heparin to prevent clot formation on the catheters, as per the 2012 HRS/European Heart Rhythm Association/European Cardiac Arrhythmia Society guidelines.

Carto (Biosense-Webster) and NavX (St. Jude) are the 2 dominant technologies used for electroanatomical mapping. The Carto mapping system uses a magnetic field emitter, which is placed below the patient, and a positional sensor; whereas the NavX system manages electrical signals transmitted between electrode patches on the body’s surface to detect the locations of the catheters. Catheter stability is important to create accurate mapping and ablation. This requires the patient to lie motionless for several hours and the administration of anesthesia is often necessary.

**Anesthetic Management**

The perioperative management of the patient about to undergo an ablation procedure is divided into 3 stages: pre-anesthetic assessment, anesthetic/sedation management during the procedure, and post-procedural surveillance.

**Preoperative Assessment**

A complete anesthesia consultation includes engaging the patient, the family, and the electrophysiology (EP) team in a systematic discussion of the anesthetic plan, patient management,
and possible complications. Information concerning medical conditions, comorbidities, medications, and previous anesthetic exposures should be elicited from the patient. The type of anesthesia and appropriate monitoring must be discussed with the patient and the EP team. A major goal of any preoperative anesthesia evaluation includes assessment of the medical conditions that may affect the peri-procedural period, identification and management of comorbidities, and prediction of risk–benefit ratios. Once all data have been reviewed, the patient and the family should be educated regarding the anesthetic plan and the possibility of anesthesia-related complications.

Patients in AF usually have comorbidities that need to be considered before the procedure, especially underlying cardiac conditions such as hypertension, CHF, angina, and valvular disease. Additionally, the anesthesia team should investigate any pulmonary, renal, and hematologic conditions that may directly affect peri-procedural management. Pulmonary complications can be common after anesthesia and the lengthy procedure can worsen any existing condition. Also, patients who have underlying renal dysfunction may be vulnerable to fluid overload in the EP suite secondary to fluid administration by the anesthesia team, as well as irrigation used by the interventional team over several hours. Finally, patients are often on some form of anticoagulation therapy, which should be identified and coagulation status verified. If the patient is not anticoagulated or treatment is subtherapeutic, transesophageal echocardiography (TEE) before the procedure may be indicated to verify the absence of clot in the atrium. On the other hand, supratherapeutic levels can contribute to bleeding and tamponade. Appropriate tests should be ordered depending on the risk–benefit ratio and identified pathology. Patients with diabetes should have a blood sugar level determined and a potassium value should be known in patients with end-stage renal disease.

A thorough preoperative assessment is especially important in remote locations such as the EP suite. Several factors can contribute to a challenging environment for the anesthetic care provider. The fluoroscopy table is difficult to position and the bed controls are at the end of the table under sterile drapes. The fluoroscopy bed is also narrow, and patient positioning and padding is important to areas vulnerable to pressure injury such as the arms, heels, and head, especially in patients who have preexisting neurologic conditions. Special vigilance should be taken when padding the ulna nerve as bulky leads from the multielectrode mapping systems may be stowed under the patient’s elbows. All peripheral IV sites should be assessed for functionality after padding and positioning. Arms that are positioned above the head for lateral imaging should not be extended beyond 90 degrees to prevent brachial plexus injury. Bulky equipment, such as the C-arm x-ray machine and the extensive application of the mapping system patches, further limit access to the patient. The remote location of the EP suite, difficult access to the patient, and EP personnel who are not trained in airway management can make emergency situations more difficult to manage than in the accustomed operating room setting.

**Intraoperative Management**

Atrial fibrillation RFA is a complex procedure and requires a combination of anesthetic management techniques. The North American Society of Pacing and Electrophysiology has recommended various sedation strategies to safely complete procedures while accounting for the complexities of specific patients and/or procedures. The decision to provide conscious sedation, monitored anesthesia care, or general anesthesia is predominantly determined by the anesthesiologist after detailed discussion with the electrophysiologist and the patient.

Typically, conscious sedation is used for less complex procedures and involves the administration of benzodiazepines and narcotics; however, patients may not tolerate lengthier procedures with
conscious sedation so deeper levels of sedation may be required. In these cases, patient comfort and procedural ease can be enabled by deeper sedation with propofol or dexmedetomidine, a selective α₂ adrenergic agonist with centrally mediated sedative effects. However, the longer duration of procedures, discomfort associated with RF energy application and need for patient immobility to provide for catheter stability often require general anesthesia. Evidence suggests that general anesthesia provides for smaller respiratory variations and greater patient immobility enabling better catheter stability, increasing the effectiveness of pulmonary vein isolation and allowing reduced procedure time and lesser procedure difficulty, which together result in greater cure rates.¹⁵,¹⁶

Standard American Society of Anesthesiologists (ASA) monitors are required, and other invasive monitors—such as direct arterial blood pressure, central venous line, or pulmonary artery catheter placement monitoring—depend on patient comorbidities. Furthermore, AF or the induction of AF during the mapping phase can significantly decrease cardiac output, resulting in hypotension, increased central venous pressure, diminished or absent peripheral pulses, and decreased urinary output.

Rapid active IV agents, such as propofol and etomidate, are generally used and titrated for induction based on ventricular function. Etomidate has been a mainstay for induction due to limited inhibition of the sympathetic nervous system and minimal hemodynamic effects. Although no individual anesthetic regimen consistently eliminates pharmacologic complications, the rational use of familiar anesthetic agents that are tailored to the patient’s preoperative status and intraprocedural response is an important factor for ensuring optimal patient outcomes.

Following induction and intubation, controlled mechanical ventilation is initiated. Maintenance of anesthesia can be accomplished by IV and/or inhaled agents to maintain an adequate anesthetic depth, amnesia, paralysis, and analgesia. Cardiac motion produced by ventilation can be limited by using high-frequency jet ventilation (HFJV).¹⁷ HFJV limits pulmonary excursion, allowing for increased precision with electroanatomical mapping and the ablated lesion. HFJV requires the use of a balanced total IV technique. Additionally, varying degrees of neuromuscular relaxation are required, depending on the procedure. The electrophysiologist may monitor the phrenic nerve during right superior pulmonary vein ablation or cryotherapy to prevent injury requiring the reversal of muscle relaxation.¹⁸

Because AF ablation procedures can last from 3 to 6 hours, perioperative hypothermia may become an issue. Hypothermia is linked to a variety of physiologic complications including coagulation disorders, vasoconstriction, myocardial infarction, increased infection, and prolonged recovery. Normothermia should be maintained using both active and passive warming, including heat moisture exchangers; posterior forced-air warming blankets; increased ambient room temperature; and the application of warm blankets, socks, and a head cover. As a standard ASA practice, core body temperature should be measured in all patients undergoing general anesthesia.¹⁹

Fluid management is important; the choice of fluid and rate of administration must be titrated based on patient need and response. The electrophysiologist can use more than 3 L of 0.9% sodium chloride for injection solution as irrigation during ablation. This irrigation, coupled with fluid given by the anesthesia team, can lead to fluid overload, heart failure, ischemia, and pulmonary edema in patients with underlying cardiac conditions. Administration of fluids should be monitored and diuretics administered as needed.
To minimize the risk for stroke from clot formation on the catheters, systemic anticoagulation is initiated with IV heparin and maintained with a heparin infusion. Recommendations note that heparin should be given before trans-septal puncture and infused to maintain an activating clotting time (ACT) of 300 to 400.\textsuperscript{20} The ACT is usually monitored every 60 minutes and heparin infusion is adjusted accordingly. Protamine is typically given at the end to reverse the effects of heparin based on the final ACT.

Complications related to catheter ablative therapy have been reported at 6% and overall mortality has been shown to be as high as 1 in 1000.\textsuperscript{21} As with most technologies, complications decrease as operator experience grows. Catheter ablation complications can be categorized based on the different stages of the procedure (Table 3). Members of the anesthesia team should be aware of the most frequently encountered complications because many of them can become life threatening. To successfully treat these complications, anticipation, knowledge of when they typically occur, and overall vigilance are essential. Rapid and correct response by the anesthesia team can be lifesaving.

Perhaps the most feared complication is the development of pericardial tamponade resulting from iatrogenic injury of cardiac structures during catheter manipulation and ablation. Pericardial tamponade is considered one of the leading causes of procedure-related mortality, with an incidence up to 2.9%. Rapid, unexplained increases in heart rate, refractory hypotension, elevated central venous pressure, and reverse pulsus paradoxus in mechanically ventilated patients (ie, abnormal increase in systolic blood pressure during inspiration compared with expiration) are all nonspecific signs that should alert the clinician to the possibility of tamponade. Diagnostic for tamponade is the presence of a large pericardial effusion with compression of right-sided cardiac structures on echocardiography. Airway management, reversal of anticoagulation with protamine, and the placement of a pigtail catheter into the pericardial space by the EP team are initial steps in management. Vasopressors and/or inotropes, transfusion of blood products and need for surgical intervention may be necessary.

Another rare but feared complication is atrioesophageal fistula resulting from an esophageal thermal injury, which manifests 3 to 6 weeks after the ablative procedure.\textsuperscript{22} The use of proton-pump inhibitors, continuous

\begin{table}[h]
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\begin{tabular}{|l|l|}
\hline
\textbf{Phase} & \textbf{Complications} \\
\hline
Anesthesia-related & Suppression of arrhythmias \\
& Airway complications \\
& Hypoxia \\
& Aspiration \\
& Hemodynamic abnormalities (hypotension) \\
& Positioning complications (nerve injury, myalgias) \\
\hline
Vascular access (femoral or subclavian/jugular) & Hematoma \\
& Retroperitoneal bleeding \\
& Pseudoaneurysm \\
& Pneumothorax \\
& Hemorrhax \\
\hline
Arrhythmia induction & Atrial and ventricular arrhythmias \\
& Hemodynamic abnormalities (hypotension) \\
& Increased central venous pressure \\
& Decreased urinary output \\
& Diminished peripheral perfusion \\
\hline
Mapping & Atrial perforation (effusion/tamponade) \\
& Aortic puncture/dissection \\
& Air embolism \\
& Thromboembolism \\
& Transient ischemic attack \\
& Stroke \\
\hline
Trans-septal puncture & Atrial tear/perforation \\
& Pericardial effusion/tamponade \\
& Mitral valve injury \\
\hline
catheter manipulation & Cardiac \\
& Mitral valve injury \\
& Pulmonary vein stenosis \\
& Sinus node injury \\
& Atrioventricular block \\
& Coronary artery occlusion \\
& Myocardial injury (tamponade) \\
& Atrial stunning \\
& Loss of atrial contractility \\
& Fluid retention \\
& Pulmonary edema \\
\hline
Extracardiac & Esophageal injury \\
& Atrioesophageal fistula \\
& Phrenic nerve injury \\
& Vagus nerve injury (pyloric spasm, gastroparesis) \\
& Left recurrent laryngeal nerve injury \\
& Superior vena cava occlusion \\
\hline
Testing (Isoproterenol, adenosine) & Ischemia \\
& Atrialventricular block \\
& Hypotension/hypertension \\
& Bronchospasm \\
& Ventricular arrhythmias \\
& Tachyarrhythmias \\
& Seizure activity \\
& Allergic reactions \\
\hline
Removal of access & Hematoma \\
(sheaths, lines, catheters) & Retroperitoneal bleeding \\
& Pseudoaneurysm \\
\hline
general & Bleeding (tamponade) \\
& Embolic events \\
& Endocarditis \\
& Skin injury/burns \\
\hline
\end{tabular}
\caption{Complications of Catheter Ablation Depending on Phase of Procedure}
\end{table}
monitoring of core body temperature using a 12-sensor probe (ie, S-Cath esophagus probe), and avoidance of delivering high energy close to the esophagus are some preventative measures. Postoperative Management

Postoperative management does not differ much from that for any other patient recovering from anesthesia, especially if the intraoperative course was uncomplicated. However, due to the fact that most EP labs are not in the main operating room tract, anesthesia recovery areas (postanesthesia care unit) often are insufficient. Proper equipment must be available to monitor vital signs and ensure adequate ventilations and oxygenation. As opposed to classical surgical patients, patients after interventional procedures often are given diuretics because they have received large amounts of irrigation fluid intraoperatively. The administration of diuretics can lead to hypotension in the postoperative period, which responds to fluid boluses and rarely requires pharmacologic intervention.

Another hurdle for appropriate postoperative management is the absence of trained personnel. Many EP suites share a recovery unit with the catheterization lab. Most catheterizations are done as outpatient procedures with mild sedation administered by a nursing team and requiring minimal postoperative care. Patients undergoing AF ablation often are under anesthesia for longer periods of time and require greater care and monitoring postoperatively. Staff that is well trained to not only monitor these patients but also to promptly evaluate for complications and initiate a treatment strategy are required.

Pain should be controlled in a multimodal fashion. Local anesthetic infiltration at the puncture sites and intraoperative IV narcotics represent the foundation for postoperative pain management. Additional IV narcotics, non-narcotics, and oral analgesics may be used as necessary. Non-narcotic agents such as IV acetaminophen are useful adjuncts for patients with obstructive sleep apnea (OSA) or chronic obstructive respiratory diseases. Patients with OSA have a higher sensitivity to opiate use, leading to an increased risk for airway compromise in the postoperative period.

Anesthetic complications can be predictable and often are treated successfully with routine measures. Nonetheless, recovery personnel and the anesthesia team must be vigilant for the serious complications that can occur in the postoperative period, especially those attributable to the ablative treatment itself. Many of these complications occur rapidly and often are diagnosed and treated intraoperatively. But some complications may be delayed and manifest during the postoperative period, including femoral pseudoaneurysm with hematoma formation at the site of access, retroperitoneal bleeding, pulmonary vein stenosis, heart block, and even stroke.

Pericardial effusion leading to cardiac tamponade is another catastrophic complication that has been shown to occur at least 1 hour after the procedure and may require immediate intervention including pericardiocentesis, pericardial window, or even a sternotomy to evacuate bleeding.

Management of the Case

In the precatheterization area, benefits and risks from the procedure and anesthesia were discussed with the patient and family and consent was received. A 20-gauge IV cannula was placed. Electrode patches and standard ASA monitors were secured; general anesthesia was induced with midazolam, fentanyl, and propofol; and endotracheal intubation was performed. Mechanical ventilation was initiated with an inspiratory to expiratory time ratio of 1:4; general anesthesia was maintained with
desflurane and intermittent boluses of fentanyl. A multisensor temperature probe, the S-cath esophageal probe, was placed in the esophagus for continuous monitoring of core body temperature. Precautions were taken to properly position and pad pressure points on the patient. Heparin was administered and an infusion started with a goal ACT greater than 300. Mapping and ablation of the dysrhythmia was performed for approximately 6 hours. At the end of the procedure, the patient was extubated without any complications and taken to the recovery area, where he was further monitored by the recovery room nurses and transferred to the floor.

Conclusion

Atrial fibrillation is one of the most common dysrhythmias, with nearly 1 in 25 individuals over the age of 60 years and 1 in 10 over the age of 80 affected. The incidence is increasing. Treatment options continue to evolve, including medical, surgical, and interventional treatment modalities. Anesthetic management often is required and involves off-site care in what may be a challenging situation for prolonged periods.

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**Post-test**

1. **Two or more episodes of atrial fibrillation (AF) that terminate spontaneously indicate _____**.
   
   a. newly diagnosed AF  
   b. recurrent paroxysmal AF  
   c. persistent AF  
   d. permanent AF

2. **All of the following are common treatment strategies for AF except_____**.
   
   a. rate control  
   b. glucose control  
   c. rhythm control  
   d. ablative therapy

3. **Which statement best describes the treatment of AF?**
   
   a. Rate control is critical only in newly discovered AF.  
   b. The treatment plan is multifactorial, including consideration of the duration of the current episode of AF.  
   c. Maintaining sinus rhythm is impossible in patients with persistent AF.  
   d. Rhythm control is critical in treating all types of AF.

4. **When using a CHADS2 score _____**.
   
   a. a low score indicates increased risk  
   b. the higher the score the greater the risk  
   c. the risk depends entirely on pharmacologic management  
   d. the score does not evaluate for risk

5. **A leading cause of procedure-related mortality in AF ablations is_____**.
   
   a. pulmonary effusion  
   b. pericardial tamponade  
   c. pulmonary edema  
   d. infection
6. What structure plays a central role in AF through the mechanism of automaticity and triggering potential?
   a. Pulmonary artery
   b. Pulmonary veins
   c. Right atrium
   d. Left atrium

7. Complications related to ablation _____.
   a. occur in up to 6% of cases
   b. are never fatal
   c. occur due to inattention by the anesthesiologist
   d. result in death in 1 in 100 patients

8. Atrial fibrillation contributes to morbidity and mortality by increasing the incidence of which of the following?
   a. Dementia
   b. Pulmonary embolus
   c. Diabetes
   d. Hyperthyroidism

9. One of the most feared long-term complications in ablative procedures is _____.
   a. pericardial effusion
   b. atrioesophageal fistula
   c. femoral hematoma
   d. pulmonary edema

10. What is a nonspecific sign pointing to the possibility of cardiac tamponade?
    a. Pulsus paradoxus in mechanical ventilated patients
    b. Decreased central venous pressure
    c. Hypertension
    d. Tachycardia