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During normal rhythm, an electrical impulse originates from the normal pacemaker of the heart (sinus node) and travels through the upper chambers of the heart (the right and left atria) to cross over a bridge (AV node) to the pumping chambers (ventricles), causing a heartbeat. This is normal sinus rhythm. Atrial fibrillation (AF) is a heart rhythm disorder with rapid, irregular, and chaotic electrical activity in the atria (Figure). The atrial electrical signals bombard the AV node, and some pass through the AV node to the ventricles, producing a rapid, irregular rate and often causing symptoms of palpitations, shortness of breath, or fatigue. AF affects more than 2 million people in the United States alone; it is seen progressively more frequently as a person ages.

There are 3 major treatment considerations for AF. First, in some people, AF promotes formation of blood clots in the atrium that can travel to the brain and cause a stroke. Daily administration of warfarin, an anticoagulant medication that reduces blood clotting, often is used to prevent these clots. Second, medications often are needed to slow the heart rate, thus improving symptoms and preventing development of heart failure. The third consideration is whether to attempt to keep the heart in normal rhythm, a sometimes controversial issue that requires an individualized approach. Medications that alter the electrical properties of the heart often are used to try to maintain sinus rhythm, but they frequently are ineffective or cause unpleasant side effects.

Catheter ablation has been used to treat heart rhythm disorders for more than 20 years. A long, thin tube called a catheter is inserted into a blood vessel, typically in the groin, and guided through the blood vessels into the heart. When the tip of the catheter is placed against the part of the heart causing the arrhythmia, radiofrequency electrical current is applied through the catheter to produce a small burn about 6 to 8 mm in diameter. Catheter ablation is very effective when the abnormal area is small, but in AF, there are many electrical waves throughout the atria. However, AF is often "triggered" by rapid electrical activity originating from small areas typically located around the pulmonary veins that drain blood from the lungs back to the left atrium (Figure). Initial studies showed that ablation of the triggers prevented AF in some patients. Subsequently, it was recognized that many triggering sites usually are present, leading to approaches in which the ablation catheter is moved from point to point, placing lesions that encircle multiple pulmonary veins regions (Figure) to electrically isolate all of the potential triggers around the veins, as well as the electrical "substrate" that allows AF to continue once it starts. With further study, it has become clear that the electrical abnormalities that promote AF can be different for different people and that some people require more ablation lesions than others. The exact nature of the ablation procedure performed varies among patients.

What to Expect Before and After Ablation

Before the procedure, special cardiac imaging with either magnetic resonance imaging (MRI) or computerized tomography (CT) scanning can be useful to define the anatomy of the pulmonary veins. Precautions are taken to prevent blood clots from forming in the atria before, during, and after ablation. Warfarin is usually administered for a month or more before the ablation procedure and then stopped a few days before the procedure, and it is sometimes

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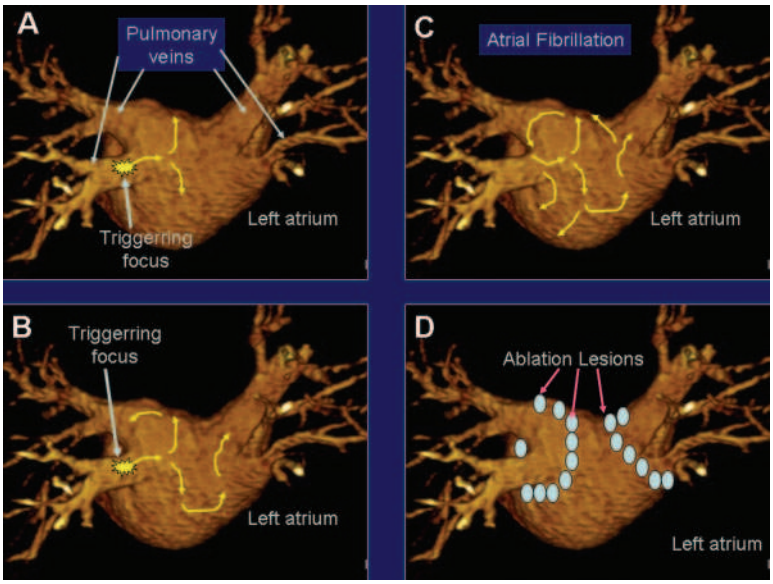

MRI of the left atrium as viewed from the patient's back and one mechanism hypothesized to result in AF. Pulmonary veins extend from each side of the atrium. A, A focus on one of the veins might fire and produce an electrical impulse (yellow arrows) that excites the rest of the atrium. B, With rapid firing, the electrical signals begin dividing as they circulate around the atrium. C, The focus is not firing, but the electrical impulses that it initiated continue to circulate around the atrium, producing atrial fibrillation. D, Location of ablation lesions (light blue circles) encircling the pulmonary veins on both sides of the atrium. These lesions prevent any triggers around the pulmonary veins from exciting the rest of the atrium and may interrupt paths needed for multiple impulses to circulate if they were to cause AF.

replaced with a shorter-acting injectable anticoagulant medication. Immediately before the procedure, a transesophageal echocardiogram may be performed to ensure there are no blood clots in the atria. The anticoagulant heparin is administered during the procedure.

During the procedure, the patient is sedated or under general anesthesia, so discomfort is minimal. Catheters are inserted through veins in the groin (and sometimes through veins in other areas such as the side of the neck) and guided into the right atrium. A long needle is used to make a small puncture in the wall (septum) between the right and left atria so that catheters can be inserted into the left atria, where most of the ablation is done. The ablation catheter is moved from point to point, cauterizing the desired areas. Catheter location is observed on x-ray (fluoroscopy), and computer mapping systems may be used to track the position of the catheter. The procedure may last 2 to 6 hours. Afterward, the catheters are removed, and the patient lies flat for several hours to prevent bleeding from the puncture sites. Mild pain and bruising in the groin area are not unusual; more severe bleeding occasionally occurs. Mild chest pain from inflammation caused by the ablation lesions usually resolves in a few days.

The swelling and inflammation produced by ablation lesions in the heart heal over the following weeks. During this period, some patients experience recurrent AF or other fast rhythms (atrial tachycardia or atrial flutter). As healing progresses, these arrhythmias usually resolve. Antiarrhythmic medications often are continued for the initial healing phase of the procedure. If rapid heart rhythms continue beyond several weeks, ablation failed to permanently damage some arrhythmia-causing regions. A second procedure to reablate these areas is needed in 10% to 50% of people.

When the procedure is successful, antiarrhythmic medications are stopped. Warfarin is usually the last medication to be stopped. AF does not always produce symptoms, and heart rhythm recordings may be needed to assess whether the AF is absent.

Benefits and Risks

The procedure is successful in maintaining sinus rhythm over the next year in approximately 30% to more than 90% of patients, depending on the type of AF and the severity of underlying disease. The success rate is low for patients who have had AF continuously for many years with serious underlying heart disease. Success rates are high in patients who have intermittent episodes of AF without other heart disease. In some patients, ablation does not completely prevent AF but improves symptoms by reducing the frequency and severity of episodes or by making drug treatment more effective.

The risk of a major, life-threatening complication such as stroke or puncture of the heart with bleeding that can require surgery is approximately 1% to 2%. Rarely, ablation may damage the esophagus, which is located behind the left atrium, leading to fatal bleeding or stroke several days after the procedure. Damage to the phrenic nerve can paralyze the diaphragm, causing shortness of breath. Severe narrowing (stenosis) of the pulmonary veins, which impedes blood flow from the lungs to the heart and can cause shortness of breath, cough, and pneumonia, is uncommon with present methods.

Is Catheter Ablation the Right Treatment Now?

Catheter ablation is relatively new. Whether sinus rhythm will last for more than a few years after successful ablation is not yet known. Whether it will extend life compared with other treatment options also is not known. Major complications are infrequent but can be life threatening. For these reasons, ablation usually is reserved for people with symptoms that adversely affect their quality of life. It is not usually considered for people with chronic AF who have no symptoms.

Ablation of AF has advanced dramatically over the past 5 years, and progress will continue. Future studies will help clarify benefits and long-term effects. It is hoped that better tools will make the procedure safer and more effective. Better surgical methods for ablation also are evolving. This leads many patients to question whether to have the procedure now or to wait for more progress. The downside of waiting is the concern that AF itself may cause electrical changes in the atria that may reduce the success of future ablation. For each person, the severity of symptoms, assessment of risks, and likelihood of success are major considerations in deciding whether ablation is the right treatment now.

Disclosures

Dr Stevenson is a consultant to and receives speaking honoraria from Biosense Webster, Inc. A. Ames reports no conflicts.

Additional Resources

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