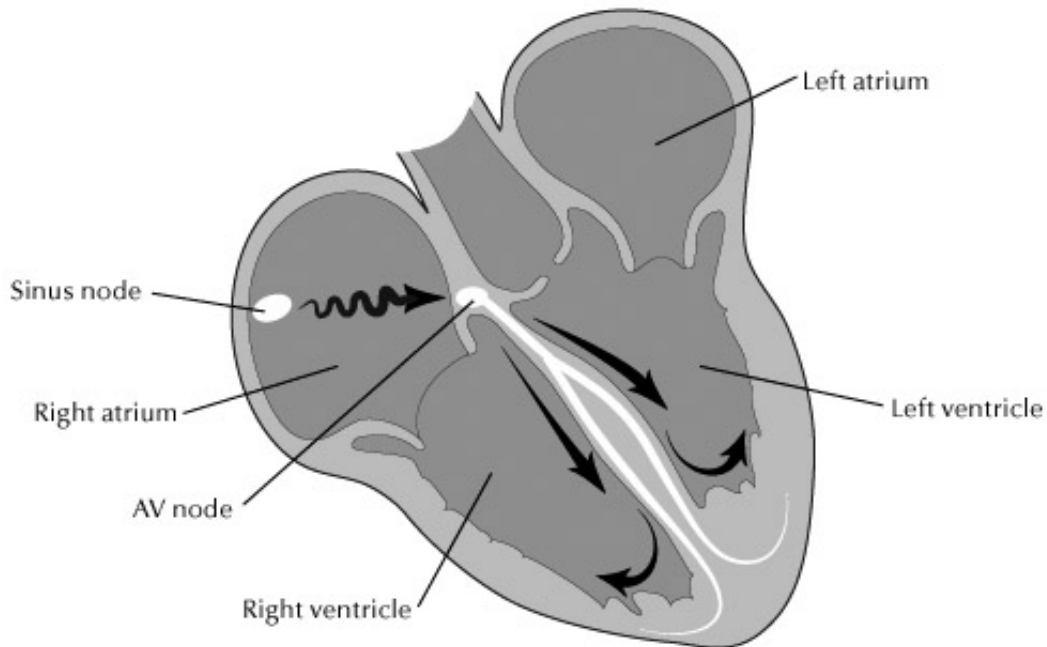


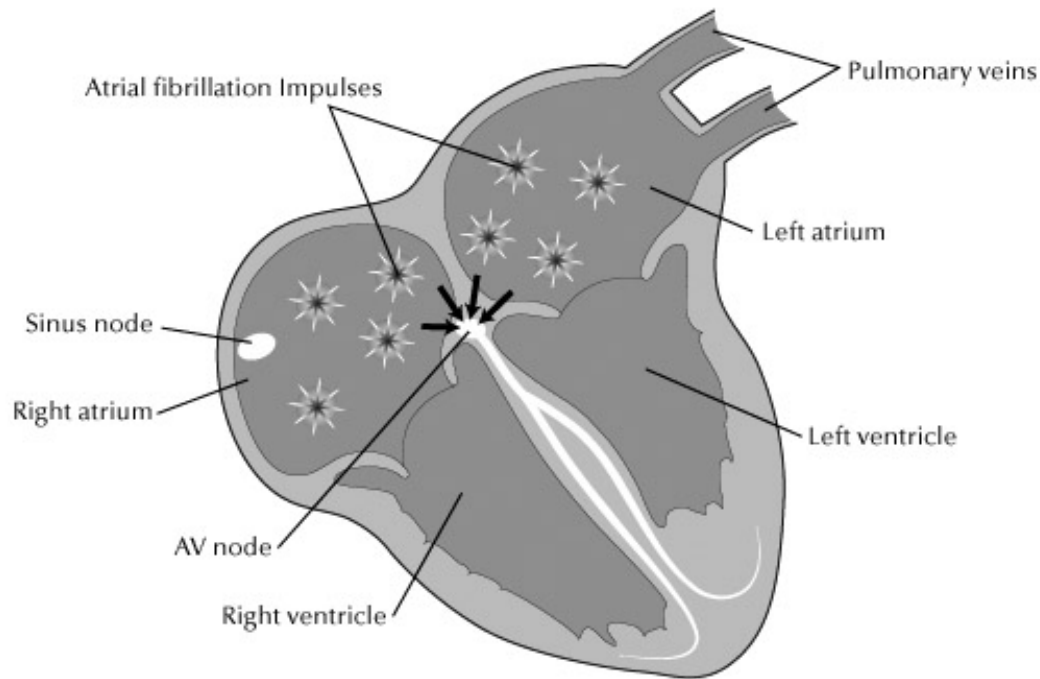
The Treatment Of Atrial Fibrillation
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What Is Atrial Fibrillation?

Atrial fibrillation is a heart rhythm disturbance that causes an irregular (and often rapid) heartbeat. It replaces the normal heartbeat, which originates in the sinus node (Figure 1).



During atrial fibrillation, the top chambers of the heart (the atria) lose their normal, organized electrical activity and develop a chaotic, unorganized rhythm that makes the bottom chambers (the ventricles) beat irregularly (Figure 2).



Atrial fibrillation often causes an erratic fluttering sensation in the chest, or palpitations. Atrial fibrillation makes the heart a less efficient pump, and this may result in symptoms of weakness, fatigue, dizziness, or shortness of breath. However, some patients who have atrial fibrillation are completely unaware of it, and have no symptoms at all.

Atrial fibrillation may be “paroxysmal” or “chronic.” Paroxysmal atrial fibrillation refers to atrial fibrillation that comes and goes on its own. The episodes may last anywhere from a few minutes to several hours, and sometimes several days. Chronic atrial fibrillation is the type of atrial fibrillation that persists once it comes on. In patients with chronic atrial fibrillation, treatment is necessary to restore a normal heart rhythm.

Because of the sluggish movement of blood through the atria during atrial fibrillation, there is a tendency for blood clots to form in some patients with atrial fibrillation. This can lead to complications such as stroke, even in patients who have otherwise been unaware that they had atrial fibrillation. For this reason, medications that thin the blood, such as aspirin or warfarin (Coumadin), are necessary for some patients with atrial fibrillation. Whether or not a blood thinner is needed depends on the particular circumstances of each individual patient.

Living With Atrial Fibrillation

Some individuals feel fine when they are in atrial fibrillation. This is more often the case in older patients who are not very active than in younger patients with active life-styles. If the atrial fibrillation is not causing any symptoms, sometimes the best course of action is to simply live with it, instead of receiving medications or other types of treatment in an attempt to restore a

normal heart rhythm. If the decision is made to live with the atrial fibrillation, medications may still be needed to prevent a rapid heart rate, and to prevent blood clots.

Treatment of Atrial Fibrillation With Medications

Besides the use of blood thinners, there are 2 types of medications that are used to treat atrial fibrillation. One type of medication is intended to prevent atrial fibrillation from occurring. This type includes medications such as propafenone (Rhythmol), flecainide (Tambocor), sotalol (Betapace), and amiodarone (Cordarone, or Pacerone). These same medications may restore the normal heart beat if taken during an episode of atrial fibrillation. The other type of medicine does nothing to restore the normal heart beat, but is intended simply to control the heart rate during atrial fibrillation. Prevention of a rapid heart beat during atrial fibrillation often makes the symptoms less severe. This type of medication includes digoxin (Lanoxin), beta-blockers such as atenolol (Tenormin), propranolol (Inderal), and metoprolol (Lopressor, or Toprol), and calcium channel blockers such as verapamil (Calan, or Isoptin), and diltiazem (Cardiazem).

Sometimes, both medications that prevent atrial fibrillation from occurring and medications that control the heart rate are necessary. In other patients, only one type of medicine may be needed, depending on the particular circumstances of a patient. Some patients may need to take the medications everyday. But in some patients who have infrequent episodes of atrial fibrillation, it may be sufficient to take the medication only when an episode of atrial fibrillation comes on.

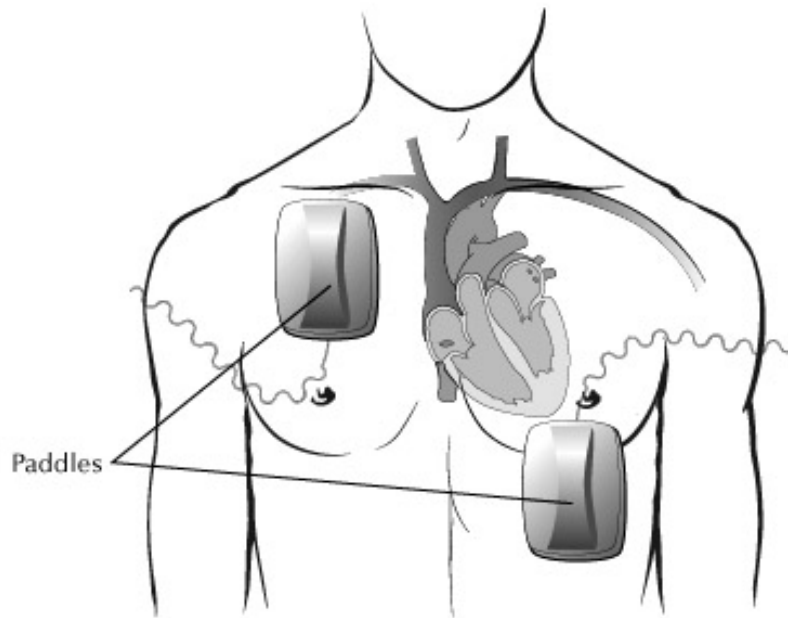
All of the medications that are used to treat atrial fibrillation may have side effects, and an adjustment of the dosage or a change to another medication is often necessary because of side effects.

There are some important points to keep in mind about medications:

1. Atrial fibrillation always eventually returns despite treatment with a medication. The goal of therapy is not to completely prevent atrial fibrillation, but to make the episodes as infrequent as possible.
2. Some medications have side effects that are more dangerous than the atrial fibrillation itself, depending on the particular circumstances of a patient. A particular medicine may be safe for some patients, and yet very dangerous for others.
3. Medications do not cure atrial fibrillation. If a patient who is responding well to a medication stops taking it, the atrial fibrillation will return.
4. Patients who are aware of the atrial fibrillation, with symptoms such as palpitations or weakness, may also have episodes that they are unaware of. Therefore, it is sometimes necessary to take a blood thinner everyday to prevent strokes even when a patient does not think that atrial fibrillation is occurring.

Electrical Cardioversion

Electrical cardioversion is a procedure in which an electric shock is delivered to the chest wall, in order to restore a normal heart rhythm in a patient with atrial fibrillation (Figure 3).



It is an effective and useful way to restore a normal rhythm, but only if the atrial fibrillation has not been present for a long time. If the atrial fibrillation has been present for more than a few months, there is a high probability that it will return shortly after cardioversion.

If there is a blood clot in the atria, cardioversion may cause the clot to leave the heart and travel to the brain or to some other part of the body. This can cause complications such as a stroke. Blood clots become a concern whenever atrial fibrillation has been present for more than 48 hours. Therefore, if the atrial fibrillation has been present for more than 48 hours, the blood must be thinned out before cardioversion. This requires taking warfarin before cardioversion, with at least 3 weeks of an INR (a blood test that indicates how thinned out the blood is) between 2 and 3. If quick cardioversion without waiting a few weeks is desired, this can be safely performed as long as a transesophageal echocardiogram shows that there are no blood clots in the heart. The blood still needs to be thinned out with warfarin for at least 1 month after cardioversion.

In some patients, medications to prevent a recurrence of atrial fibrillation may not be needed after cardioversion. But in many patients, medications are needed to prevent an early recurrence of atrial fibrillation after cardioversion.

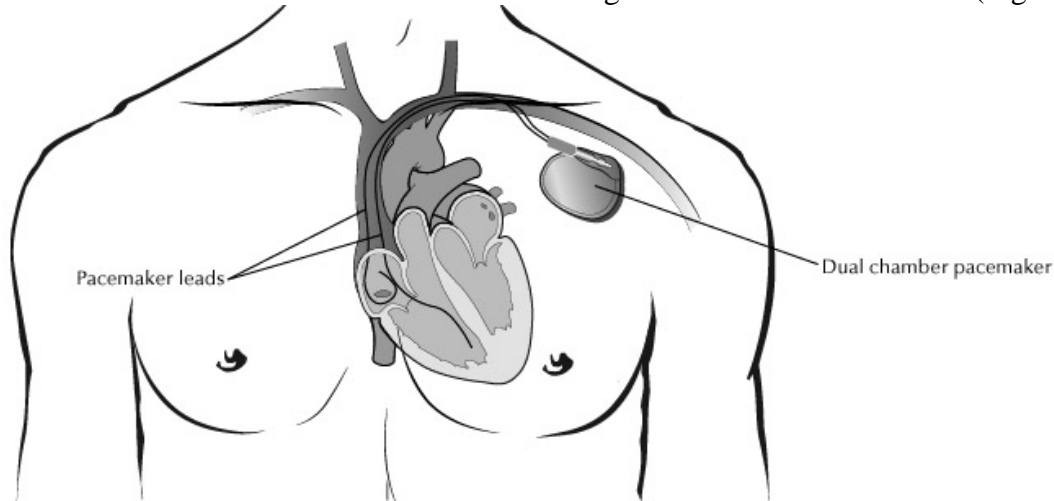
The following are some important points about electrical cardioversion:

1. Electrical cardioversion terminates an episode of atrial fibrillation and restores a normal heart rhythm, but does nothing to prevent the atrial fibrillation from returning. Therefore, it should not be considered a “cure” for atrial fibrillation.
2. “Atrial fibrillation begets atrial fibrillation.” In other words, the longer the atrial fibrillation has been present, the greater the tendency for it to return shortly after cardioversion. The best chance for maintaining a normal rhythm after cardioversion is when the atrial fibrillation has been present for less than 3-4 months.
3. In many patients, a return of atrial fibrillation after cardioversion is inevitable. The goal of treatment is to maintain a normal heart rhythm for as long as possible, (hopefully for as long as 1 year), realizing that the atrial fibrillation will eventually come back. If necessary cardioversion can be repeated many times, as long as the intervals of normal rhythm are at least 6 months.

4. Patients who can't tell whether or not atrial fibrillation is present may need to continue taking a blood thinner indefinitely after cardioversion. Otherwise a stroke may occur if atrial fibrillation returns and is undetected.

Pacemaker

A pacemaker is an electronic device that is implanted on the upper chest, under the skin. It is connected to 1 or 2 wires that are inserted through a vein and sit in the heart (Figure 4).



The pacemaker delivers painless electric pulses that stimulate the heart to beat. Pacemakers usually are implanted in patients whose heart beat is slower than it should be.

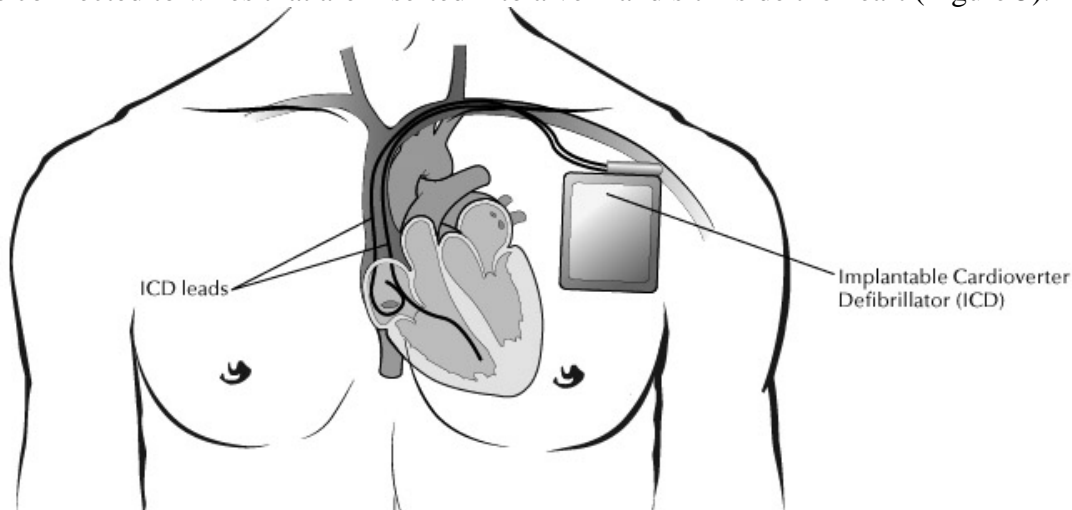
In most patients, a standard pacemaker does nothing to prevent or treat atrial fibrillation. However, there are 2 situations in which a standard pacemaker may be useful in patients with atrial fibrillation:

1. Some patients have a “sick sinus syndrome,” in which episodes of atrial fibrillation are separated by periods of a very slow heart rhythm. Because the medications that are used to treat atrial fibrillation will often aggravate the slow heart rhythms, a pacemaker may be useful by preventing the heart from slowing down and allowing medications for the atrial fibrillation to be used safely.
2. In some patients, atrial fibrillation comes on at rest or during sleep, when the heart beat slows to a rate of less than 50 beats per minute. This is referred to as “vagotonic” atrial fibrillation. A pacemaker sometimes can prevent this type of atrial fibrillation by maintaining a heart rate of at least 70 beats per minute at all times. However, even after a pacemaker is implanted, medications may still be needed to prevent atrial fibrillation from coming on.

A new type of pacemaker that is designed specifically for patients with atrial fibrillation is now available. This pacemaker stimulates the heart in a way that is designed to prevent episodes of atrial fibrillation, and also to quickly terminate an episode of atrial fibrillation by bursts of rapid stimulation. However, the success rate of this type of pacemaker for preventing and treating atrial fibrillation is fairly low, and therefore this type of pacemaker is not implanted unless a patient has a slow heart beat and needs a pacemaker anyway.

Automatic Defibrillator

The automatic defibrillator is a device that is implanted under the skin in the upper chest. It is connected to wires that are inserted into a vein and sit inside the heart (Figure 5).



An automatic defibrillator (commonly referred to as an “ICD”) is often implanted in patients who are at risk of life-threatening heart rhythm disorders arising in the bottom chambers of the heart (the ventricles). It monitors the heart rhythm and automatically delivers a shock inside the heart when a life-threatening heart rhythm disorder (ventricular tachycardia or ventricular fibrillation) occurs.

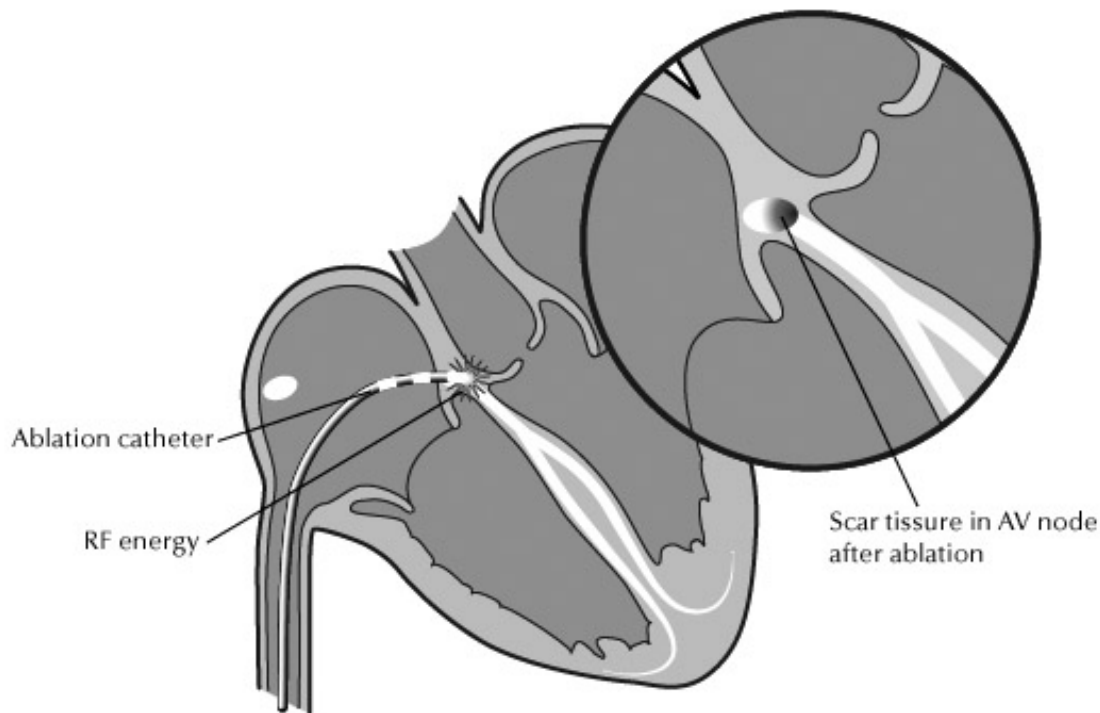
A few years ago, an automatic defibrillator designed to treat atrial fibrillation became available. It was not a popular form of therapy, because the shocks used to treat atrial fibrillation were painful. Furthermore, because atrial fibrillation may return shortly after a shock treatment (cardioversion), some patients were receiving frequent shocks. Therefore, at present, an automatic defibrillator designed to treat only atrial fibrillation is no longer available. However, an automatic defibrillator designed to treat life-threatening heart rhythm disorders and also atrial fibrillation is available. This type of device generally is suitable only in some patients with life-threatening ventricular tachycardia or ventricular fibrillation who also have occasional episodes of atrial fibrillation.

AV Node Ablation

In some patients with atrial fibrillation, medications are not effective in preventing episodes or in controlling the heart rate. Patients who have a rapid rate during atrial fibrillation are often troubled by uncomfortable palpitations, shortness of breath during exertion, dizziness, and exercise intolerance. Another bad effect of the rapid rate is that it can weaken the heart muscle after a few months.

AV node ablation is very effective at eliminating the rapid and irregular heart beat that may accompany atrial fibrillation. This procedure is performed only in patients who do not

respond to medications or cannot take them because of side effects. A catheter is inserted into a vein in the area of the groin and positioned near the AV node, a nerve that conducts electrical impulses from the top chambers to the bottom chambers of the heart (Figure 6).



Radiofrequency energy is passed through the catheter to destroy the AV node. This eliminates the rapid and irregular heart beats caused by atrial fibrillation. The pulse rate usually drops to 30 beats per minute, and a pacemaker must be implanted to maintain a normal heart rate. The pacemaker will increase the heart rate when the patient exercises. The procedure (including implantation of the pacemaker) takes about 3 hours to perform. The patient spends 2 nights in the hospital before going home.

AV node ablation has both advantages and disadvantages compared to other forms of treatment. The advantages are:

1. The procedure has a very high success rate (99%), and a very low risk of serious complications (less than 2%).
2. The procedure is usually very effective in alleviating the symptoms caused by a rapid and irregular heart rate.
3. A rapid heart rate can eventually weaken the heart muscle, and AV node ablation is very effective in preventing this.
4. AV node ablation eliminates the need for medications aimed at preventing atrial fibrillation, and also medications aimed at controlling the heart rate.

The disadvantages of AV node ablation are:

1. The patient becomes dependent on a pacemaker for the rest of his/her life.

2. AV node ablation does not cure the atrial fibrillation. Although the pulse is normal, atrial fibrillation is still present in the top chambers, and there may still be a need for a blood thinner to prevent strokes.
3. Although the heart functions much more efficiently after AV node ablation than when the heart rate is rapid and irregular, it does not function as efficiently as when atrial fibrillation is not present. Therefore, although a patient's energy level improves after AV node ablation, it may not become totally normal.

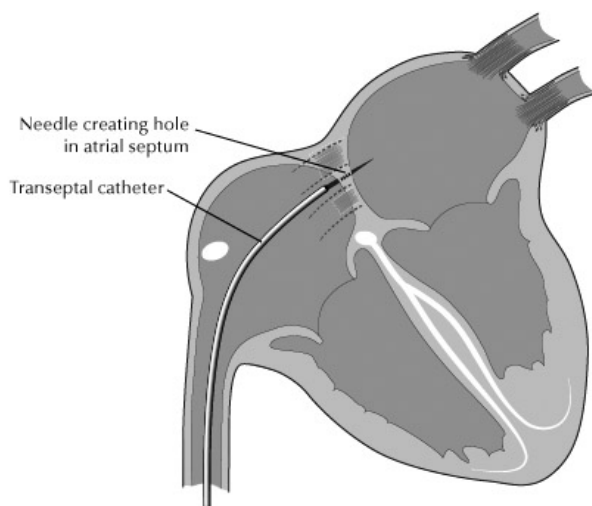
Left Atrial Radiofrequency Catheter Ablation

Left atrial radiofrequency catheter ablation is a catheter technique intended to cure atrial fibrillation without major surgery. Using a specially designed catheter that is positioned in the left atrium, radiofrequency energy is applied to the heart muscle to cauterize the “short circuits” that are generating the atrial fibrillation. This type of procedure may be effective for either paroxysmal or chronic atrial fibrillation. However, it is unlikely to be effective if the left atrium is very enlarged.

A special type of X-ray examination (CT scan) may be performed before the ablation procedure, because it provides a 3-dimensional view of the left atrium and the veins that attach to it.

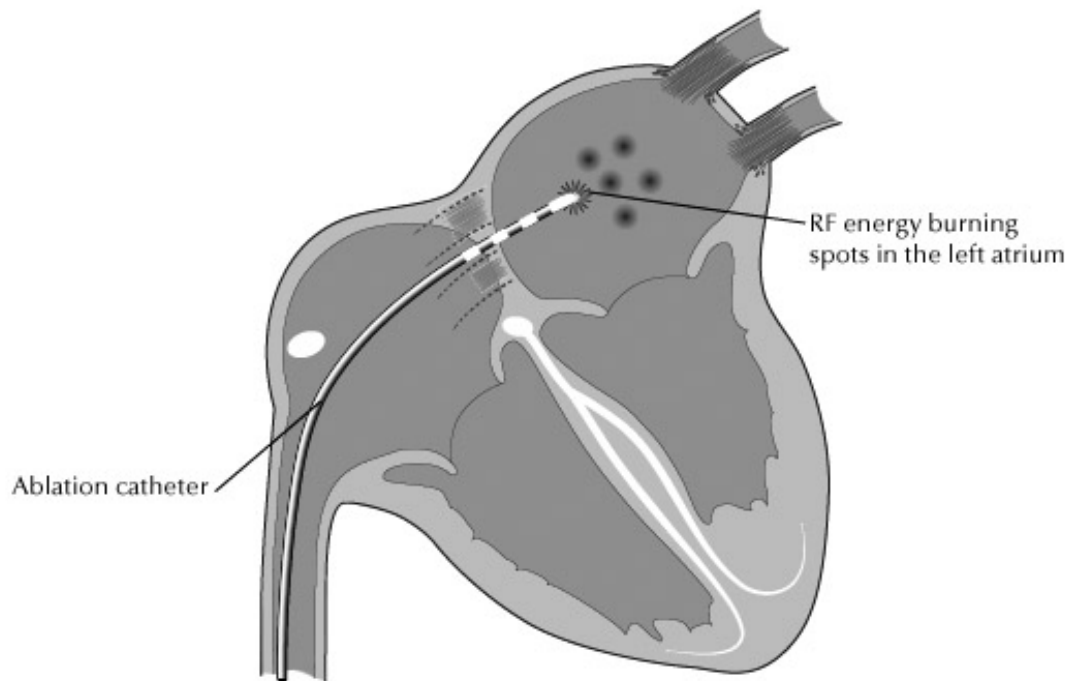
In some patients, a transesophageal echocardiogram is performed immediately before the ablation procedure, to make sure that there are no blood clots in the left atrium. After a sedative is administered, a small tube is passed down the esophagus (the connection between the mouth and the stomach) to visualize the left atrium. If a blood clot is seen, the ablation procedure would be postponed until the clot has dissolved.

For the ablation procedure, the right groin is numbed with a local anesthetic, and a sedative is administered to induce sleep. Catheters are inserted with a needle into a vein that runs up to the heart. The left atrial ablation procedure requires the insertion of a catheter into the left atrium. This is accomplished by “transeptal catheterization,” in which a small hole is purposely made with a needle that is pushed through the wall that separates the 2 top chambers of the heart (Figure 7).



The correct position of the needle usually is confirmed visually with a tiny echo (ultrasound) probe that is on the end of a catheter positioned within the heart, and this makes transeptal catheterization a safe procedure. The catheter is visualized with an X-ray camera (fluoroscopy) that emits a low level of radiation.

A computerized, 3-dimensional mapping system is used to guide the procedure. The catheter and the left atrium are visualized on the computer screen, and this makes it possible to guide the catheter very precisely. The 3-dimensional mapping system also cuts down on the amount of X-ray needed during the procedure. By recording the electrical activity inside the heart, the short circuits that are generating the atrial fibrillation can be identified, and these spots are cauterized with the radiofrequency energy (Figure 8).



In a typical patient, between 100 and 200 different spots need to be cauterized to eliminate the atrial fibrillation.

Certain portions of the left atrium are very sensitive to the radiofrequency energy, and the applications of radiofrequency energy may cause chest pain. Your comfort level will be closely monitored during the procedure by a nurse, and medications are used to keep you comfortable. These medications usually cause amnesia for all or most of the procedure, so that there is little or no memory of the discomfort.

The entire left atrial ablation procedure takes 3-4 hours to perform, including the time needed to prepare for the procedure and to remove the catheters from the body.

After the procedure, the patient spends one night in the hospital before being discharged. Heparin (an intravenous blood thinner) is infused overnight to prevent blood clots from forming in the left atrium after the procedure. In addition, warfarin is used to keep the blood thin for 3 months after the procedure, until the inner lining of the heart has healed from the effects of the radiofrequency energy. Warfarin (Coumadin) usually takes about 5 days to become fully effective. Therefore, an injectable form of heparin (Lovonox) is self-administered for 5 days

after discharge, as a precaution against blood clots. Patients are instructed on how to inject themselves with the tiny needle that is used to deliver the heparin under the skin.

Because the ablation procedure itself may temporarily irritate the heart and cause atrial fibrillation, patients often are treated with a medication to suppress atrial fibrillation for 2-3 months afterwards. When atrial fibrillation has been chronic, the heart develops a “memory” for the atrial fibrillation, and there is a strong tendency for the atrial fibrillation to recur in the first 3 months after a normal rhythm is restored. To stabilize the heart rhythm during the first 3 months after left atrial ablation, patients often are treated temporarily with medications to help maintain a normal rhythm.

Despite being treated with medications, many patients experience episodes of atrial fibrillation during the first 3 months after left atrial catheter ablation. This is because it may take 3 months for the full effect of the procedure to occur. The scars that are created by the radiofrequency energy may take up to 3 months to fully develop, and some patients may have atrial fibrillation during this healing phase that eventually goes away.

More than 3,000 ablation procedures aimed at curing atrial fibrillation have been performed at the University of Michigan over the past few years. We have found that the success rate of left atrial ablation in patients with atrial fibrillation depends on whether the atrial fibrillation is paroxysmal or chronic. In the case of paroxysmal atrial fibrillation (the kind that comes and goes on its own), the atrial fibrillation can be eliminated in approximately 70% of patients with a single procedure. When the procedure is repeated in patients who still have atrial fibrillation after the 1st procedure, the overall success rate increases to approximately 85%. In the case of chronic atrial fibrillation (the kind that has been present consistently for several months to years), the atrial fibrillation can be eliminated in approximately 60% of patients with a single procedure and if the procedure is repeated in patients who still have atrial fibrillation after the 1st procedure, the overall success rate increases to approximately 75%.

The risks of left atrial ablation include: 1) 1% risk of a catheter puncturing a wall of the heart. If the catheter punctures the heart, blood leaks out through the hole and fills the membrane sac that surrounds the heart. This interferes with the pumping action of the heart and requires that the blood be drained out. This is accomplished by placing a drain through the front of the chest into the sac that surrounds the heart. A patient usually must stay in the hospital for 4-5 days if this complication occurs; 2) a 1% risk of a blood clot traveling from the heart to the brain or to some other part of the body. Blood tends to clot whenever it comes into contact with a foreign body. This can happen with the catheters that are used for left atrial ablation. To prevent blood clots from forming, a strong blood thinner (heparin) is used during the procedure. However, a blood clot sometimes forms even though the blood has been thinned; 3) less than a 1% risk of pulmonary vein stenosis. If the radiofrequency energy is delivered inside of a pulmonary vein, it can cause the vein to scar down, obstructing blood flow from the lungs into the heart. This can cause shortness of breath. The risk of this complication is very small, because radiofrequency energy is not delivered inside the pulmonary veins during left atrial ablation; 4) a very small risk of death. There has been one patient out of 3,000 who died as a result of the procedure. In this patient, the radiofrequency energy burned through the back of the heart into the esophagus (the food tube that runs from the throat to the stomach, behind the heart). One other patient also experienced damage to the esophagus, but this patient was operated upon and survived. To avoid damage to the esophagus from the radiofrequency energy, we now have the patient swallow a small amount of barium paste at the beginning of the procedure. The barium allows us to see

with X-rays where the esophagus is. We can then avoid using the radiofrequency energy to burn any spots in the heart that are near the esophagus.

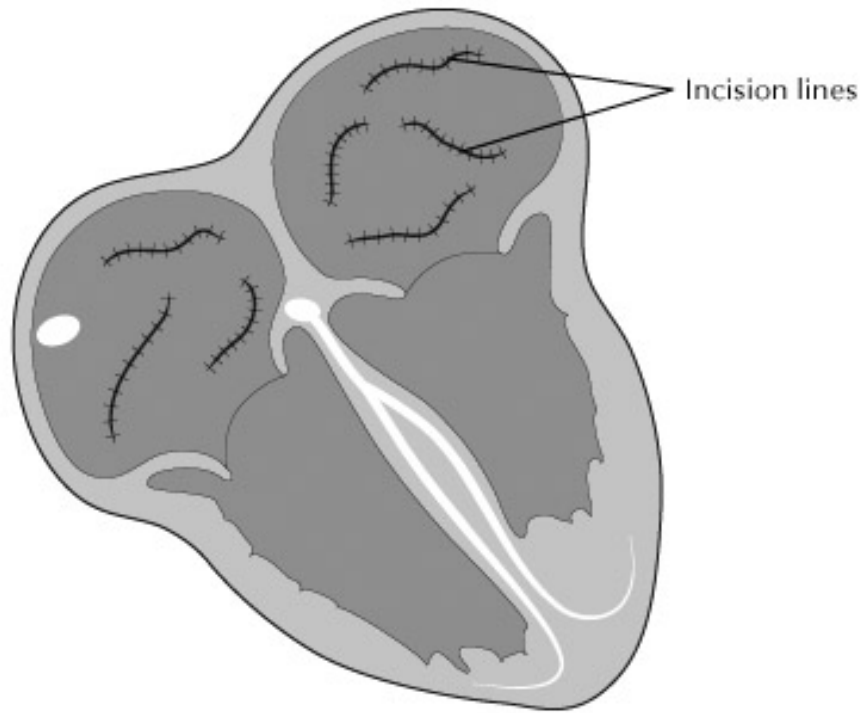
In addition to these complications, in about 15% of patients, left atrial ablation may create a new “short circuit” that may cause a rapid heart beat referred to as “left atrial flutter.” If this occurs, the patient is treated temporarily with medications. The left atrial flutter usually goes away on its own within 3-4 months, but it may take up to 6 months before it goes away. In about 10% of patients, the left atrial flutter does not go away on its own and another catheter ablation procedure is needed to eliminate the flutter.

Typical Atrial Flutter

Some patients with paroxysmal atrial fibrillation also have right atrial flutter. Right atrial flutter results from a “short circuit” in the right atrium and causes symptoms that are very similar to the symptoms of atrial fibrillation. Most patients cannot tell the difference between atrial fibrillation and atrial flutter. Radiofrequency energy can be used to cure right atrial flutter, with a 95% success rate, and with a very low risk (less than 1%) of complications. In patients who have both atrial fibrillation and right atrial flutter and who undergo left atrial ablation to cure the atrial fibrillation, catheter ablation to eliminate the right atrial flutter often can be performed during the same session. However, to avoid an overly lengthy procedure, a 2nd procedure on another day is sometimes necessary to eliminate the right atrial flutter.

Open-Heart Surgery

There is an open-heart operation that can eliminate atrial fibrillation, whether paroxysmal or chronic. The operation is often referred to as a “Maze operation.” The incision used for the operation usually is in the center of the chest and goes through the top to the bottom of the breastbone (the sternum). A heart-lung bypass machine is used to maintain the circulation during the operation. The surgeon uses a combination of incisions, freezing (with a cryoprobe), and cauterization (with a radiofrequency energy probe) to destroy the “short circuits” that generate atrial fibrillation (Figure 9).



When performed by an experienced surgeon, the operation eliminates atrial fibrillation in about 95% of patients. The duration of hospitalization is usually about 1 week, and most patients can return to work within 1-2 months. Patients undergoing this operation are exposed to the risks and discomfort of open-heart surgery. Because of these drawbacks, the operation is most suitable for patients who already require open-heart surgery for another type of problem, such as a leaky heart valve.

In patients whose only problem is atrial fibrillation, a “mini-Maze” operation has been developed. In this type of operation, the chest incisions are small and the surgeon uses special tools to destroy the areas of the heart generating the atrial fibrillation. The long-term success rate of the mini-Maze operations has not yet been clearly established.