

# Mechanism of Pacemaker in Heart

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**Abstract-** A healthy heart has a steady, regular rhythm, but in some people this rhythm can be disrupted. This condition is called arrhythmia. Arrhythmias can have many types and causes, and a PPM is not needed for all arrhythmias. Your doctor will consider the type of arrhythmia you have, how it makes you feel, and any health problems you might have before deciding if you need a PPM. A pacemaker is a small device that sends electrical impulses to the heart muscle to maintain a suitable heart rate and rhythm. If your heart is having trouble maintaining its own rhythm, you need a pacemaker. A permanent pacemaker (PPM) is a small device that is inserted under the skin of your chest to help the heart beat in a regular rhythm. PPMs have two parts: a small battery-powered pacemaker and leads that are connected to your heart. It sits under the skin on the left or right side of your upper chest. The pacemaker sends electrical signals to your heart to keep it pumping at a normal rate. A pacemaker is a small, battery-operated, computer-driven device that's typically implanted just beneath your skin, usually in the chest area right under the collarbone. Small wires (electrodes) connect the pacemaker to your heart. When the pacemaker's computer senses an abnormal rhythm, it sends electrical signals through the attached electrodes to your heart, jump-starting it back into an appropriately timed beat. A pacemaker can be programmed to act during episodes of bradycardia (an excessively slow beat), atrial fibrillation (a fast, fluttery heart rhythm), or cardiac arrest (cessation of the beat altogether).

## Description:

The heart is a pump responsible for maintaining blood supply to the body. It has four chambers. The two upper chambers (the right atrium and left atrium) are the chambers that receive blood as it returns from the body via the veins. The lower chambers (the right and left ventricle) are the chambers responsible for pumping the blood out to the body via the arteries. Like any pump, the heart has an electrical system that controls how it functions.

## Normal heart rhythm.

In order for the heart to do its work (pumping blood throughout the body), it needs a sort of spark plug or electrical impulse to generate a heartbeat. Normally this electrical impulse begins in the upper right chamber of the heart (in the right atrium) in a place called the sino-atrial (SA) node. The SA node is the natural pacemaker of the heart. The SA node gives off electrical impulses to generate a heartbeat in the range of 60 to 100 times per minute. If you are exercising, doing strenuous work or are under stress, your heart rate will be faster. When you rest or sleep your heart rate will slow down. If you take certain medications, your heart rate may be slower.

From the Sinus Node, the electrical impulse is relayed along the heart's conduction system. It spreads throughout both the right and left atria causing them to contract evenly. When the impulse spreads over the right atrium it reaches the atrio-ventricular (AV) node. This is a very important structure in the heart because it is the only electrical connection between the top chambers and the bottom chambers. It is therefore the only way in which an electrical impulse can reach the pumping chambers (the ventricles). The impulse spreads through the AV node and down into the lower chambers or ventricles of the heart. This causes them to contract and pump blood to the lungs and body.

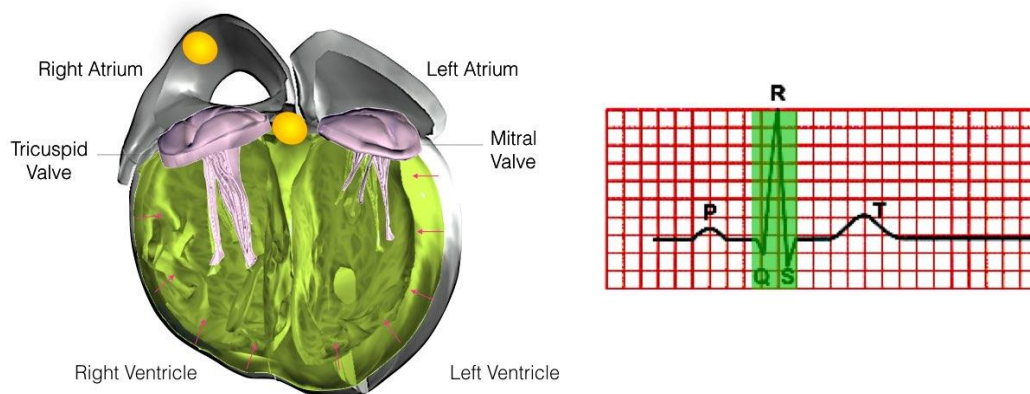


Fig-1

In some people the electrical system of the heart may stop working properly. This can occur in a number of different ways. Sometimes the SA node fails to make enough impulses and the heart slows down and even pauses. This is sometimes called “**sick sinus syndrome**”. On other occasions, even though the SA node is making enough impulses, there are problems with either the AV Node, or the left and right bundle branches. When this happens, the impulses are not conducted down into the pumping chambers. This is termed “**heart block**” (This doesn’t mean there are blockages in arteries but rather in the electrical system). This will also cause the heart to slow down or pause.

When the heart slows down or pauses symptoms may include tiredness, breathlessness or lightheadedness.

However, commonly when the heart pauses, you will experience dizziness or actually pass out and collapse. You may experience very little or no warning prior to collapsing

Normally, the heart is signaled to contract, or squeeze, by an electrical impulse that starts in the sinus node at the top of the right atrium. The impulse then travels through the heart's "wires," to the muscles of the lower chambers of the heart (right and left ventricles), telling them to contract and cause a heartbeat. This natural system helps the heart pump in an efficient rhythm.

A problem with any part of this system, though - either the heart's natural "pacemaker" or the wires carrying the impulses - can cause a slow heart rate.

An artificial pacemaker may be needed to reset the heart to the right pace and make sure blood and oxygen are pumped to the brain and other parts of the body.

A healthy heart has a steady, regular rhythm, but in some people this rhythm can be disrupted. This condition is called arrhythmia. Arrhythmias can have many types and causes, and a PPM is not needed for all arrhythmias. Your doctor will consider the type of arrhythmia you have, how it makes you feel, and any health problems you might have before deciding if you need a PPM. A pacemaker is a small device that sends electrical impulses to the heart muscle to maintain a suitable heart rate and rhythm. A pacemaker may also be used to treat fainting spells (syncope), congestive heart failure, and, rarely, hypertensive cardiomyopathy. It is implanted just under the skin of the chest during minor surgery. The healthy heart has its own pacemaker that regulates the rate at which the heart beats. A pacemaker is a small device that helps maintain a healthy heart beat using electrical impulses. It consists of a battery and leads, and it sits under the skin on the left or right side of your chest. The pacemaker sends electrical signals to your heart to help it to beat at a normal rate. The heart has its own pacemaker that regulates the rate at which it beats. But some hearts don't beat regularly, a problem called arrhythmia. Often, a pacemaker device can correct it.

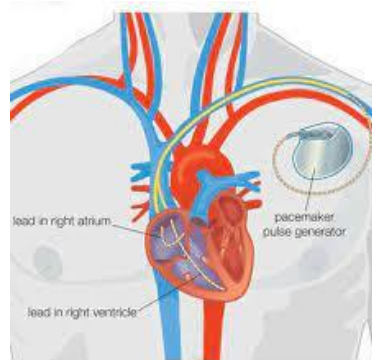


Fig-2 Pacemaker

The pacemaker has two parts: the leads and a pulse generator. The pulse generator houses the battery and a tiny computer, and resides just under the skin of the chest. The leads are wires that are threaded through the veins into the heart and implanted into the heart muscle. They send impulses from the pulse generator to the heart muscle, as well as sense the heart's electrical activity.

Each impulse causes the heart to contract. The pacemaker may have one to three leads, depending on the type of pacemaker needed to treat your heart problem.

### Heart Rhythm Disorders

Millions of people experience irregular or abnormal heartbeats, called arrhythmias, at some point in their lives. Most of the time, they are harmless and happen in healthy people free of heart disease. However, some abnormal heart rhythms can be serious or even deadly. Having other types of heart disease can also increase the risk of arrhythmias.

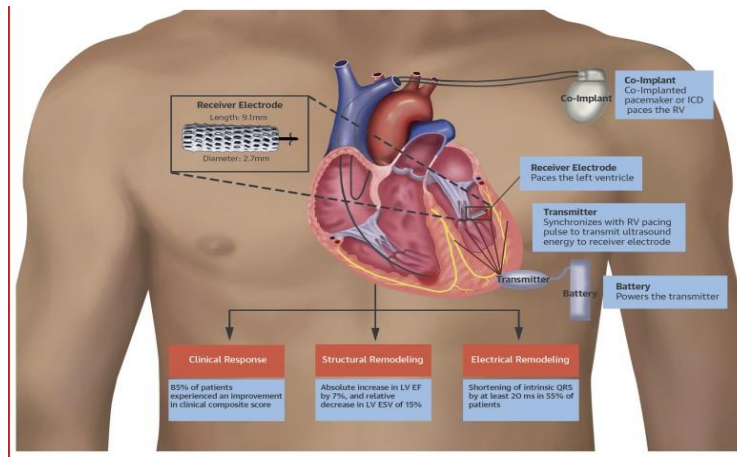


Fig-3 Mechanism

**Pediatrics and Congenital Heart Disease (CHD)**

This section is for pediatric patients and families living with heart rhythm disorders and heart rhythm disorders related to congenital heart disease (CHD).

**Early Warning Signs**

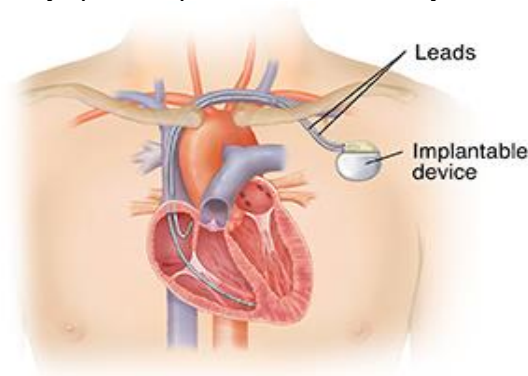
If you are experiencing a racing, pounding, rumbling or flopping feeling in your chest or if you have been fainting, having repeated dizzy spells, feeling lightheaded or you are extremely fatigued, it's time to see a doctor to discuss your heart health.

**Common Treatments**

Learning about the underlying cause of any heart rhythm disorder provides the basis for selecting the best treatment plan. Information and knowledge about care options, and their risks and benefits help you work with your health care provider to make the best choices.

**Lifestyle**

Since other heart disorders increase the risk of developing abnormal heart rhythms, lifestyle changes often are recommended. Living a "heart healthy" lifestyle can ease the symptoms experienced with heart rhythm disorders and other heart disorders, and can be



beneficial to overall patient health.

Fig-4 implantable device

**The Normal Heart**

The heart is a fist-sized muscle that pumps blood through the body 24 hours a day, 365 days a year, without rest. The normal heart is made up of four parts: two atria on the top of the heart (right atrium and left atrium), and two ventricles (right ventricle and left ventricle) which are the muscular chambers on the bottom of the heart that provide the major power to pump blood.

**Types of Pacemakers**

There are different types of pacemakers:

- Single chamber pacemakers use one lead in the upper chambers (atria) or lower chambers (ventricles) of the heart.
- Dual-chamber pacemakers use one lead in the atria and one lead in the right ventricle of your heart.
- Biventricular pacemaker uses three leads: one placed in the right atrium, one placed in the right ventricle, and one placed near the left ventricle.

The doctor will program your minimum heart rate. When your heart rate drops below that set rate, your pacemaker generates (fires) an electrical impulse that passes through the lead to the heart muscle. This causes the heart muscle to contract, creating a heartbeat. If your heart is having trouble maintaining its own rhythm, you may need one. Your doctor will do tests to find out for sure.

Pacemakers are usually used to treat the following:

Bradycardias. These are slow heart rhythms that may arise from disease in the heart's electrical conduction system (such as the SA node, AV node or HIS-Purkinje system).

Heart failure. This device is called cardiac resynchronization therapy (CRT) or biventricular pacing.

#### **Pacemakers are implanted two ways:**

- **Endocardial approach.** This is the most common technique used.
  - This procedure is done in a pacemaker or electrophysiology lab.
  - A local anesthetic (pain-relieving medication) is given to numb the area. A cut is made in the chest where the leads and pacemaker are inserted.
  - The lead(s) is inserted through the incision and into a vein, then guided to the heart with the aid of a fluoroscopy machine.
  - The lead tip attaches to the heart muscle, while the other end of the lead (attached to the pulse generator) is placed in a pocket created under the skin in the upper chest.
- **Epicardial approach.** This is more commonly used in children.
  - This procedure is done by a surgeon in a surgical suite. General anesthesia is given to put you to sleep.
  - The surgeon attaches the lead tip to the heart muscle, while the other end of the lead (attached to the pulse generator) is placed in a pocket created under the skin in the abdomen.
  - Although recovery with the epicardial approach is longer than that of the other approach, minimally invasive techniques have enabled shorter hospital stays and quicker recovery times.

The endocardial pacemaker takes about 1-2 hours to implant.

#### **Precaution:**

1. Do not lift objects that weigh more than 10 pounds.
2. Do not hold your arms above shoulder level for 3 weeks.
3. Avoid activities that require pushing or pulling heavy objects, such as shoveling the snow or mowing the lawn.
4. Stop any activity before you become overtired.
5. For 6 weeks after the procedure, avoid golfing, tennis, and swimming
6. Try to walk as much as possible for exercise
7. Ask your doctor when you can resume more strenuous activities.
8. Your doctor will tell you when you can go back to work, usually within a week after you go home. If you can, ease back to your regular work schedule.

Pacemaker surgery is generally safe, but problems do happen.

- Increased swelling, bleeding, bruising, or infection near the site
- Blood vessel or nerve damage
- A collapse lung
- Reaction to any medicine used during the surgery

#### **Avoid certain thing**

- Electric blankets, heating pads, and microwave ovens can be used and will not interfere with the function of your pacemaker.
- A cellphone should be used on the side opposite of where the pacemaker was implanted.
- Cellphones should not be placed directly against the chest or on the same side as your pacemaker.
- You will need to avoid strong electric or magnetic fields, such as: some industrial equipment; ham radios; high intensity radio waves (found near large electrical generators, power plants, or radio frequency transmission towers); and arc resistance welders.
- Do not have any tests that require magnetic resonance imaging (MRI) unless you have been told that you have an MRI-compatible pacemaker.
- When going through airport security, show your pacemaker card without going through the screening machine because the pacemaker will set off the security alarms.
- Your doctor or nurse can provide more information about what types of equipment may interfere with your pacemaker

#### **Difference between a pacemaker (PPM) and implantable cardioverter defibrillator (ICD)**

A pacemaker and an implantable cardioverter defibrillator (ICD) perform different functions, but both are devices with a battery and leads that go into the heart. A pacemaker sends a regular, electrical signal to make the heart beat, while an ICD sends an electrical shock to the heart to reset an abnormal heart rhythm in an emergency.

Arrhythmias can have many causes, including:

- The natural ageing process
- Inherited or genetic causes
- Previous heart attack or heart valve or heart muscle problems

You should be able to return home in most circumstances within 24-48 hours.

Artificial pacemakers are devices that are implanted into the body, usually just below the collarbone, to take over the job of the heart's own electrical system and prevent slow heart rates.

Although they weigh only an ounce and are the size of a large wrist watch face, a pacemaker contains a computer with memory and electrical circuits, a powerful battery (generator), and special wires called "leads." The generator creates electrical impulses that are carried by the leads to the heart muscle, signaling it to pump.

**Rate Responsive Pacemakers** adjust the heart rate to a patient's level of activity. They pace faster when a patient is exercising and slower when a patient is resting.



**Antitachycardia Pacemakers** can detect and treat atrial arrhythmias with overdrive pacing.

Pacemakers are used to treat abnormally slow heart beats. They may be prescribed for a number of conditions, including:

**Bradycardia** A condition in which the heart beats too slowly, causing symptoms such as fatigue, dizziness or fainting spells.

**Atrialfibrillation(AFib)**

A common heart rhythm disorder in which the heart beats too fast and chaotically. Sometimes, people with AFib can also have slow rhythms. Medications used to control atrial fibrillation may result in slow rhythms, which are treated by pacemakers.

**HeartFailure**

A condition in which the heartbeat is not strong enough to carry a normal amount of blood and oxygen to the brain and other parts of the body. A special pacemaker can be programmed to increase the force of heart muscle contractions. This is called "biventricular pacing or "resynchronization" therapy.

**Syncope**

A condition best known as "fainting," usually not serious. Some patients faint when their heart rate becomes too slow. A pacemaker prevents slow heart rates and can cure syncope in some patients.

Your heart relies on electrical signals (neurotransmitters) from your brain as well as structures within the heart itself to maintain the pumping action required to circulate blood throughout your body. Normally, your heart beats about 100,000 times a day at a steady rate and rhythm of 90-110 beats per minute. Irregular beats (arrhythmias) and conditions like heart failure or heart block can interfere with the heart's rhythmic beat; this, in turn, results in insufficient blood for your muscles, brain, and other vital organs and bodily structures.

A pacemaker is a small, battery-operated, computer-driven device that's typically implanted just beneath your skin, usually in the chest area right under the collarbone. Small wires (electrodes) connect the pacemaker to your heart.

When the pacemaker's computer senses an abnormal rhythm, it sends electrical signals through the attached electrodes to your heart, jump-starting it back into an appropriately timed beat.

A pacemaker can be programmed to act during episodes of bradycardia (an excessively slow beat), atrial fibrillation (a fast, fluttery heart rhythm), or cardiac arrest (cessation of the beat altogether).

*Dual-chamber pacemaker*

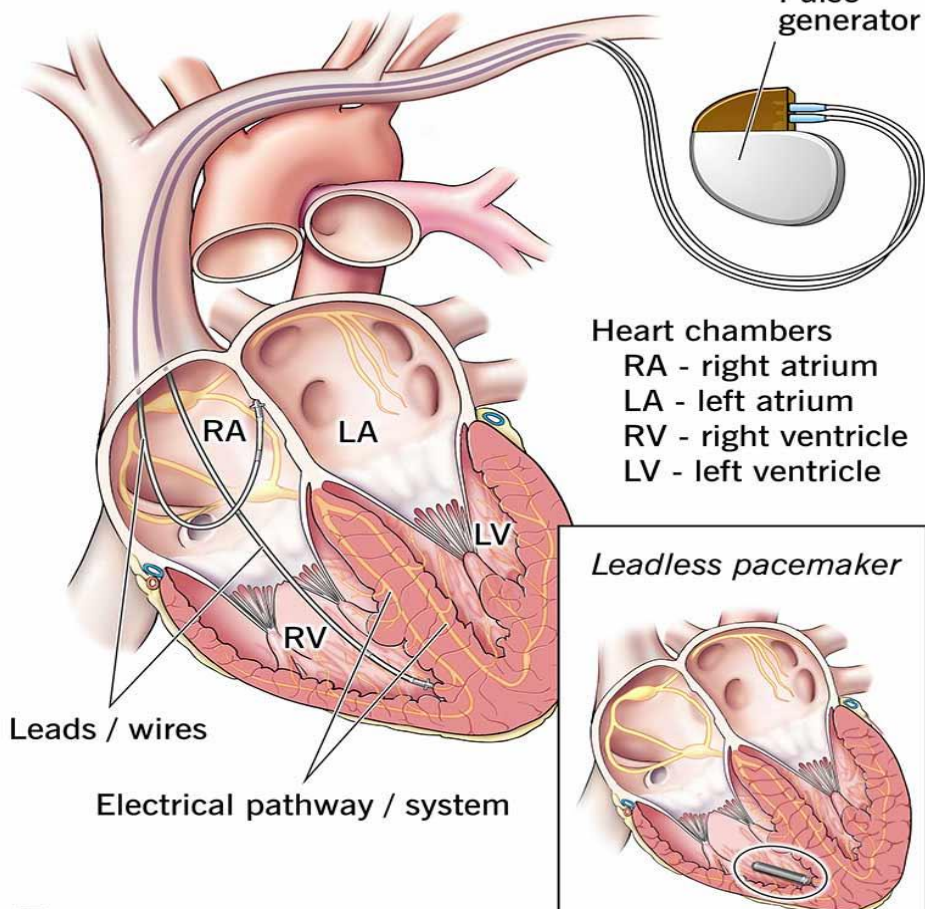


Fig-5 Leads and Leadless pacemaker

In the case of congestive heart failure (CHF), a special pacemaker, known as a “biventricular pacemaker,” can also be used to help increase your heart’s ejection fraction (pumping force), which is often severely compromised by CHF.

Symptoms that may indicate the need for further cardiac evaluation and possible pacemaker treatment include one or more of the following:

- An overall sense of fatigue that makes it difficult to complete even simple daily tasks
- Dizziness and lightheadedness that may occur only with standing or become relatively constant
- Muscle weakness in your arms and/or legs
- Shortness of breath that may occur with light physical activity or no activity at all
- Feeling of mental confusion, due to lack of oxygenated blood to the brain
- Sensation that your heart is fluttering or pounding
- Pulse rate under 90

Persistent edema/swelling in the feet/ankles, legs, and/or abdomen, which are symptoms of CHF, can also signal the need for treatment that may include a pacemaker. Usually the discomfort and swelling from the wound settles gradually over several weeks. If the wound becomes increasingly tender reddened and swollen or you have any other concerns

Although most people undergoing defibrillator implantation do not experience any complications, you should be aware of the following risks:

- Haematoma (large bruise) – this may occur at the pacemaker insertion site. This may be uncomfortable and can take several weeks to settle.
- Pneumothorax –During the procedure it is necessary to insert the pacemaker leads into your heart via a small vein under the collar-bone. This vein runs very close to the lung and there is a small chance that a small hole could be inadvertently made in the lung (Pneumothorax). Should this occur, it would usually heal by itself. However, occasionally a small tube may need to be inserted to drain out the air. This can be uncomfortable and means spending several extra days in hospital.
- Lead Dislodgment. – Although a great deal of care is taken in placing the pacemaker leads inside your heart, occasionally one of them moves and will need to be repositioned. This usually occurs in the first 24 hours after the procedure and is detected by testing the pacemaker.
- Infection – There is a very small chance that the pacemaker will develop an infection. Should this occur, it is usually necessary to remove the pacemaker in order to clear the infection.
- Cardiac perforation – Very rarely, one of the leads can make a small hole in the heart causing blood to accumulate around the heart. If this occurs the problem will be dealt with immediately. This is a very rare occurrence.

Others Names of Pacemaker

Cardiac pacemaker implantation; Artificial pacemaker; Permanent pacemaker; Internal pacemaker; Cardiac resynchronization therapy; CRT; Biventricular pacemaker; Arrhythmia - pacemaker; Abnormal heart rhythm - pacemaker; Bradycardia - pacemaker; Heart block - pacemaker; Mobitz - pacemaker; Heart failure - pacemaker; HF - pacemaker; CHF- pacemaker

pacemakers weigh as little as 1 ounce (28 grams). Most pacemakers have 2 parts:

- The generator contains the battery and the information to control the heartbeat.
- The leads are wires that connect the heart to the generator and carry the electrical messages to the heart.

A pacemaker is implanted under the skin. This procedure takes about 1 hour in most cases. You will be given a sedative to help you relax. You will be awake during the procedure.

A small incision (cut) is made. Most often, the cut is on the left side (if you are right handed) of the chest below your collarbone. The pacemaker generator is then placed under the skin at this location. The generator may also be placed in the abdomen, but this is less common. A new "leadless" pacemaker is a self-contained unit that is implanted in the right ventricle of the heart.

Pacemakers may be used for people who have heart problems that cause their heart to beat too slowly. A slow heartbeat is called bradycardia. Two common problems that cause a slow heartbeat are sinus node disease and heart block.

When your heart beats too slowly, your body and brain may not get enough oxygen. Symptoms may be

- Lightheadness
  - Tiredness
  - Fainting spells
  - Shortness of breath
- Some pacemakers can be used to stop a heart rate that is too fast (tachycardia) or that is irregular.

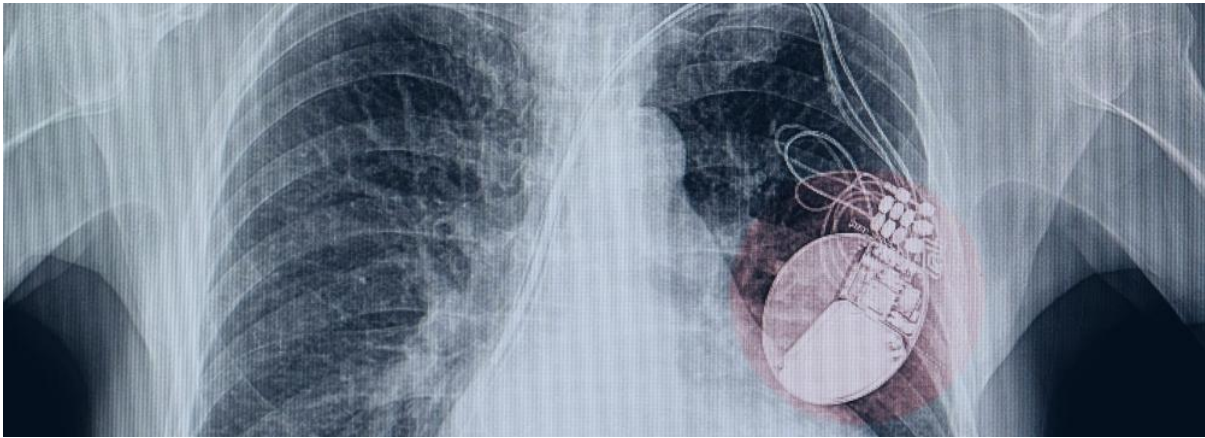
Other types of pacemakers can be used in severe heart failure. These are called biventricular pacemakers. They help coordinate the beating of the heart chambers.

Most biventricular pacemakers implanted today can also work as implantable cardioverter defibrillator (ICD). ICD restore a normal heartbeat by delivering a larger shock when a potentially deadly fast heart rhythm occurs.

Possible complications of pacemaker surgery are:

- Abnormal heart rhythms
- Bleeding
- Punctured lung. This is rare.
- Infection
- Puncture of the heart, which can lead to bleeding around the heart. This is rare.

A pacemaker senses if the heartbeat is above a certain rate. When it is above that rate, the pacemaker will stop sending signals to the heart. The pacemaker can also sense when the heartbeat slows down too much. It will automatically start pacing the heart again.



**Fig-5 showing original body pacemaker**

**Conclusion:** Pacemakers may be used for people who have heart problems that cause their heart to beat too slowly. A slow heartbeat is called bradycardia. Two common problems that cause a slow heartbeat are sinus node disease and heart block.

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