

Artificial heart pacemakers

Introduction

The heart is a highly efficient pump with four chambers. The two chambers on the right side of the heart receive oxygen-poor ('blue') blood from the body and pump this blood to the lungs, where it receives oxygen. The oxygen-rich ('red') blood returns to the left side of the heart, and the two left chambers pump this oxygenated blood to the rest of the body. The lower (major) pumping chambers, called the ventricles, receive blood from the top chambers, the atria, and do the hard work of pumping the blood to the other parts of the body.

In a normal heart, the atria contract (squeeze) first, pushing blood into the ventricles. The ventricles then contract, pumping the blood out to the lungs and the rest of the body. This process repeats at a regular rate, usually around 60 to 100 times every minute.

Normally, the contraction of the atria is set off by tiny electrical signals that come from the heart's natural 'pacemaker' – a small area of the heart called the sinus node that is located in the top of the right atrium. These signals travel rapidly throughout the atria to ensure that all the muscle fibres contract at the same time, pushing blood into the ventricles.

These same electrical signals are passed on to the ventricles, via the atrioventricular (AV) node, and this causes the ventricles to contract a short time later, after they have been filled with blood from the atria.

Sometimes, the heart's own electrical system does not work as it should to keep the heart beating in a regular manner and at an appropriate rate. In some cases, where the ventricles are beating too slowly to keep enough blood flowing around the body, an artificial heart pacemaker can help.

Who needs an artificial pacemaker?

The most common reason for needing an artificial heart pacemaker is disease of the heart's electrical system resulting in a heart beat that is too slow ('bradycardia'). In some cases, this may be accompanied by occasional abnormally fast heart rhythms ('tachycardia'). These are felt as palpitations.

A pacemaker may help:

- If the sinus node or atria are damaged (sick sinus syndrome) or
- If electrical signals don't get through to the ventricles (heart block).

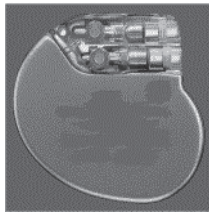
These problems are usually related to age and are called degenerative diseases. The affected person may complain of tiredness or suffer from blackouts.

More recently, special pacemakers have been designed to help a very poorly pumping heart in people who do not necessarily have a slow heart rhythm (i.e. in people with heart failure). These are very sophisticated and complex systems called biventricular pacemakers.

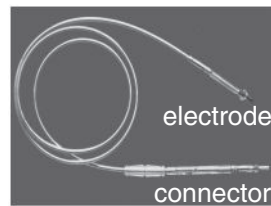
What is an artificial pacemaker?

Like the normal heart's electrical system, the artificial pacemaker uses small electrical currents to stimulate the heart muscle and cause it to contract (pump). The pacemaker consists of a 'pulse generator' and one or more leads. The pulse generator is a tiny, sophisticated computer powered by a very reliable lithium battery (similar to those used in cameras or watches). The pulse generator lasts many years.

The pulse generator is about the size of a large watch.



Pulse generator



Lead

The leads connect the pulse generator to the inner wall (or sometimes the outer surface) of the heart. Each lead is made of a metal coil covered by soft plastic insulating material, with small metal electrodes which attach to the heart.

How does a pacemaker work?

When the heart rate is slow, the pacemaker delivers up to five volts of electricity into the atrium or ventricle, which then contracts to pump blood out. The person with the pacemaker cannot 'feel' this amount of electricity.

The lead, together with the pulse generator, can also be used to 'sense' the heart's natural rhythm, and then inhibit the pacemaker to allow the heart's natural pacemaker to work.

Pacemakers come in three types; single chamber, dual chamber and biventricular.

Single chamber systems 'pace' only one heart chamber, usually the ventricle. Dual systems need two pacing leads and are more sophisticated. They use information about the electrical activity of the atria to set the ventricles' pumping rate. These systems are ideal for patients with 'heart block'. Biventricular systems use three leads, one in the right atrium and one in each of the ventricles (left and right).

In people with sick sinus syndrome, the heart rate may not increase to meet the demands of physical activity. Special pacemakers can 'sense' vibrations or measure the way the patient breathes, enabling the pacemaker to work out the level of exercise being done and change the pace rate accordingly. Both single and dual chamber pacemakers have these special sensors, but dual chamber systems are not suitable for all patients.

The procedure

The implantation of a pacemaker can be done in the operating room, but is commonly performed in the cardiac catheterisation laboratory where many cardiac tests are performed. The procedure usually takes about one hour under local anaesthesia and sedation. A small incision is made under either collar bone, and the lead of the pacemaker is threaded through a vein. Using x-ray techniques to assist with placement, the lead or leads are passed to the right heart and secured there by fine soft plastic hooks or a small metal screw. If a biventricular device is being used, then a second ventricular lead is implanted in the left ventricle. This is a much more complex process and can add one or two hours to the procedure. The leads are then attached to the pulse generator which is hidden under the skin. There is some post-operative discomfort, but most patients go home the next day.

Pacemaker follow-up

After patients receive a pacemaker they attend a clinic or visit a doctor regularly for tests. Modern pacemakers can be fine-tuned painlessly from outside the body using a radio-wave programmer.

Pacemakers are checked every six months on average. When batteries begin to run down, the generator (but not the leads) can be replaced easily under local anaesthetic.

Pacemakers and everyday activities

People with artificial pacemakers can do most normal activities, such as drive a car, bathe and swim, have sex and play non-contact sports.

Pacemakers are protected from electrical interference, although patients should discuss any concerns with their doctor. There are no problems with using or being near microwave ovens, televisions, shop theft detectors, any type of mobile or portable phone and most electrical tools. Metal pulse generators may trigger airport security machines, but these machines will not damage the pacemaker. Most medicines will not affect the way pacemakers work.

For more information contact Heartline, the Heart Foundation's telephone information service, on 1300 36 27 87 (cost of a local call).

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