Artificial Pacemakers

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The pacemaker is used in the human body to regulate rhythm disorders. The heart is essentially a hollow muscle with four chambers, the two atria are the upper chambers, and the two ventricles are the lower chambers. The heart is divided into right and left side which is responsible for pumping blood throughout the body. In order for the blood to pump through the body, the heart depends on electrical pulses that are passed from the upper chambers to the lower chambers. These impulses that are carried coordinate contraction and allow the heart to beat rhythmically.

Aging and diseases can cause a disturbance in the natural heart rhythm. As a result, the heart may beat irregularly and/or too slowly. This will deprive the body of sufficient amounts of oxygen causing weakness, dizziness, or tiredness. An example of a condition that leads to irregular heart beat would be Atrial fibrillation (AF). Atrial fibrillation is a common heart rhythm disorder in which the upper chambers of the heart beat rapidly and chaotically. Medicines used to control atrial fibrillation may result in slow rhythms which are treated by pacemakers.

A permanent pacemaker may allow anti-arrhythmic medications to be given that control AF that cannot be given without a permanent pacemaker because the medicines themselves slow the heart too much. Some very sophisticated pacemakers are now coming into use that may be able to reduce the frequency of AF by speeding up the heart when extra beats occur in the upper chamber, thereby suppressing the triggering beats that initiate AF.

A pulse generator, which contains both the battery and the intelligent circuits, can be very small. This device can be connected to a lead which makes contact with either the atrium or the ventricular muscle. The lead wire, with a "J" shape, is used for optimal positioning in the atrium. It is “unipolar”, and therefore smaller, and is a “tined” lead which makes passive contact with the atrial muscle. In contrast, the lead on the bottom is larger because it is a bipolar device which has more wire within it. It has a small screw at the end so that it can be actively fixated to the muscle.

There are three different types of pacemakers. In a single-chamber pacemaker, only one wire (pacing lead) is placed into a chamber of the heart. Sometimes it is the upper chamber, or atrium. Other times it is the lower chamber, or ventricle. In dual-chamber pacemakers, wires are placed in two chambers of the heart. One lead paces the atrium and one paces the ventricle. This approach more closely matches the natural pacing of the heart. This type of pacemaker can coordinate function between the atria and ventricles. Rate-Responsive pacemakers have sensors that automatically adjust to changes in a person's physical activity.

However, there are things that someone with a pacemaker has to be careful around. Some things to avoid would be certain types of strong electrical and magnetic devices can potentially interfere with the function of your pacemaker. It is important to consult with your doctor before coming in contact with objects such as MRI machines; the magnet in an MRI scanner may interfere with your pacemaker, power plants, large generators, large magnets, and electrical power lines.

References:

http://www.affacts.org/Procedures/pacemaker.html

http://academic.uprm.edu/~mgoyal/materialsdec2003/e03pacemaker.pdf

http://www.hrspatients.org/patients/treatments/pacemakers.asp

http://www.heartpoint.com/pacemakers.html