

Role of Pacemakers in restoring the rhythm of life

Ashish Singh*

India Medtronic Pvt. Ltd., Mumbai- 400093, Maharashtra, India

Abstract

The pacemaker has the important task of regulating the heart rhythm which may be irregular or slow by regularizing the heart rate to normal functioning. The sinoatrial (SA) node is considered as the "natural pacemaker" of the heart and serves the purpose of heart beats. The SA node regularly sends electrical signals which lead to correct beats of the heart (60 to 100 times each minute). However, in abnormal conditions the heart rhythm may show arrhythmia by being too slow or too fast. Pacemakers work on any conditions of asynchrony and improve the conditions of bradycardia or tachycardia to bring them to the normal rate. The present article explains the common causes of bradycardia and how pacing the heart is instrumental in maintaining the heart system. The latest developments in various types of pacemakers is also discussed.

Keywords: Pacemakers, Heart block, Bradycardia, Leadless Pacemakers

Introduction

Cardiovascular disease (CVD) is a general term coined for indicating a group of disorders associated with heart or blood vessels. CVDs is a collective term given to different conditions ranging from rheumatic heart disease, coronary heart disease (heart attack), cardiomyopathies, heart failure, cerebrovascular disease (stroke); peripheral vascular disease and congenital heart disease. Some risk factors for these conditions in developing countries include unhealthy lifestyles, habits such as smoking and tobacco use, and obesity. The CVDs are frequently related to deposition of fats inside the arteries, this condition is known as atherosclerosis which increase the risks of blood clots. The heart attacks or heart strokes are the acute events which are triggered by the blocking caused by fats that stops the blood to reach heart or brain.

There is a need to raise awareness on leading a preventive lifestyle right from a young age and focusing on healthy habits. Estimates suggest that about 23.6 million people would die of cardiovascular disease (CVD) by 2030 and about 80% of these deaths would be in low and middle-income countries including India. [1, 2]

India and other developing countries contribute to about 80% of cardiovascular disease mortality. [2] There is thus a need to raise awareness on the fact that a preventive lifestyle can avert the risk of acquiring CVDs and those with any existing risk factors must take particular care.

With socio-economic changes, people in developing countries are increasingly becoming prone to several non-communicable diseases including heart problems [3]. What makes the situation worse is that many do not undertake preventive measures or undergo timely health check-ups – sometimes even after having obvious risk factors. There is a need to increase awareness that if these conditions are not detected and managed on time, they can lead to other associated health complications over time. Prevention must start early and habits such as avoiding processed food should be inculcated from a young age. It is possible to address most of these conditions through timely diagnosis and management.

Youngsters including professionals have an on-the-go lifestyle today. This can increase stress levels, which is one of the major risk factors for CVDs. When combined with the other factors they can prove detrimental to heart health. For cases where management through lifestyle changes is not enough, medication can be given.

*Corresponding Author:

Mr. Ashish Singh

E-mail: singhashisha@yahoo.com

Those who develop complications would require surgery and other treatment as needed.

Indians are genetically predisposed to heart diseases. Research has shown that people who lead a healthy lifestyle too may not be aware of certain changes in the heart. In fact, a routine checkup can show up blockages in those who have never experienced heart-related problems. Hence it is important to be aware of the various risk factors and importance of undergoing health checkups in a timely manner. The critical symptoms like an increase in heart rate should be carefully noted by people and reported for medical help at the earliest. Especially those above the age of 35 should be more careful.

There are technologies that detect abnormalities right at the outset and pave way for timely management. For instance, a procedure called transthoracic echocardiography (2D ECHO) is a simple, non-invasive imaging technique that uses 2-dimensional thin-slice imaging to provide a comprehensive imaging of the heart [4]. There is also a need to raise awareness on taking preventive measures such as changing to a healthy lifestyle, avoiding processed food, and getting adequate exercise every day to avoid heart ailments.

Obese children are at a greater risk for getting heart disease. This is because in such children, there is an increased likelihood of other associated risk factors including elevated blood pressure, blood lipids, and blood glucose. All of these are gateways to heart diseases. Overweight and obese children have a higher heart rate and increased size of the brachial artery diameter. It is imperative, therefore, that those with a family history of premature heart disease adopt a healthy lifestyle to avoid complications later. Parents must be educated and made aware of how to inculcate healthy habits in children from an early stage. They themselves can become role models for children by quitting smoking, undertaking regular exercise, eating a healthy diet, and getting their vitals checked regularly.

In people who develop a heart disease and complications such as an acute heart attack, it is imperative to provide immediate treatment in the

form of angioplasty to minimize or avoid the damage to the heart muscles. Angioplasty is a procedure which is useful in restoring and improving blood flow in the arteries. Angioplasty involves using a long, thin tube (catheter) to gain access to the blocked area through which the rest of the procedure can be completed. A thin wire mesh (stent) mounted on a deflated balloon is then passed through the catheter to the narrowed area. The balloon is inflated; compressing the deposits against the artery walls and leaving expanded stent embedded in the artery. Drug-eluting stents release medication to help heal the stressed arteries post procedure. Few drug-eluting stents are USFDA approved and well-studied for safe use in patients with complications such as diabetes, high bleeding risk or in patients who might have to interrupt medication a month after angioplasty. In coronary artery bypass grafting (CABG), the surgeon takes a vessel from another part of the body, like the leg or the mammary vessels, which creates a graft to bypass blocked coronary arteries. This helps blood to flow around the blocked or narrowed coronary artery hence relieving the patient of the symptoms.

A number as high as 60 per cent of cardiac diseases representations are due to cardiac arrest occurring. This is due to arrhythmias and not blockages in the arteries as we read earlier. Sudden cardiac Arrest (SCA) is among the most common causes of death throughout the world. The estimation of annual SCA deaths is as high as 3 million with a very low survival rate of 1%.

Adults in their mid-30s to mid-40s are most frequently affected by Sudden cardiac arrest. Also, it affects men twice as often as it does to the women population.

Usually SCA strikes without any warning or symptoms. As SCA requires immediate action to ensure survival the initial 5 minutes become very critical. If treatment is initiated within the first minutes after sudden cardiac arrest the survival of the affected can be as high as 90 percent. With every minute passing by this rate decreases by about 10 percent. Immediate CPR should be administered if the patient is “unconscious” and “not breathing”. This has to be followed by defibrillation. The recommendation from

American heart association (AHA) is that defibrillation has to be administered within five minutes.

Implantable cardioverter defibrillators (ICDs) and implantable pacemakers have emerged as new technologies in the recent years to treat these lethal arrhythmias.

2. Pacemakers – restoring the rhythm of life

The human heart is an intricate four chamber organ with its own “electrical” activity that controls how frequently and regularly the blood is pumped. Every step is critical, so if something in electrical system of the heart gets disturbed or damaged, it can change the regularity of the heartbeat.

Normal heartbeat is hardly felt. It is regular rhythmic & appropriate for our activities such as slow in sleep, fast during exercise. Irregular heart rhythms or “arrhythmias” makes one aware of one’s own heartbeat which is scientifically known as the palpitations.

In rhythm disturbance (arrhythmia), the heart may beat too slowly (bradycardia), too quickly (tachycardia) or irregularly. While some of these rhythm abnormalities could be mild of not much importance, some arrhythmias could be grave/risky.

Symptoms to watch out for incase of bradycardia - which is defined as a slow, regular or irregular heart rhythm, usually less than 60 beats per minute- dizziness, fatigue, shortness of breath, inability to exercise. The syncope or fainting spells happens because not enough blood gets pumped out of heart per minute and brain gets less than desired blood sugars.

3. Common causes of bradycardia

The main causes of bradycardia include a hereditary heart defect (Congenital), certain illnesses of heart muscle (Infiltration), the natural aging process (Degeneration) or as a result of a heart attack (Scar) and drug induced (Iatrogenic).

A Sick sinus syndrome (or sinus node dysfunction) – Heart has a natural “Battery” called sinus node. From this electrical current starts and spreads through a special carrying system (Conduction system). Disease in the sinus node leads to slow or irregular heart rates. This can also result in pauses in heart beats which could produce symptoms as severe as fainting (syncope), or mild greying in front of eyes.

Heart block – Conduction system of the heart gets diseased, heart gets slow. This “block” is in the electrical system of the heart. Usually “blocks” of coronary arteries are discussed, which involves the plumbing system of the heart. Heart with this type of electrical block becomes slow, irregular or can pause. This also results into symptoms described above.

Brady arrhythmias are diagnosed by symptoms, slow pulse rate, ECG, watch type ECG or 24 hour ECG (Holter). There are no effective permanent medical/drug solutions for Brady arrhythmias. Most patients would end up getting a pacemaker.

4. Pacing the Heart - Main treatment for slow heart system (Bradycardia)

A pacemaker’s main purpose is to keep the heart beating from going too slow and thereby prevent the problems and symptoms associated with slow heart rhythms. The pacemaker consists of 2 parts – the **pulse generator** and **one or two insulated wires called leads**. The PG is a small metal can, containing electronic circuitry and a battery which can last between 7 to 10 years depending on how much it is used.

Getting a pacemaker implant involves the following:

- It is a minimally invasive procedure performed in local anesthesia. The pacemaker is placed below the collarbone, most people can go home within a day.

- Once implanted, the pacemaker sends an electrical impulse to the heart when the heart's own rhythm is too slow or compromised.
- The electrical impulses delivered by the pacemaker are so small in energy that the patient does not feel anything when the pacemaker is in action.

Although the main function of the device is to pace, the device is smart enough to sense the heart's natural rhythm. When the pacemaker senses an intrinsic (which means the natural heartbeat), it will not deliver a pacing pulse. Thus, it is a watch dog allowing normal heart rhythm but taking control of heart when heart slows down.

Pacemakers have made a lot of advancement today and have several features that ensure patient safety at all times. Various types of pacemakers available today are:

- **Single chamber pacemakers** – A very basic type of pacemaker which is only to be used in specific conditions and paces only one chamber of the heart
- **Dual chamber pacemakers** – An advanced type which is capable of pacing both the upper and lower chamber of the heart. It is a more efficient system as it mimicks the normal heart.

- **Rate responsive pacemakers** – Evolved pacemakers that are capable of varying electrical impulses to increase heart rate according to the need of the body. Comes both in single and double chamber. (Heart rate will increase with exertion and slow down at rest).
- **MR safe Pacemaker** - Till a few years ago pacemakers were not safe in high magnetic fields. The modern ones are now “MR” safe. This allows safety in airport securities, MRI diagnostic imaging, etc.

In the era of miniaturization, the latest innovation is a new generation device which obviates the needs of leads inside the heart attached to a traditional pacemaker.

Leadless Pacemakers: These are world's smallest pacemakers inserted in the right side of the heart by a catheter. The advantages include less chance of infection and that there is no need for wires (leads). [5]

This pacemaker is a capsule size device which is 93% smaller than traditional pacemakers and weighs less than 2 grams. Technological advances have also made this 0.8cc device to serve an amazing average battery life of approximately 12 years.



Fig. 1: World's smallest pacemaker—the Medtronic Micra™

5. Alternatives to the pacemakers

The Risks connected with pacemaker cannot be ignored as there are tools such as gas-powered appliances which may be in contact. [6, 7] Moreover, the implanted pacemaker may have the major limitations of complications from the operation or presence of electromagnetic fields [8]. There can be infection at the surgical site or the device may not be able to deliver the desired therapy when needed. It is important to mention that the pacemakers are not to be thought as the treatment and cure for the heart disease because the pacemakers do not work on the root cause of the reasons for the irregular heartbeats. Hence, one has to look for achieving better health and maintain a healthy body so as to avoid any chances of irregular heartbeats. Some recommendations like taking care of weight by exercising regularly and eating a diet that is rich in fruits, vegetables, and whole grains. There has to be a limit in the sodium intake to under 5gm per day and get plenty of potassium (at least 4,700 mg per day) from fruits and vegetables. The stress in life has to be reduced by yoga and meditation.

Monitoring the blood pressure regularly, and working with a doctor will enable keeping all health parameters in a healthy range.

6. Conclusion

The advances in pacemakers have led to drastic improvements in fainting spells or CHF and cardiomyopathy. The newer developments in the pacing mode have made substantial improvements in QOL of patients. These small devices serve the purpose efficiently once implanted under the skin by a minor surgery and continuously work on sending appropriate electrical signals in the form of impulses. This allows the heart muscle to not only have the desired heart rate but also maintain the rhythm of heartbeats. In conclusion, the pacemakers actually synchronize the rhythm of life which should not be disturbed.

Conflict of Interest

The authors declare no conflict of interest.

Disclaimer

The views, thoughts and opinions expressed in this review belong solely to the authors, and not necessarily to the author's employer, organization, committee or other group or individual.

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