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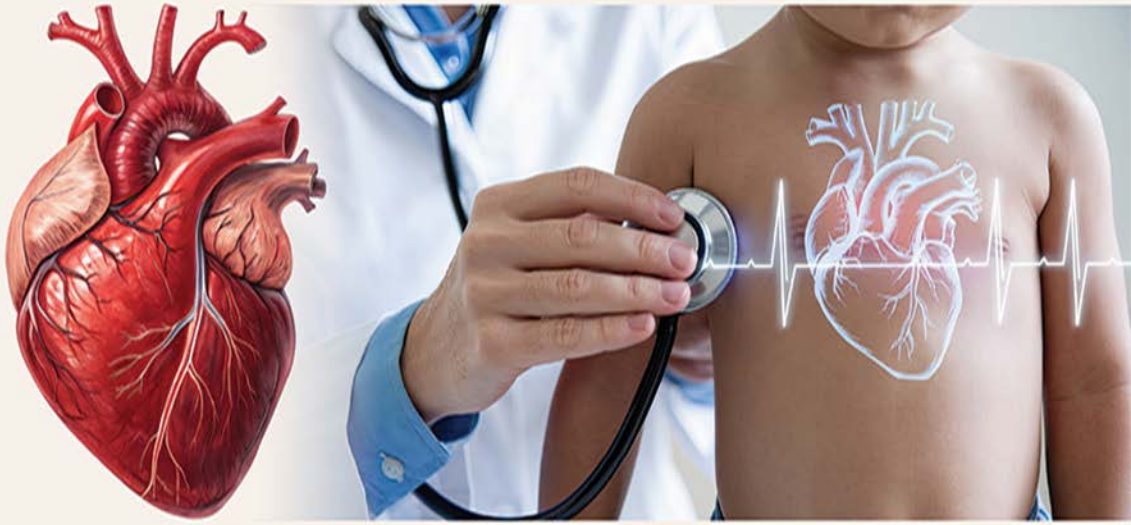
Essentials of PEDIATRIC CARDIOLOGY

2nd Edition



Anita Khalil

Foreword
Panna Choudhury

JAYPEE

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CHAPTER

4 Pacemakers in Children

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A pacemaker is a small battery powered medical device designed to electrically stimulate the heart muscle in an effort to restore the heart rhythm towards normal.[5]

A pacemaker system consists of two main parts:

The pulse generator and pacing leads. The pulse generator houses the lithium iodine battery and electronic circuits (like small computer). These circuits contain timers that regulate how often the pacemaker must send impulse to stimulate the heart.[2]

The pulse generator is small, measuring approximately 2" x 2" x 1/4" (45 mm x 45 mm x 6 mm) and weighing less than 2 ounces (20-30 gm). The pacing leads are flexible, insulated wires that connect to the pulse generator and carry the electronic impulse to the heart. In addition the leads also carry signals back from the heart to the pulse generator allowing the latter to sense the hearts natural electrical activity.[5]

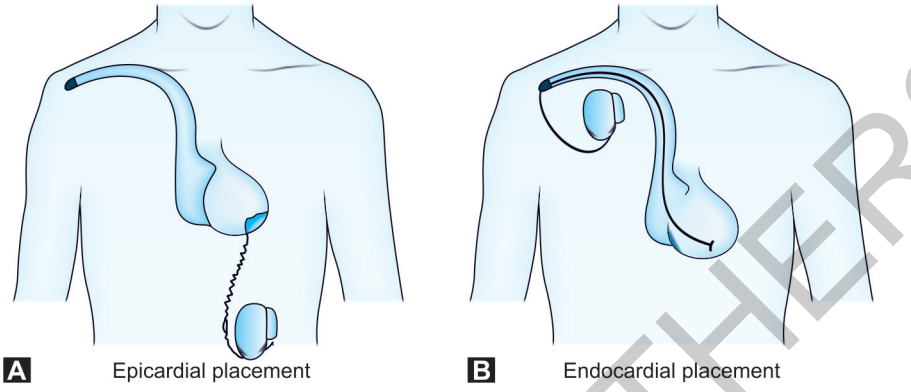
By sensing the patient's natural rhythm, the pacemaker will only pace the heart whenever it is necessary.

The normal heartbeat originates in the heart's natural pacemaker called the 'sinus node'. The sinus node is usually located in right atrium, though this location can be different in the setting of some congenital heart defects. When the sinus node fires, a wave of electricity sweeps across the upper chambers of the heart (atria) causing the upper chambers to contract. The electrical impulse then travels from atria to lower chambers of the heart (ventricles) through "A-V node" located in center of heart resulting in ventricular contraction, which allows the blood to be pumped to the body (Figs 4.1A and B).

PACEMAKER THERAPY[3]

In general, the pediatric conditions that require pacemaker implantation are:

1. Symptomatic bradycardia → on medications
2. Recurrent bradycardia – tachycardia → sick sinus syndrome
3. Congenital A-V block → congenital complete heart block
4. Postoperative prolonged second on third degree A-V block or surgically acquired heart block which lasts for more than 7 days after surgery.
5. Others – Those with leaking valves, hypertrophic cardiomyopathy, dilated cardiomyopathy.



Figs 4.1A and B: Pacemaker attachment. (A) leads attached to the outer surface. (B) leads attached to the inner surface

Indications for Permanent Pacing in Children and Adolescents (American College of Cardiology/American Heart Association)

Guidelines for implantation of Cardiac Pacemakers and anti-arrhythmia devices.[3,4]

Class I Pacemaker Implantation – Necessary and Beneficial

1. Advanced second or third degree A-V block with symptomatic bradycardia, CCF or low cardiac output.
2. Sinus node dysfunction – Age appropriate bradycardia.
3. Postoperative advanced second or third degree A-V block that persists 7 days after cardiac surgery.[8]
4. Congenital third degree A-V block in an infant – ventricular rate < 50 beats/min or congenital heart disease < 70 beats/min.[1]
5. Sustained pause dependent ventricular tachycardia with/without prolonged QT.
6. Congenital third degree A-V block with a wide QRS escape rhythm or ventricular dysfunction.

Class II A Pacemaker Implantation–may be Beneficial

1. Bradycardia-Tachycardia syndrome with anti-arrhythmic treatment.[6]
2. Congenital third degree A-V block beyond 1st year – average heart rate of < 50 beats/minute.
3. Long QT syndrome with 2:1 AV block or third degree AV block.
4. Asymptomatic sinus bradycardia in a child with complex congenital heart disease with a resting heart rate of < 35 beats/minute.

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Class II B Pacemaker Implantation–Usefulness Less Well Established

1. Transient postoperative third degree A-V block that reverts to sinus rhythm with residual bifascicular block.
2. Congenital third degree A-V block in an asymptomatic neonate, child or adolescent with an acceptable rate, narrow QRS complex and normal ventricular function.
3. Asymptomatic sinus bradycardia in an adolescent with congenital heart disease with heart rate < 35 beats/min.

Class III Pacemaker Implantation – not useful

1. Transient postoperative AV block with return of normal AV conduction within 7 days.
2. Asymptomatic postoperative bifascicular block with or without first degree A-V block.[9]
3. Asymptomatic type I second degree AV block.
4. Asymptomatic sinus bradycardia in an adolescent with the longest RR interval < 3 seconds and a minimum heart rate > 40 beats/minute.

Pacemaker - Types

1. Single chamber pacemakers use a single lead attached to either the atrium or to the ventricle.
2. Dual chamber pacemakers – use two leads, one attached to the atrium and other to the ventricle. Leads can be attached either to the inside surface (endocardium) or outside surface (epicardium) of the heart leads attached to the endocardium can be placed through a transvenous route that communicates with the heart. The leads are positioned within the heart with the help of fluoroscopy.[5]

Leads attached to the epicardium require surgical exposure of the heart by using an incision through the xiphoid process in a neonate or small infant. The pulse generator is positioned under the skin (sometimes under the muscle) in the upper chest near the collar bone or in the abdominal area depending upon age and size of the patient.

The cardiologist, cardiac surgeon and the nurse looking after the child can reprogramme the pulse generator with a special pacemaker programmer.

Lithium anode batteries of the iodide types are used exclusively. Battery longevity depends on battery size, stimulation frequency and output per stimulation. Battery life varies from 3 years (dual chamber) to 15 years (large single chamber device).

Postoperative Precautions

1. Following the procedure, certain activities will be restricted for days to a week.
   - Wound care – aseptic precaution of the incision – to be kept dry and clean.

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- Pacemaker malfunction – The concerned doctor to be consulted for dizziness, excessive fatigue, fainting, difficulty in waking up breathless, palpitation and persistent hiccups. For infants – poor feeding and irritability should be a cause for concern.[7]
- Exercise–After the wound heals, the child should be active but should avoid contact sports, e.g. football, Karate, boxing, judo – where pacemaker may be damaged.

Precautions

1. Magnetic resonance imaging – is not allowed.
2. The pacemaker may set off some types of alarms at metal detectors at airports – the pacemaker identity card should be shown.
3. Mobile Phones should not be placed over pacemaker site.
4. Microwave ovens, most cordless and cellular phones and X-rays are safe.

CONCLUSIONS

Pacemaker installation should not greatly affect a child's school life, as long as instructions listed above are borne in mind and followed.

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