Pacemaker syndrome

Pacemaker syndrome is a term proposed in 1979 by Erbel and refers to symptoms and signs in the pacemaker patient caused by inadequate timing of atrial and ventricular contractions. It was first described in 1969 by Mitsui et al. as an iatrogenic disease characterised by the disappearance of symptoms with restoration of atrioventricular synchrony (AV synchrony). It means if atria and ventricles contract at appropriate timings (as close to physiological), pacemaker syndrome can be prevented.

It has been postulated that the greater the AV dyssynchrony, the greater the incidence of this syndrome. VVI pacing (Single Chamber Ventricular Pacemaker) is the commonest pacemaker mode, but as it is a single chamber pacemaker mode, it can create AV dyssynchrony.

The lack of normal atrioventricular synchrony may result in decreased cardiac output. In most cases this syndrome can be cured by dual chamber pacing, which relieves almost all the symptoms. This is because dual chamber pacing is more close to normal physiology than single chamber pacing. However, there are several reports of pacemaker syndrome occurring in dual chamber modes. It can even occur with AAI pacing with long PR intervals.

Incidence

The overall incidence of pacemaker syndrome is very difficult to estimate but is about 20% in a landmark trial called the Mode Selection Trial (MOST). It occurs with equal frequency in both sexes and can occur at any age. In this trial 2010 patients were randomly assigned to VVIR (Ventricular Rate Modulated Pacing) versus DDDR (Dual Chamber Rate Adaptive Pacemaker) pacing modes. This trial was a single blinded study enrolling around 2000 patients with sick sinus syndrome.

All patients were implanted dual chamber pacemakers programmed to VVIR or DDDR before implantation. Pacemaker syndrome was a secondary endpoint studied. Severe pacemaker syndrome developed in nearly 20% of VVIR-paced patients and improved with reprogramming to the dual-chamber pacing mode.

Clinical presentation

Symptoms of pacemaker syndrome are non-specific and

Key points

- Pacemaker syndrome refers to symptoms and signs in the pacemaker patient caused by inadequate timing of atrial and ventricular contractions.
- The lack of normal atrioventricular synchrony may result in decreased cardiac output.
- The strongest predictor of pacemaker syndrome appears to be a high percentage of ventricular paced beats according to the MOST trial.
- Quality of life improved significantly after patients were upgraded to dual chamber pacing.
may be confused with the ageing process. Moreover elderly patients report less symptoms due to memory deficits or other reasons. There has been a considerable overlap among the signs and symptoms of pacemaker syndrome and physiological ageing symptoms. Nevertheless commonly patients present with the nonspecific symptoms ranging from fatigability to syncope and these occur during the time the ventricles are being stimulated by the pulse generator. Postulated mechanisms include loss of AV synchrony, vasodepressor reflexes, and retrograde atrial activation.

The strongest predictor of pacemaker syndrome appears to be a high percentage of ventricular paced beats according to the MOST trial.

Diagnosis

The diagnosis of pacemaker syndrome is based on the clinical features listed in table 2 especially in a patient with a VVIR pacemaker and the disappearance of all or most of the symptoms with upgrading of the pacemaker to a dual chamber one.

Plasma ANP levels have also been used a marker of non-physiological pacing in the PASE trial and elevated levels (>90pg/ml) can be helpful in the diagnosis. On upgrading the pacemaker to DDDR, there should be a prompt decline in ANP levels and prompt resolution of symptoms.9–12

Pacemaker syndrome is more likely if the systolic blood pressure drops more than 20mmHg during ventricular pacing (VVIR).13 Despite attempts to identify clinical variables and biochemical markers that predict the development of pacemaker syndrome, multiple studies have failed to identify any consistency.

Management

In the past two decades, a vast majority of cardiologists have modified their practice by shifting away from VVI/VVIR pacing. Patients with pacemaker syndrome after VVIR pacing can be managed by upgrading to a DDDR system. Rarely, a patient with a dual chamber pacemaker may present with similar symptoms of pacemaker syndrome,5,6 which needs pacing clinic follow up for ensuring
that the atrial lead is working and by avoiding atrial non-tracking modes (DDI or DVI). Avoiding atrial non-pacing modes, reducing the lower pacing rate to encourage conduction of underlying rhythm, use of hysteresis (delaying pacing conduction of underlying rhythm, the lower pacing rate to encourage atrial conduction), and withdrawal of any rate limiting medications affecting sinus node are all helpful.

**Conclusion**

The MOST trial showed no baseline demographic, clinical or pacemaker implant variables predictive of pacemaker syndrome. A high percentage of paced beats during follow up was the only independent predictor. Patients noticed significant deterioration in their quality of life with the syndrome and it improved significantly after being upgraded to dual-chamber pacing. Because patients who will develop pacemaker syndrome cannot be accurately identified at the time of implantation, it may be advisable to treat all patients with atrial-based pacemakers. VVI pacing should be used only in patients with chronic or persistent atrial fibrillation with good chronotropic response to exercise, or with transient bradyarrhythmias.

**Conflict of interest:** none

**References**


**Table 1:** Types of pacemaker

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
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<tbody>
<tr>
<td>VVI pacing</td>
<td>This is by far the most common type of pacemaker mode. It senses spontaneous ventricular impulses and paces the ventricles only when needed.</td>
</tr>
<tr>
<td>Dual chamber pacing</td>
<td>This is said to happen when both the atria and the ventricles are paced with one lead in the atria and the other lead in the ventricle.</td>
</tr>
<tr>
<td>AAI pacing</td>
<td>This is a pacemaker similar to the VVI except that it senses and paces the atria, thereby maintaining the sequence of atrial and ventricular contraction.</td>
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**Table 2:** Clinical features of pacemaker syndrome

<table>
<thead>
<tr>
<th>Category</th>
<th>Symptoms</th>
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<tbody>
<tr>
<td>Neurological</td>
<td>Dizziness, near syncope, and confusion</td>
</tr>
<tr>
<td>Heart failure</td>
<td>Dyspnoea, orthopnoea, paroxysmal nocturnal dyspnoea, and peripheral oedema</td>
</tr>
<tr>
<td>Hypotension</td>
<td>Seizure, mental status change, diaphoresis, and signs of orthostasis and shock</td>
</tr>
<tr>
<td>Low cardiac output</td>
<td>Fatigue, weakness, dyspnoea on exertion, lethargy, and lightheadedness</td>
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<tr>
<td>Hemodynamic</td>
<td>Pulsion in the neck and abdomen, choking sensation, jaw pain, right upper quadrant (RUQ) pain, chest colds, and headache</td>
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<tr>
<td>Heart rate related</td>
<td>Palpitations associated with arrhythmias</td>
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*Atrial/pacemaker syndrome* is by far the most common type of pacemaker mode. It senses spontaneous ventricular impulses and paces the ventricles only when needed. *Dual chamber pacing* is said to happen when both the atria and the ventricles are paced with one lead in the atria and the other lead in the ventricle. *AAI pacing* is a pacemaker similar to the VVI except that it senses and paces the atria, thereby maintaining the sequence of atrial and ventricular contraction.