Permanent Pacemaker Implantation Post Cardiac Surgery: A Cautionary Tale

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Abstract

We performed a dual chamber pacemaker implant on a 74-year-old male with surgically acquired heart block post aortic valve replacement. Mid procedure the patient experienced a sudden cardiac arrest requiring cardiopulmonary resuscitation. Fortunately, the patient made a full recovery, and the cause of his dysrhythmia could be revealed by analysis of his full disclosure ECG. We present this case to raise awareness of a rare pacing complication and to highlight the benefits of full disclosure ECG recording during pacemaker implant.

Case Presentation

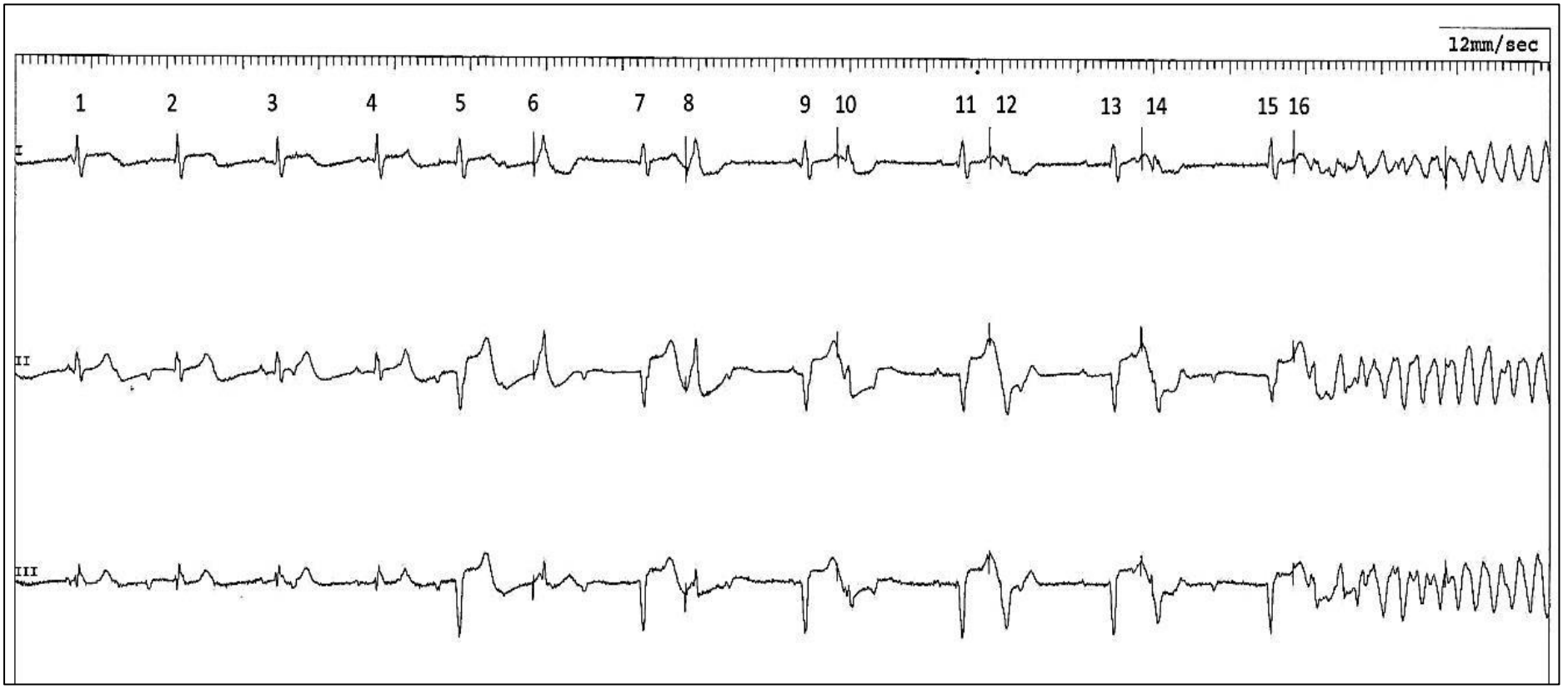
A 74-year-old male with severe aortic stenosis and unobstructed coronaries underwent aortic valve replacement surgery. Postoperatively epicardial pacing support was required due to surgically acquired heart block. After seven days his heart block had failed to recover and the patient was listed for permanent pacemaker implantation.

On arrival to the electrophysiology lab the patient had an epicardial pacemaker system programmed to VVI at 40 bpm. The epicardial system was functioning well with appropriate pacing and sensing seen. The rate was reduced to assess for an intrinsic rhythm which uncovered a stable and well tolerated narrow complex escape with AV dissociation. The intrinsic heart rate was similar to the programmed pacing rate so to avoid competition with the intrinsic rhythm the epicardial system was programmed to VVI at 30 bpm allowing for back up pacing if required. The R wave sensitivity threshold was programmed to 2mV with appropriate sensing seen.

Two uncomplicated axillary punctures were made with active atrial and ventricular leads successfully positioned to the right atrial appendage and right ventricular apex respectively. As the leads were being secured the patient suffered a sudden cardiac arrest. The electrocardiogram showed polymorphic ventricular tachycardia (PVT). External defibrillator pads were applied but without external cardioversion the rhythm self-terminated and the patient regained consciousness.

Fluoroscopy revealed no lead displacement or perforation. The onset of the arrhythmia was reviewed on the full disclosure ECG (Figure 1).

Figure 1 - The ECG strip shows the onset of the polymorphic ventricular tachycardia episode. From top to bottom the ECG channels displayed are leads I, II and III. The sweep speed is 12mm/sec. The vertical scale is 1mm/mV.



Discussion

The 1st, 2nd, 3rd and 4th beats of ECG in Figure 1 are narrow complex escape beats with evidence of AV dissociation. The 5th beat shows a change in QRS morphology and axis. This complex is under sensed by the epicardial pacemaker. The lower rate interval (LRI) programmed to 2000 ms (30 bpm) times out resulting in the delivery of an epicardial pacing stimulus which captures the myocardium (6th beat). The 7th beat is again undersensed by the epicardial pacing system and is followed by another epicardial paced complex (beat 8) at the LRI. The sequence of under sensed broad beats (9th, 11th, 13th and 15th beats) followed by epicardial paced complexes (10th, 12th, 14th and 16th beats) is repeated.

The paced complexes are noted to be close to the T waves of the previous under sensed beat. The final paced complex (beat 16) triggers polymorphic ventricular tachycardia due to the R on T phenomenon. We therefore concluded that the cardiac arrest was the result of epicardial pacemaker undersensing. With the patient conscious and stable a decision to proceed with pacemaker implantation was made. The epicardial system was turned off and the procedure was completed with no further complications.

Commentary

Permanent pacemaker implantation post cardiac surgery is a well-practiced procedure performed to treat patients with unresolved conduction disturbance. It is estimated that 1-2% of patients undergoing cardiac surgery will develop conduction disturbance after heart surgery, with patients at highest risk including those with pre-existing conduction disease and those undergoing aortic valve replacement [1]. If conduction disturbances do not resolve within 7 days European guidelines recommend permanent pacemaker implantation as a class I indication in this setting [2].

Most patients requiring a permanent pacemaker post cardiac surgery will come to the electrophysiology laboratory with temporary epicardial pacemaker wires in situ. The presence of an epicardial system adds to the technical complexity of the procedure with concurrent management of the permanent pacemaker system, pacing system analyser (PSA) and temporary epicardial system required. Knowledge of each system's function, and the possible risks of interactions between systems, is important to the success of the procedure. Management strategies are often down to the discretion of the local team who may or may not have available written guidelines.

In patients who are pacemaker dependent, strategies may include programming the epicardial system to synchronous or asynchronous pacing depending on the use of electrocautery. In patients who have a slow but tolerated intrinsic rhythm

strategies may include turning the epicardial system off or programming the epicardial system to a synchronous mode. If programmed to a synchronous mode the lower rate interval is often programmed low enough to avoid competing with the intrinsic rhythm whilst providing backup pacing if sudden bradycardia occurs. Regardless of the management method adopted the primary aim is to avoid episodes of significant bradycardia or interactions between systems.

The R on T phenomenon is described as the superimposition of an ectopic (or paced beat) onto the T wave of a preceding beat [3]. This is capable of inducing ventricular arrhythmias and cardiac arrest. In cardiac pacing the phenomenon is rare and caused by an inappropriately delivered pacing stimulus which captures the ventricle when it is vulnerable to this phenomenon. A few case reports have been published in the literature illustrating the risk of R on T episodes when an epicardial pacing system is present. These reports have described epicardial wire undersensing [4,5] and asynchronous pacing modes [6] as the reason for cardiac arrests. All these reports have described episodes occurring early in the acute post-operative period in the intensive care or post-operative ward setting.

In our report we have demonstrated that the occurrence of this phenomenon is possible several days post-surgery and during the setting of a permanent pacemaker implant when an epicardial pacemaker system is present. It is clear from our tracing that the epicardial system undersensing was the cause of the ventricular arrhythmia despite appropriate sensitivity settings. We can only hypothesis that the undersensed beat originated from a site where the propagating wave front was

travelling away from the sensing electrode. The case highlights that operators and support staff should be aware of this potential risk when an epicardial system is present despite being programmed correctly.

Interestingly, a retrospective review of the entire full disclosure ECG recording, discovered two additional short episodes of intermittent undersensing occurring prior to the patient's arrest. Had this been observed at the time it may have been possible to prevent the dysrhythmia. This highlights the importance of meticulous monitoring of the ECG throughout the procedure to identify undersensing or changes in QRS morphology early.

A final comment must highlight the usefulness of recording a full disclosure ECG during a permanent pacemaker implant which was essential in this case in identifying the cause of cardiac arrest. Identifying a cause meant that the consultant operating was able to make an informed decision on how best to proceed. The patient appropriately received a pacemaker and was not inappropriately considered for an implantable cardioverter defibrillator (ICD).

Key learning points

- There is a risk of R on T cardiac arrest during permanent pacemaker implantation when an epicardial system is present despite being programmed to a synchronous mode.

- Operators and physiologists should consider turning off the epicardial pacemaker system when a stable and tolerated intrinsic rhythm is present as this would remove the risk of epicardial wire undersensing causing an R on T cardiac arrest

- If the epicardial system remains on in a synchronous mode, extra attention should be made to monitor for and identify epicardial wire undersensing. Settings should be adjusted immediately on observing undersensing. There may only be a short window of opportunity to do this.

- Recording of a full disclosure ECG is recommended during pacemaker implants as retrospective ECG analysis is quick and extremely useful in aiding decision making.

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