Pacing Lead Perforation on the Right Side of the Heart

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ABSTRACT

Cardiac perforation is a rare potentially serious and often unrecognized complication of pacemaker lead implantation. In this paper, we present a case with pacing lead perforation on the right side of the heart.

KEYWORDS

Pacemaker lead, cardiac perforation, unipolar electrograms

ÖZET

Kardiyak perforasyon, elektrot implantasyonunun çoğunlukla tanınamayan nadir fakat önemli bir komplikasyonudur. Bu yazida, pacing elektroduna bağlı sağ kalp perforasyonu olan bir olgu sunulacaktır.

ANAHTAR KELİMELER

Pacemaker elektrodu, kardiyak perforasyon, unipolar elektrogramlar

İLETİŞİM ADRESİ

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Cardiac perforation is a rare potentially serious and often unrecognized complication of pacemaker lead implantation. It may occur at the time of implantation when it may cause hypotension from cardiac tamponade. Perforation usually does not lead to tamponade if the lead is withdrawn and repositioned because the perforation is often self-sealing.

The reported incidence of symptomatic perforation after initial implantation is about 1%. The true incidence of perforation is not well known because it may be subclinical and asymptomatic. Indeed CT scans in patients with uncomplicated pacing show a staggering 5% incidence of right ventricular perforation and 10% in the case of atrial leads. Risk factors include female sex, increasing age, the use of stiff styles and active-fixation leads. Administration of oral steroid within 7 days preceding lead implantation predisposes to perforation.

The clinical presentation of perforation has changed and occurs later than in the past. The use of active-fixation small body diameter leads and implantable cardioverter-defibrillator leads may be associated with increased risk for delayed right ventricular perforation. The late presentation is a less recognized complication of device implantation and may create an important diagnostic problem with potentially catastrophic consequences if unrecognized. The development of small-diameter Subacute right ventricular perforation (several days or weeks after seemingly uncomplicated implantation (usually up to 60 days after implantation and occasionally much later) is a rare but serious complication of lead implantation. Perforation can occasionally present after several months or a year.

After implantation, right ventricular perforation of the free wall may be recognized by pericardial pain, abdominal pain, dyspnea, syncope, friction rub, sinus tachycardia, increasing ventricular pacing threshold, poor sensing, left diaphragmatic stimulation (though this may also occur in the absence of perforation), intercostal muscle stimulation, pericardial effusion and left hemothorax. Rarely perforation occurs into the left ventricle through the ventricular septum. Rare complications of RV lead perforation include lead migration into the peritoneal cavity, rib perforation and damage to a left internal mammary graft to the left anterior descending artery (with myocardial infarction). Also, the left anterior descending coronary artery (LAD) runs on the epicardial surface of the heart within the interventricular groove superficial to the interventricular septum. From a pacing perspective, the LAD lies at the junction between the septal and anterior walls of the RV outflow tract. Therefore, inadvertent lead placement on the anterior wall or at the junction between anterior and septal walls (rather than septal fixation) may endanger the LAD with the helix of an active-fixation lead and cause acute myocardial infarction.

The paced ECG may show a right bundle branch pattern if the lead paces the left ventricle usually from the pericardial space (Figure 1). The chest X ray may show the lead beyond the cardiac shadow of a peculiar appearance not seen with traditional uncomplicated right ventricular apical placement (Figure 2). An echocardiogram and CT scan should be performed to document lead position. Transesophageal echocardiography is superior to transthoracic echocardiography in delineating the entire course of a pacing lead. Difficulty in visualizing the lead in the right ventricle is not rare. The CT scan is particularly helpful when echocardiography is equivocal. Multidetector computed tomography is emerging as the imaging modality of choice in diagnosing atrial and ventricular lead perforation (Figure 3).
ECG showing a right bundle branch block pattern during VVI pacing with lead perforation of the right ventricular free wall. The previous ECG had shown a left bundle branch pattern during pacing. On top the ventricular electrograms show a dominant R wave from the tip (T) and proximal or ring electrode (R) consistent with perforation. A phonocardiogram on the right shows a pacemaker sound (PS) consistent with perforation. B = bipolar.

Chest X ray showing unusual position of right ventricular lead in a patient with lead perforation of the right ventricle documented in Figure 3.

CT scan showing perforation of a right ventricular lead

These complications may lead to death if they are not recognized early. In most patients, the leads can safely be removed percutaneously in the operating room under fluoroscopic guidance and continuous EGM monitoring to confirm the diagnosis, with surgical backup support and together with TEE monitoring. Simple withdrawal of the lead is successful in 80%
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of the cases. A stable asymptomatic perforation can be left alone if pacing and sensing are satisfactory. If parameters are unsatisfactory, a stable asymptomatic perforated lead can be left in place and a new lead implanted.

**Diagnostic Value of the Unipolar Electrogram**

High levels of ST segment elevation (current of injury) in the unipolar tip electrogram, greater than 10 mV at the time of implantation, were found to predispose to electrode perforation (Figure 4). With RV perforation the unipolar EGM may show an upright complex that looks like a standard precordial lead over the lateral chest with disappearance of ST elevation. When the lead is gradually withdrawn, some ventricular ectopy may occur as the lead passes through the ventricular wall. Then, obvious ST elevation (current of injury) occurs (Figure 5). This disappears when endocardial contact is lost. The intracavitary EGM often shows a deep S wave followed by gradual reduction of its amplitude and P waves when the lead lies in the right atrium.

Recording of an adequate unipolar ventricular electrogram from the proximal RV electrode but an atypical one from the distal electrode should raise the suspicion of lead perforation and so does the presence of ST elevation from the proximal electrode and its absence from the distal electrode. In the latter case, perforation may be absent if the distal portion of the lead is curled up and the tip points superiorly so that endocardial contact occurs only via the proximal electrode.

**Atrial Leads**

Atrial (like RV) lead perforation can be delayed for weeks or much longer. Right atrial leads may perforate both pericardium and pleura, resulting in pericarditis, cardiac tamponade, right-sided pneumothorax (associated with left-sided venous access), pneumopericardium (with or without contralateral pneumothorax), pneumomediastinum, isolated pneumopericardium and rarely aortic laceration.

Successful and safe percutaneous lead withdrawal (except for aortic perforation) has been reported and should be attempted on in the ope-

![Unipolar electrogram from the tip of a passive fixation pacemaker lead. The marked ST elevation in relation to the QRS deflection indicates myocardial wedging. Excessive wedging with marked ST elevation resembles a monophasic–like action potential. The S wave disappears because the rapid and massive ST elevation gives the impression of a dominant R wave. Withdrawal of the lead by a few millimeters restores the dominant negativity of the QRS part of the electrogram.](image)
rating room under transesophageal echocardiographic guidance. Surgery is popular based on the belief that a non-surgical approach is more likely to cause bleeding as the wall of the right atrium is thin and non-muscular.

Recurrent postcardiac injury syndrome in the absence of perforation (diagnosis by exclusion) should be considered in patients who, after pacemaker lead insertion, develop hemorrhagic pleuro-pericardial effusion associated with markers of inflammation. It may occur some weeks after uncomplicated perforation at the time of initial implantation. Cardiac tamponade is rare. A pericardial window may be required and some workers advocate lead withdrawal. Indomethacin is useful therapy. This situation may lead to surgical exploration in the belief that perforation is present.

REFERENCES


