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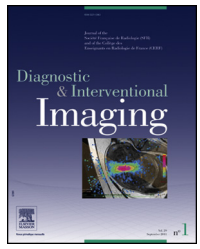

SHORT ORIGINAL ARTICLE /*Cardiovascular imaging*

Iatrogenic cardiac perforation due to pacing lead displacement: Imaging findings

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Abstract
Purpose: Cardiac perforations due to pacing and implantable defibrillator lead displacement are rare and their detection may be difficult. The goal of this study was to review the clinical and imaging presentation of cardiac perforation related to pacing lead displacement.
Patients and methods: The clinical and imaging files of four patients (two men and two women) who experienced cardiac perforation related to pacing lead displacement were reviewed. The four patients were investigated in our radiology department over a 24-month-period.
Results: Two patients had clinical symptoms at the time lead displacement was detected and the other two were free of symptoms. In all patients, lead displacement was visible on imaging examinations in retrospect but was not detected prospectively.
Conclusion: Radiologists should pay attention to the position of the tips of the leads on chest X-ray and CT, even late after the implantation and in asymptomatic patients.

Cardiac perforations due to pacing lead displacement are rare, occurring in around 0.1—1% of cases for pacemakers and in 0.6—5.2% of cases for defibrillators [1]. They are particularly rare when they occur late after implantation of the device (more than 30 days after the procedure). The diagnosis is generally made upon the six monthly check on the device and the displacement can be confirmed by imaging, which provides information about the site of the displaced lead. In other circumstances, and particularly in emergency situations, imaging is performed before the cardiology assessment and it is up to the radiologist to suggest the diagnosis.

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The goal of this study was to review the clinical and imaging presentation of cardiac perforation related to pacing lead displacement.

Patients and methods

We retrospectively reviewed all the cases of cardiac perforation related to pacing lead displacement tagged in our Picture Archiving and Communication System (Carestream Vue version 11.4.0.1253; Carestream Health, Inc., Toronto, Canada) and matching the key words ''perforation'' and/or ''heart'' and/or ''cardiac'' and/or ''lead'' over a 24-month-period (between August 2011 and September 2013 inclusively).

Clinical and all available imaging files were reviewed for all patients.

Results

Patient 1

A 24-year-old woman presented to the emergency department with respiration-dependent left basal chest pain, which had developed three days previously and was associated with breathlessness. She had neither cough nor fever. Her past history included catecholaminergic tachycardia for which a single chamber automatic defibrillator had been implanted three years previously. The defibrillation lead had been replaced six weeks prior to her presentation (active fixation lead) because of malfunction and the post-implantation cardiology review found no abnormality. Based on her clinical presentation, the recent history of the procedure and raised D-dimers (1239 ng/mL [normal value < 500 ng/mL] with a CRP of 7 mg/L [normal value < 10 mg/L]), an inspiration and expiration X-ray was performed followed by a chest CT angiogram.

The chest X-ray showed no gaseous pleural detachment. In retrospect, the pacing lead was found to have been displaced compared to the post-procedure investigation performed six weeks previously and she had a small left pleural effusion (Fig. 1).

CT angiogram showed no enhancement defect in the pulmonary arteries although in retrospection the end of the pacing lead was found to have perforated the myocardium and pericardium, passing 28 mm outside of the myocardium and coming into contact with the anterior arch of the 5th left rib. She had a moderate left sided pleural effusion but no pericardial effusion. After returning home following her consultation at the emergency department the patient was recalled after the CT angiogram had been reread. Patient condition ultimately improved after extracting the displaced lead and inserting a new one.

Also in retrospect, the tip of the lead already appeared to be incorrectly positioned on the post-implantation lateral film, projecting unusually forwards.

Patient 2

A 33-year-old man presented to cardiology for routine follow up of a dual chamber pacemaker with active fixation leads implanted nine months previously for paroxysmal complete atrioventricular block (Fig. 2). The patient was free of any symptoms. When the device was checked the cardiologist found defective capture and sensing in the right atrial lead, which was reprogrammed. He was then offered a further follow up evaluation at six months. Later during the day, the radiologist interpreted the chest X-ray and found that the right atrial lead was abnormally positioned. The patient was recalled for a chest CT with cardiac synchronization, which confirmed that the tip of the lead had perforated and entered over 2 cm into the middle lobe of the lung. He had neither pericardial nor pleural effusion, nor ground glass nor consolidation in the lung parenchyma. The patient had a favorable outcome after the displaced lead was removed.

Patient 3

A 62-year-old man who had had a focal atrial tachycardia ablated from his left atrium four years previously was admitted to the emergency department in another hospital with palpitations. His electrocardiogram (ECG) showed a re-entry tachycardia of over 200 beats/minute, which was treated with verapamil. Shortly afterwards, the patient developed a very slow bradycardia with long pauses which required a temporary external pacemaker to be inserted and he was then transferred to our hospital for radiofrequency ablation of the cardiac arrhythmia. His pre-procedure cardiac CT angiogram showed perforation of the apex of the right ventricle with displacement of the lead more than 6 cm outside of the myocardium, the tip of the lead coming into contact with the diaphragm (Fig. 3). This perforation could not have been suspected from the chest X-ray, which was performed at the patient's bedside. The patient improved after removal of the temporary lead and radiofrequency ablation.

Patient 4

A 69-year-old woman was referred to the emergency department by her general practitioner because of worsening of clinical condition, abdominal pain and grade IV dyspnea. The patient had past history including atrial disease (alternating sinus pauses and episodes of tachyarrhythmia on a Holter ECG) for which a pacemaker had been implanted three months previously (Fig. 4). An outpatient blood sample showed a severe acute phase reaction with acute renal failure, hepatitic changes and vitamin K antagonist (VKA) overdosage, with an INR > 7. As a result of her clinical presentation, an acute abdominal condition with secondary dyspnea was first considered and an unenhanced abdominal CT (not enhanced because of her renal failure) which was performed before the chest X-ray showed firstly acute cholecystitis and secondly a large hemopericardium. Abdominal ultrasonography confirmed acute cholecystitis and also showed signs of a cardiac liver. The patient was then directly transferred to the cardiology intensive care unit where an echocardiogram confirmed a large pericardial effusion with severe impact on the cardiac cavities. Nine hundred and fifty mL of serous-bloody pericardial fluid were aspirated followed by improvement in cardiorespiratory status. One week later, cardiac CT angiogram confirmed displacement of the lead, the tip of which had penetrated the