Left ventricular free wall perforation by a right ventricular pacemaker lead: a case report

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Background
Lead perforation is one of the major complications of pacemaker implantation, but cases of right ventricular (RV) lead perforation through the septum and left ventricle are rarely reported. We described a rare case of left ventricular (LV) free wall perforation by an RV lead and the management of this complication.

Case summary
An 84-year-old man was admitted with a dual-chamber pacemaker due to pacing failure caused by an RV lead fracture. New lead implantation was performed on the next day, but pacing failure occurred again on the second post-operative day (POD). We found the lead perforation on the fluoroscopy during temporary pacemaker insertion. Computed tomography scan and transthoracic echocardiogram showed that the added lead perforated through both the septum and LV free wall. A new lead was inserted on the fourth POD, and an off-pump open chest surgery for extraction of the penetrating lead was performed uneventfully on the 20th POD.

Discussion
We considered that some features of the lead (SelectSecure 3830-69, Medtronic) may be related to this complication, as the lead was very thin, had a non-retractable bare screw and was inserted with a dedicated delivery catheter. We have to be careful when performing implantation of this kind of lead to avoid such a rare complication.

Keywords
Case report • Pacemaker • Complication • Lead perforation • Left ventricular perforation • Lead extraction

Learning points
- Pacemaker lead perforation not only through the septum but also through the left ventricular free wall is a rare but serious complication following pacemaker implantation.
- Despite initially unremarkable pacemaker performance measurements, lead perforation has to be considered when pacing failure occurs and further diagnostic examinations should be performed.
- One should take extreme care not to screw a lead deeply and not to give too much slack. This is particularly the case for non-retractable bare screw leads that are implanted using a dedicated delivery catheter.
Cardiac perforation by a pacemaker lead is a serious and rare complication, occurring in only 0.1–0.8% of pacemaker implantation procedures. Although most perforations are recognized during or shortly after implantation, subacute and late perforations have also been reported. The most frequent site of lead perforation is the right ventricular (RV) apex; however, only one case of lead penetration through both the ventricular septum and the left ventricular (LV) free wall has been reported. Here, we described a case of both septum and LV free wall perforation by an RV pacemaker lead within a few days after the new lead insertion.

### Case presentation

An 84-year-old Japanese man with a dual-chamber pacemaker implanted via the left cephalic vein for complete atrioventricular block 7 years prior was admitted to our hospital with syncope due to pacing failure caused by an RV lead fracture (impedance: 1671 Ω, threshold: 2.25 V at 0.4 ms) (Figure 1A). He was on 10 mg amlodipine besylate and 100 mg aspirin once a day for hypertension and atherosclerotic stroke, and not on any medicine precipitating syncope. There were no signs of neurological deficits. The previous device check-up conducted 6 months prior to pacing failure showed normal impedance, threshold and pacing status (562 Ω, 1.25 V, 70% of atrial and 100% of ventricular pacing). He had no finding of heart failure, and the transthoracic echocardiogram (TTE) on admission showed normal LV contraction (ejection fraction was 55%) and mild tricuspid valve regurgitation. There was no visible dislocation or lead fracture on the chest X-ray.

On the following day, a new RV lead, a thin lumenless lead with a diameter of 1.37 mm (SelectSecure 3830-69, Medtronic, Minneapolis, MN, USA) was inserted. It was carefully screwed into the RV septum with a non-deflectable delivery catheter (C315S10, Medtronic). This lead was selected because of its thinness as there was a narrowing of the left cephalic vein caused by the two previous leads. Moreover, we considered that it might be easy to screw it to a specific position by a non-deflectable delivery catheter despite of the obstruction by the previous RV lead. There were no abnormalities and no complications during and immediately after the surgery (intraoperative RV lead impedance and threshold were 814 Ω and 0.9 V, and those immediately after operation were 646 Ω and 1.0 V, respectively).

On the first post-operative day (POD), transient ventricular pacing failure appeared with more than 10-s pause causing syncope. His electrocardiogram showed the right bundle branch block pattern (Figure 1B), but there was neither detectable pericardial effusion on TTE nor pneumothorax or dislodgement on X-ray (Figure 1C). However, such pacing failure became more frequent. Finally, on the second POD, he had a pacemaker exit block with a slow ventricular escape rhythm (20 b.p.m.) (Figure 1D). Right ventricular lead data did not show any remarkable change (RV lead impedance and threshold were 513 Ω and 1.75 V, respectively). A temporary transvenous pacemaker was inserted emergently, and we first found the additional lead penetrating through the cardiac wall on fluoroscopy (Figure 2A). Computed tomography (CT) and TTE showed the tip of the additional lead exiting in the left thoracic cavity passing through the septum and the LV free wall (Figure 2B–D). On the fourth POD, an additional new lead (CapSureFix NOVUS 5076-SB, Medtronic) was inserted in the RV septum, and the temporary transvenous pacemaker was removed. Finally, an off-pump open chest surgery for the extraction of the penetrating lead was performed on the 20th POD, with prior discontinuation of aspirin for 2 weeks. The tip of the lead was found piercing through the LV posterior free wall into the thoracic cavity (Figure 3). The parietal pleura was scratched by the tip of the lead without lung damage. The lead was extracted from the generator pocket smoothly, and the perforation wounds of the LV and pericardium were sutured using the felt sandwich technique. The clinical course after the open chest surgery was uneventful. On subsequent pathological examination, the tissue sample from the extracted lead showed the normal structure of the myocardium.

The patient was discharged on the 34th POD, and he had been uneventful for a year.

### Discussion

We experienced a rare case of RV pacemaker lead perforation through both the septum and the LV free wall. We speculate the patient’s clinical course after the new lead insertion as follows: first, when the pacing failure occurred on the first POD, the lead perforated only through the septum; second, the failure occurred and resolved because of the intermittent LV wall pacing after the penetration of the septum; finally, the pacing failed completely when the lead penetrated through the LV free wall.

We consider that certain features of the lead (SelectSecure 3830-69, Medtronic) are related to this complication. It is thin with a non-retractable bare screw and is inserted with a dedicated delivery catheter. The tip load of the thin lead is quite heavy and may have created some stress on the cardiac wall. Moreover, the operator’s torque was easily and directly conducted to the tip of the lead while positioning the lead into the
cardiac wall with its non-retractable screw; thus, it may have caused subacute damage to the deeper layers of the myocardium, including perforation. This lead is successfully used in clinical practice for His-bundle pacing (HBP) and left bundle branch area pacing (LBBAP). Here, we considered that HBP and LBBAP would not be optimal for our elderly patient with preserved LV function; however, the features of the lead being thin and easily controllable were useful as described in the previous section. All the reported lead perforations related to HBP and LBBAP were caused by this lead and the delivery system. There were some reports of septal perforation by this lead but not of LV free wall perforation before. To avoid such a lead complication with additional lead implantation, a leadless pacemaker in combination with the functional AAI system could be an alternative therapy.

On initial examination, X-ray and TTE were not suggestive of lead perforation. According to a previous report on patients with lead perforation, pericardial effusion and tamponade occurred in only 38% and 19% of patients respectively, although 72% of all patients showed symptoms. Hence, CT should provide an accurate diagnosis in cases with ambiguous findings. There is only one previous case reporting asymptomatic RV lead perforation through both the septum and LV free wall. According to that report, diagnosing lead perforation with no obvious findings was quite difficult; however, the lead perforation was found unexpectedly by X-ray at a routine 2-week follow-up.

Figure 1 Twelve-lead electrocardiogram and chest X-ray on the admission day and first and second post-operative day. (A) The initial electrocardiogram on admission showed that ventricular pacing occurred once every two times of atrial pacing. (B,C) Twelve-lead electrocardiogram showed the right bundle branch block pattern and X-ray showed no abnormalities after syncope. (Black arrow shows the new right ventricular lead.) (D) Twelve-lead electrocardiogram showed transient failure of ventricular capture.
appointment. Thus, the present case is the first to show the course of the progress of RV lead perforation through the LV wall.

With respect to lead extraction, a previous study reported transvenous extraction with cardiac surgery in standby as a safe method to treat the lead perforations; however, there has been no clear consensus on the appropriate management of LV perforation in stable patients. Here, we chose an open chest surgery for the extraction of the penetrating lead because of the high risk of LV free wall penetration. As a result, there was no complication with the lead extraction.

In conclusion, we experienced a rare case of RV lead perforation through the septum and the LV free wall. We recommended that while inserting thin leads with a non-retractable bare screw by a dedicated delivery catheter, extreme care should be taken to avoid screwing too deeply and creating excessive redundancy and to wait for a moment until the torque can be released.

**Figure 2** Various imaging modalities showing the lead perforation. (A) White arrows show following leads on fluoroscopy at the time of temporary transvenous pacemaker insertion. (a) right atrial lead, (b) old right ventricular lead, (c) the new lead penetrating through the cardiac wall, (d) temporary transvenous pacemaker lead. (B) White arrow shows the new lead passing through the septum on transthoracic echocardiogram. (C, D) White arrow shows the new lead passing through the septum (C), and its tip exiting in the left thoracic cavity through the left ventricular free wall on computed tomography (D). LV, left ventricle; RV, right ventricle.

**Lead author biography**

Natsuko Satomi, M.D., is working as a general cardiologist at the Cardiovascular Center in Ogikubo Hospital, from 2019. She graduated from Nippon Medical School in 2015. She finished her resident program (2015–17) in Tokyo Metropolitan Police Hospital and her fellowship in cardiology (2017–19) at Tokyo Women’s Medical University. Currently, she and her colleagues are working actively in treating
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**Supplementary material**

Supplementary material is available at *European Heart Journal—Case Reports* online.