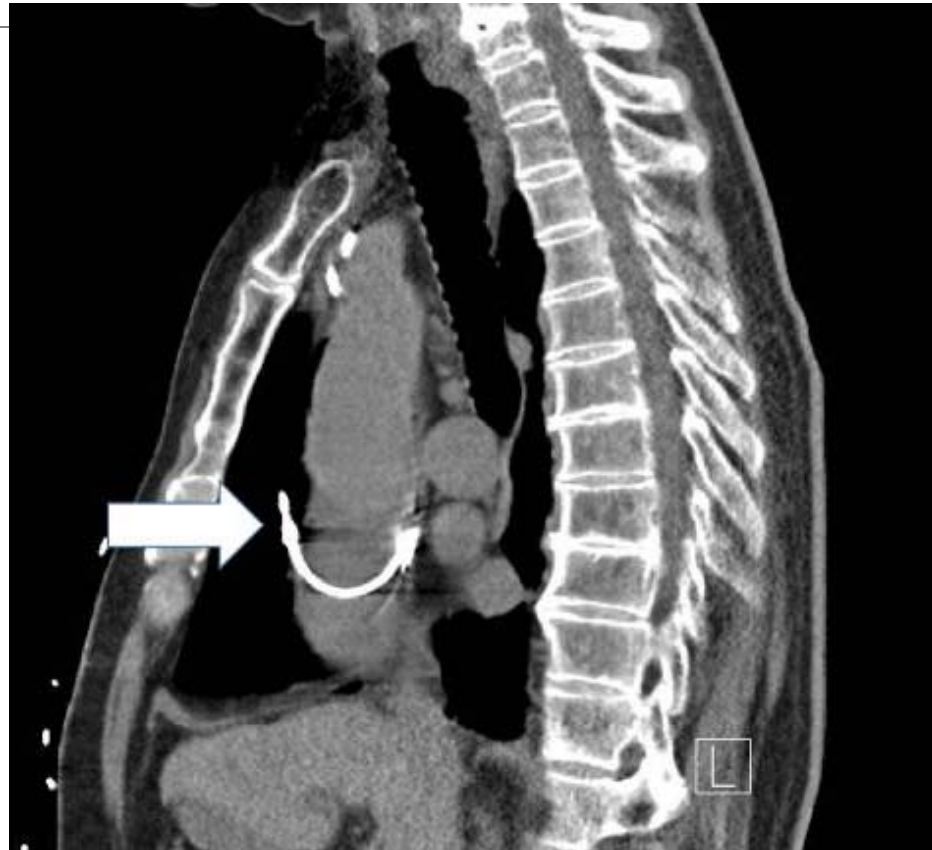




ΓΕΝΙΚΟ ΝΟΣΟΚΟΜΕΙΟ ΑΘΗΝΩΝ
Ο ΕΥΑΓΓΕΛΙΣΜΟΣ

Lead perforation – A case report



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Ειδ/νος καρδιολογίας
ΓΝΑ «Ο Ευαγγελισμός»

Case presentation

83-years-old male presented to the emergency department with a 4-days history of fever 38°C and dyspnea.

The patient's history included: smoking (>30pack years), COPD, hypertension, surgically repaired abdominal aortic aneurysm, colectomy due to colon cancer and a recent (one month ago) dual chamber pacemaker implantation because of complete AV block.

The physical examination revealed:

Vital signs: BP: 140/80mmHg, pulses:115/min, SpO2: 93%, Temp 37,7°C

Tachypnea, S1S2 irregular sounds without murmurs, bilateral basilar crackles, bilateral lower extremities edema, jugular veins distention

Blood exams showed increased inflammatory markers (wbc, crp) without other pathological findings

ECG

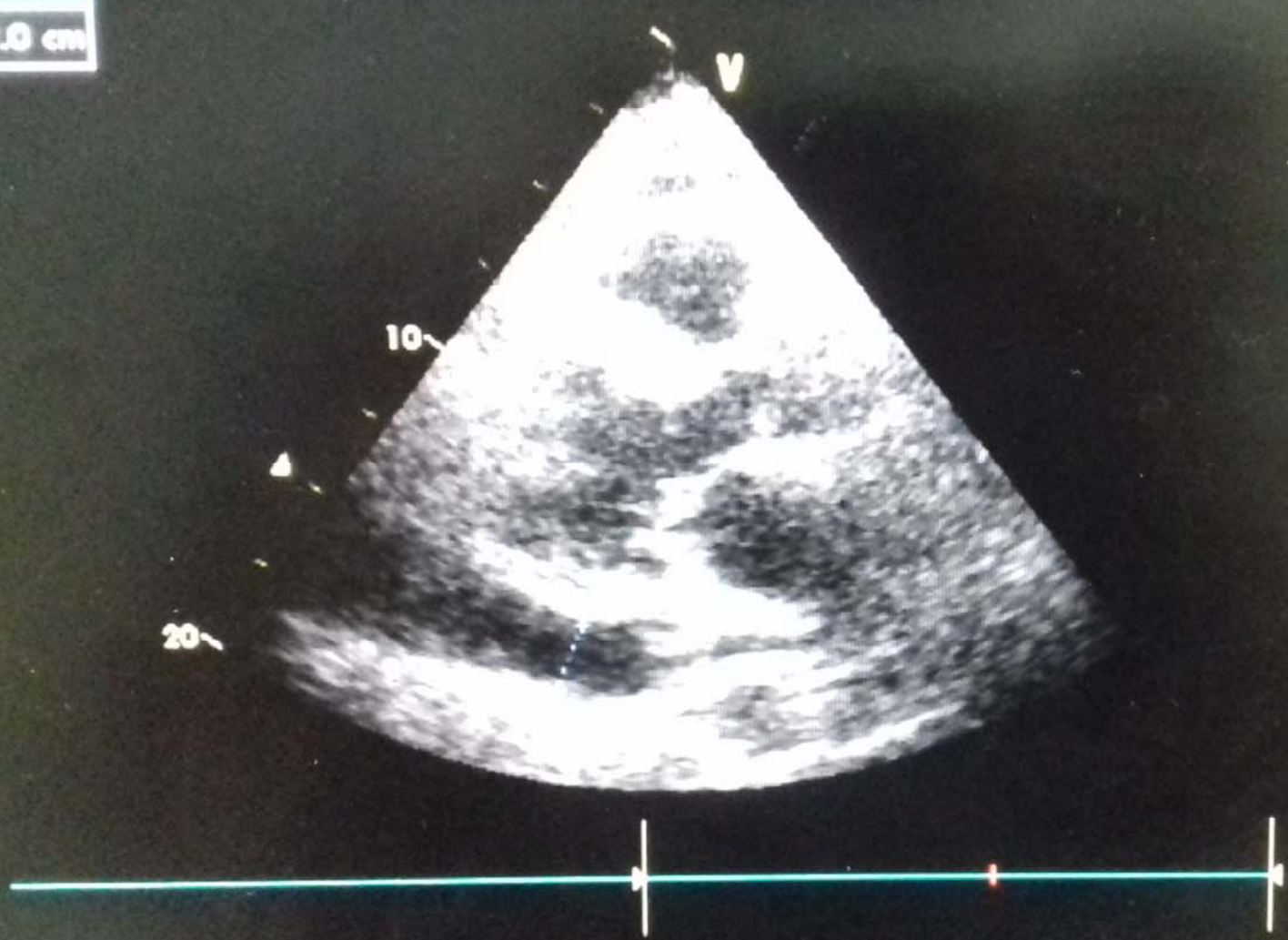


Echo findings

EF 45% with paradoxical movement of the interventricular septum, ARoot within normal range, MR 1-2+/4+, TR 2+/4+, PASP 40mmHg and circular pericardial effusion measured (1,4cm) without echocardiographic findings of tamponade.

Device interrogation revealed loss of capture of the atrial lead

Subsequent echocardiographic evaluations showed a progressive increase in pericardial effusion (3,2cm) without tamponade physiology findings

A screenshot of the "ZD Freeze" menu from the game. The menu has a dark blue background with white text. At the top, it says "ZD Freeze". Below that are several options: "Freeze", "Unfreeze", "Freeze All", "Unfreeze All", "Freeze Selected", "Unfreeze Selected", "Freeze Deselect", "Unfreeze Deselect", "Freeze Deselect All", "Unfreeze Deselect All", "Freeze Deselect All", "Unfreeze Deselect All", "Freeze Deselect All", "Unfreeze Deselect All". The "Freeze" option is highlighted with a yellow bar.

1 L 1.8 cm



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2D Freeze

Compress

Adaptive Reject

DDP

UD Clarity



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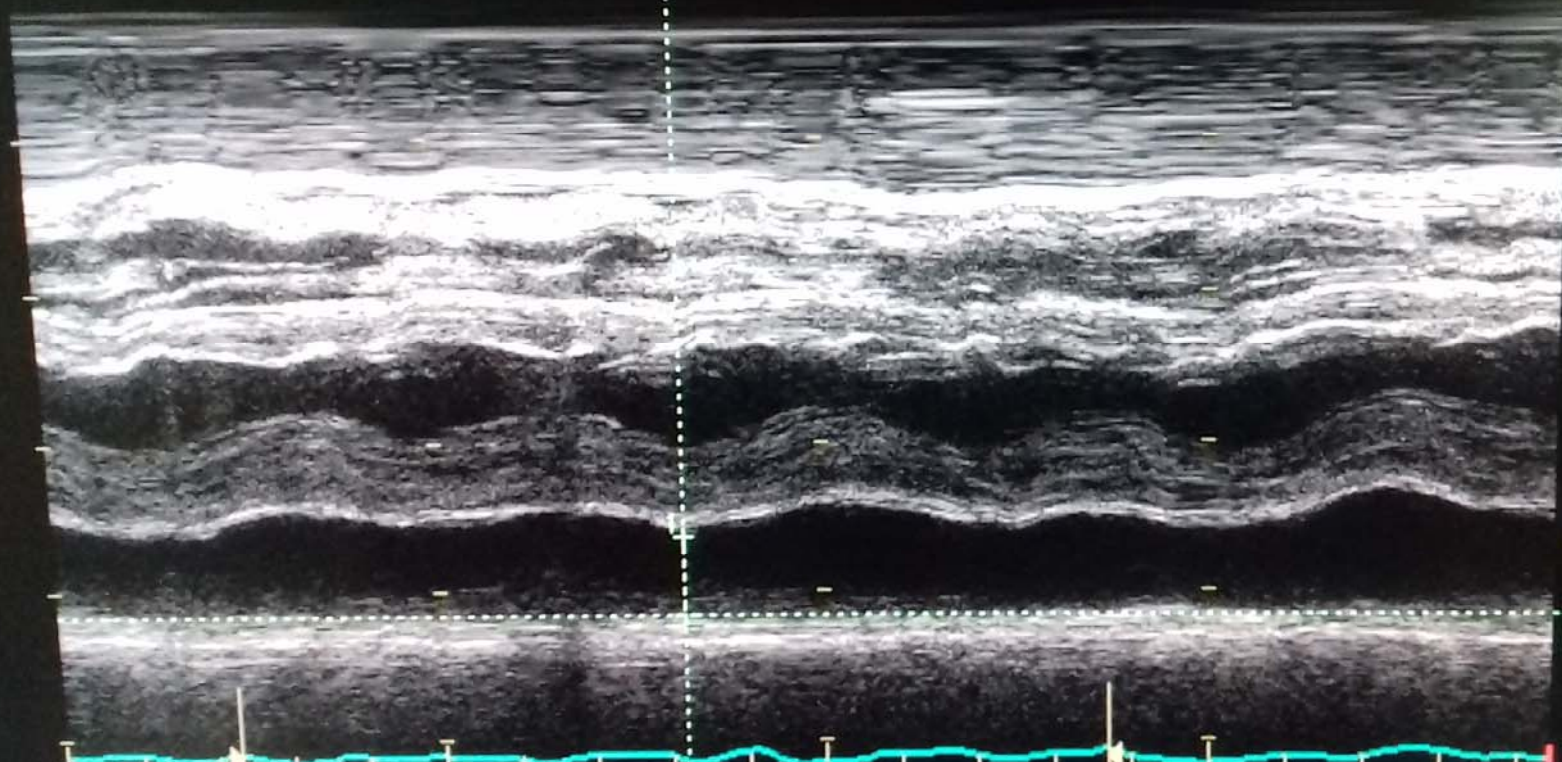
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1 L 2.7 cm

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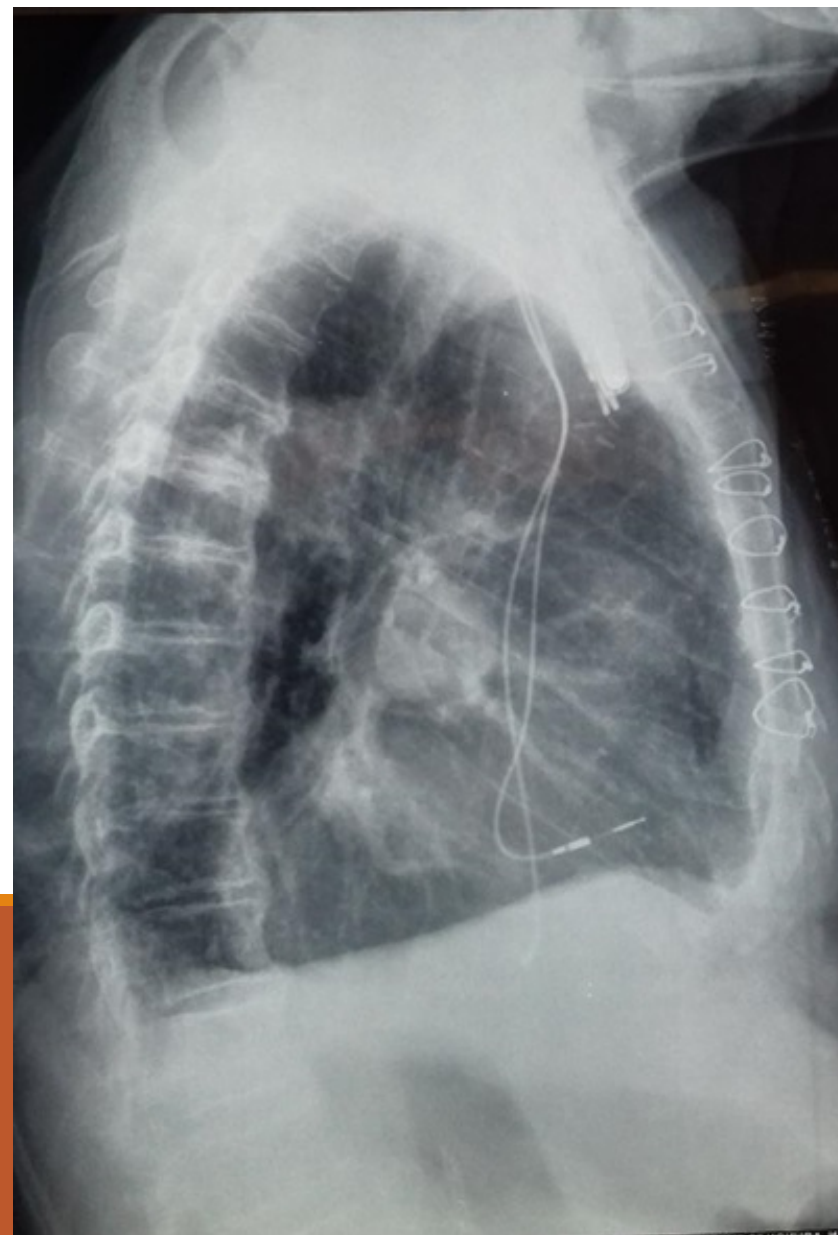
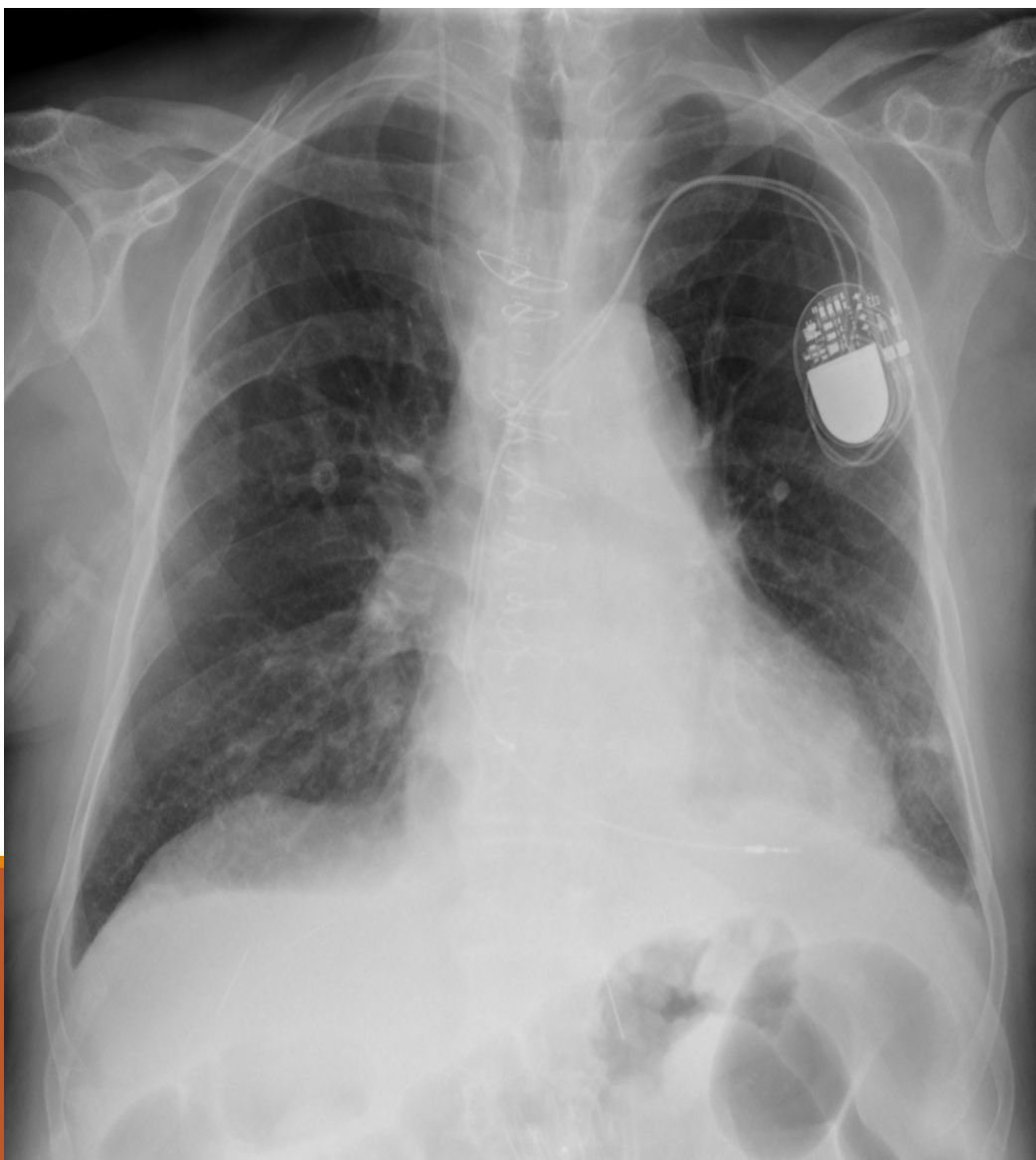
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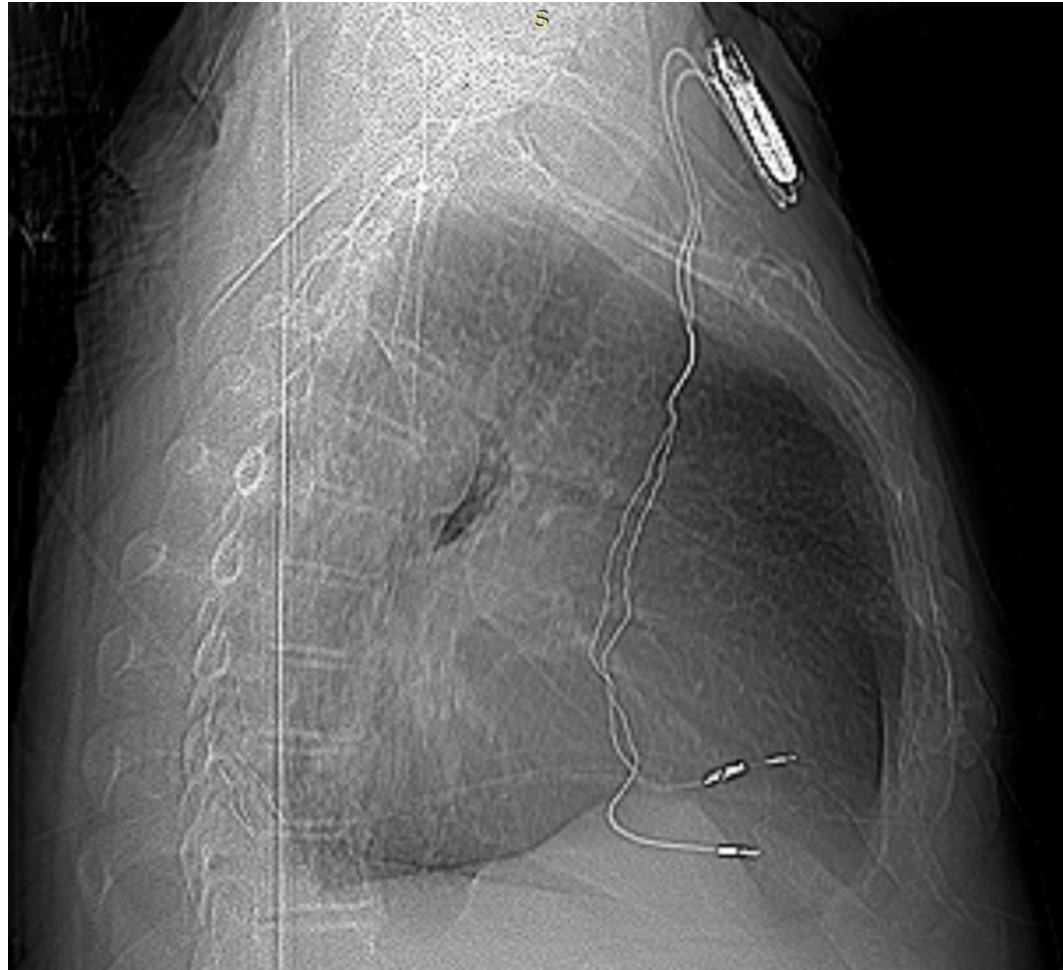
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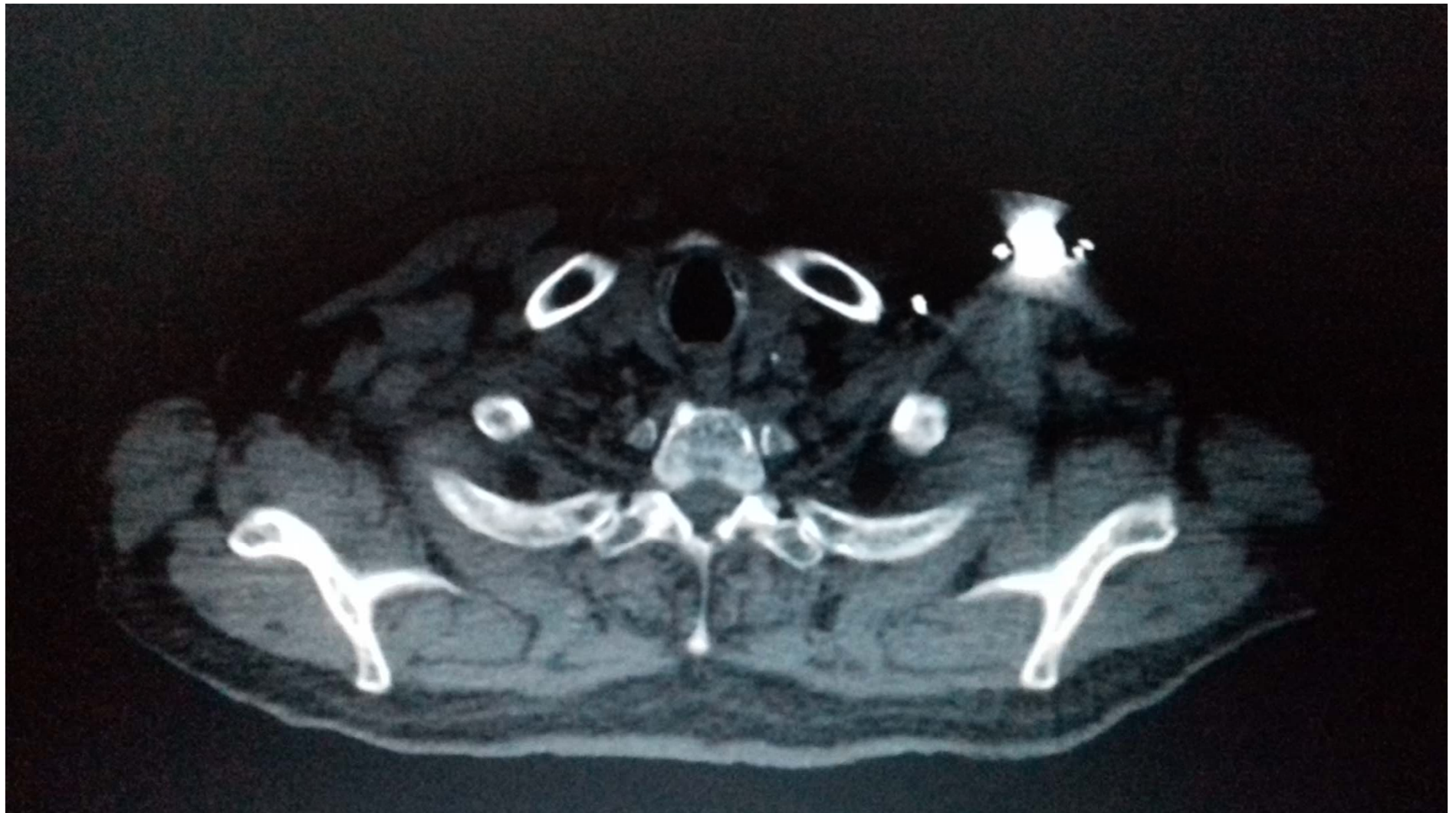
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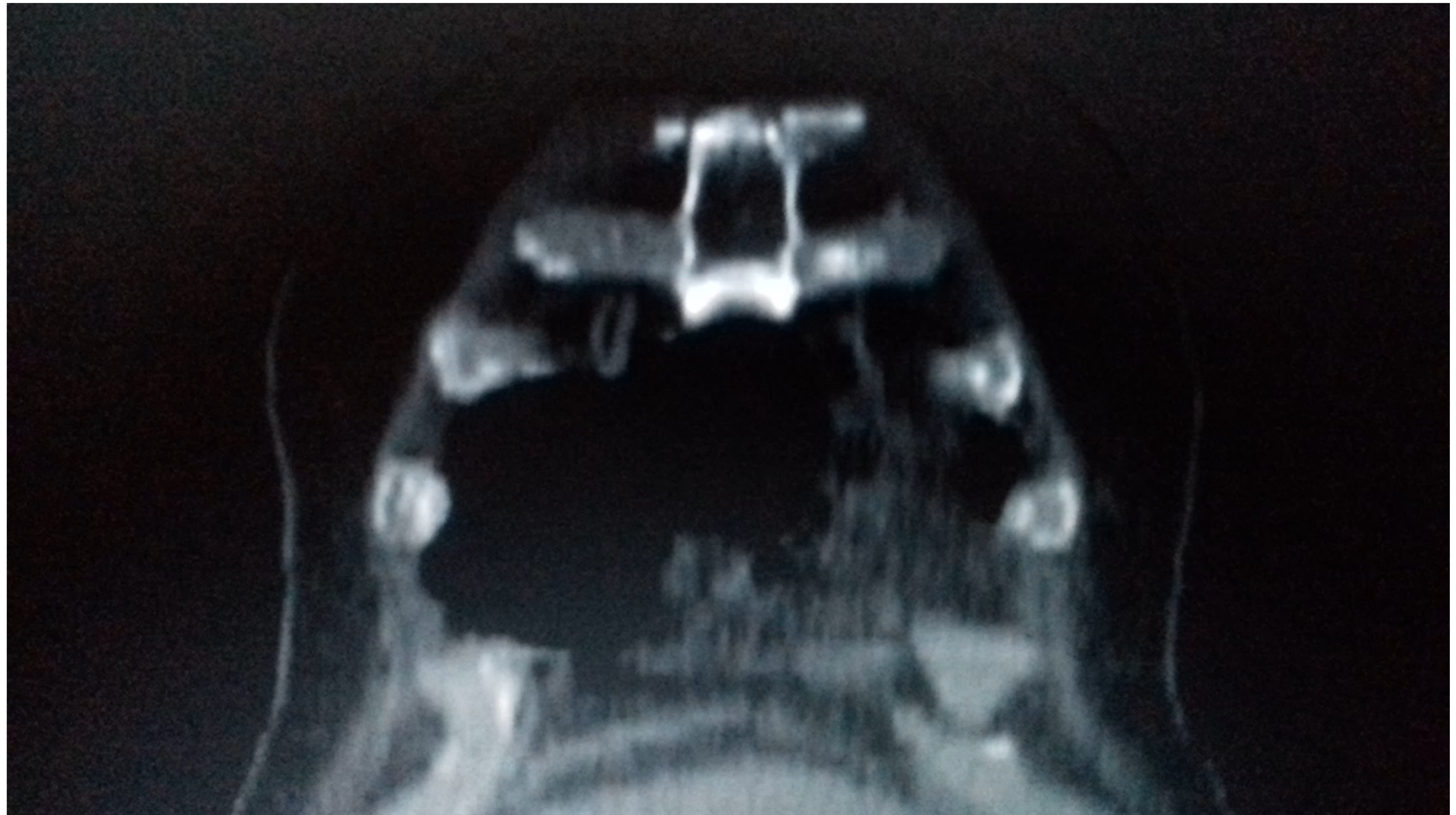
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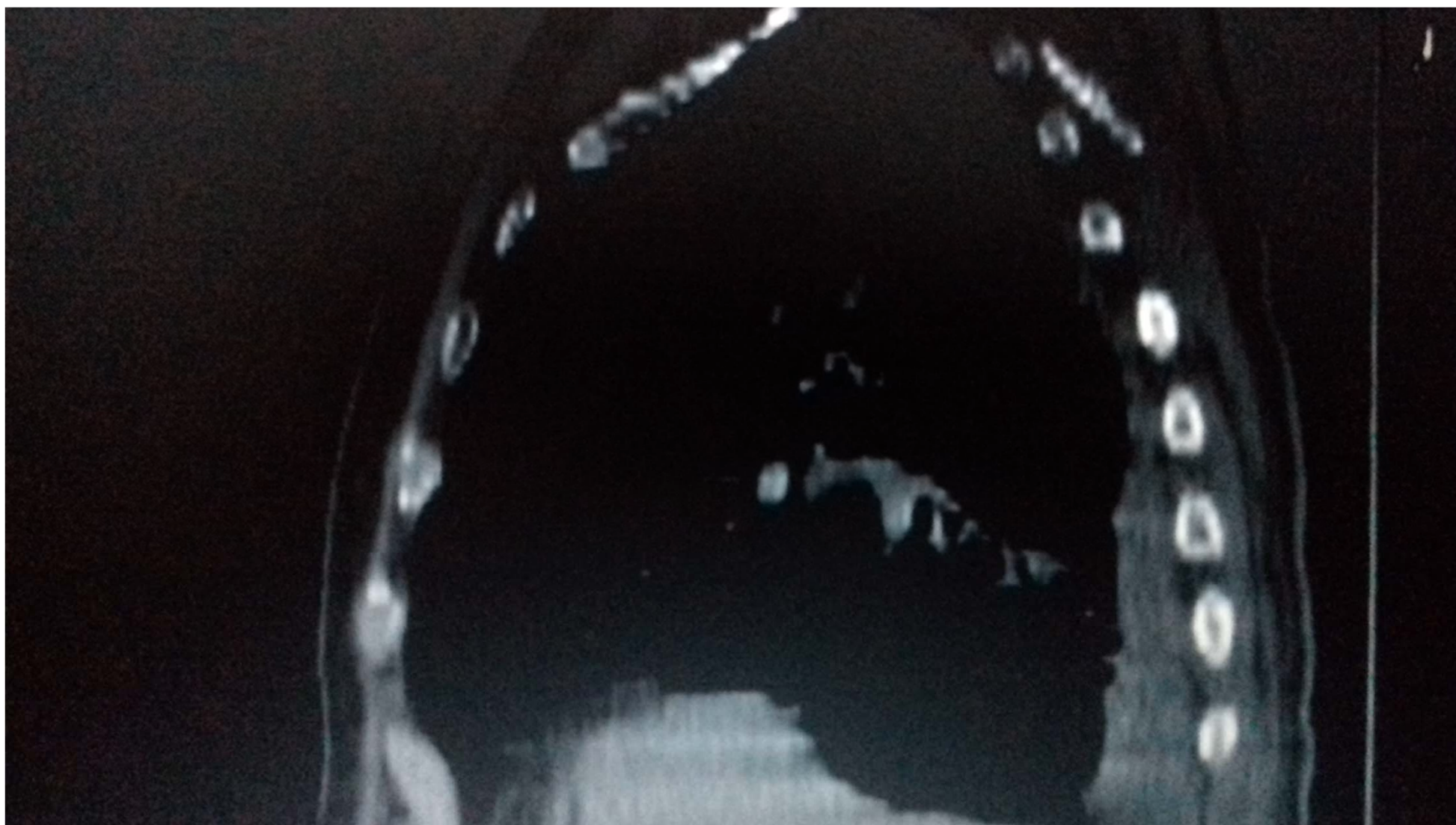


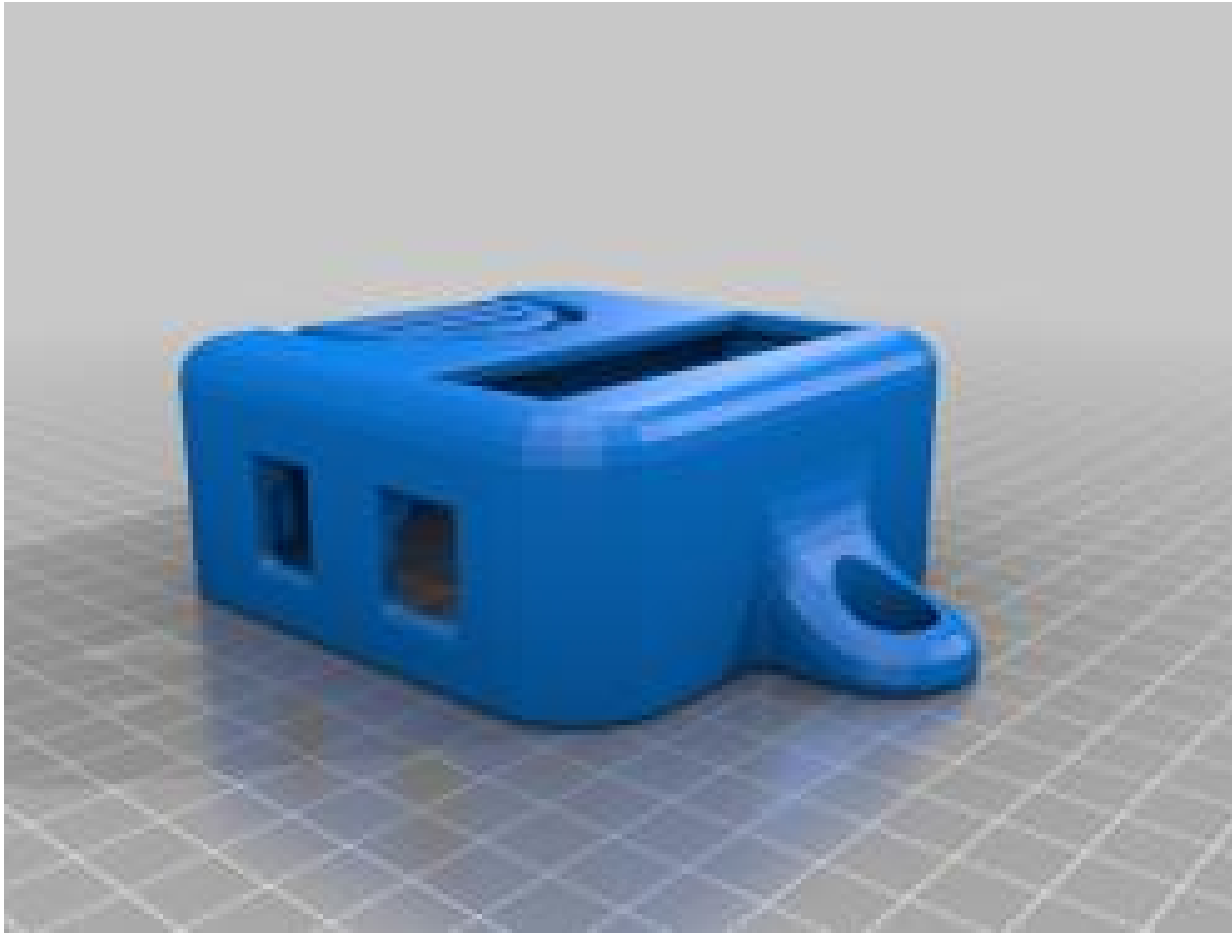






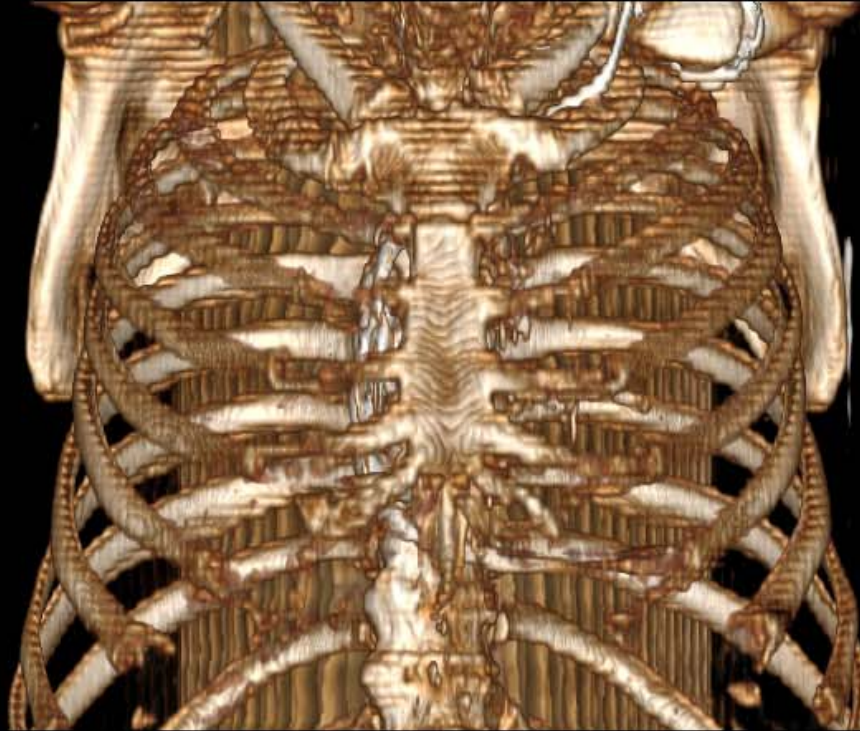






3D
models

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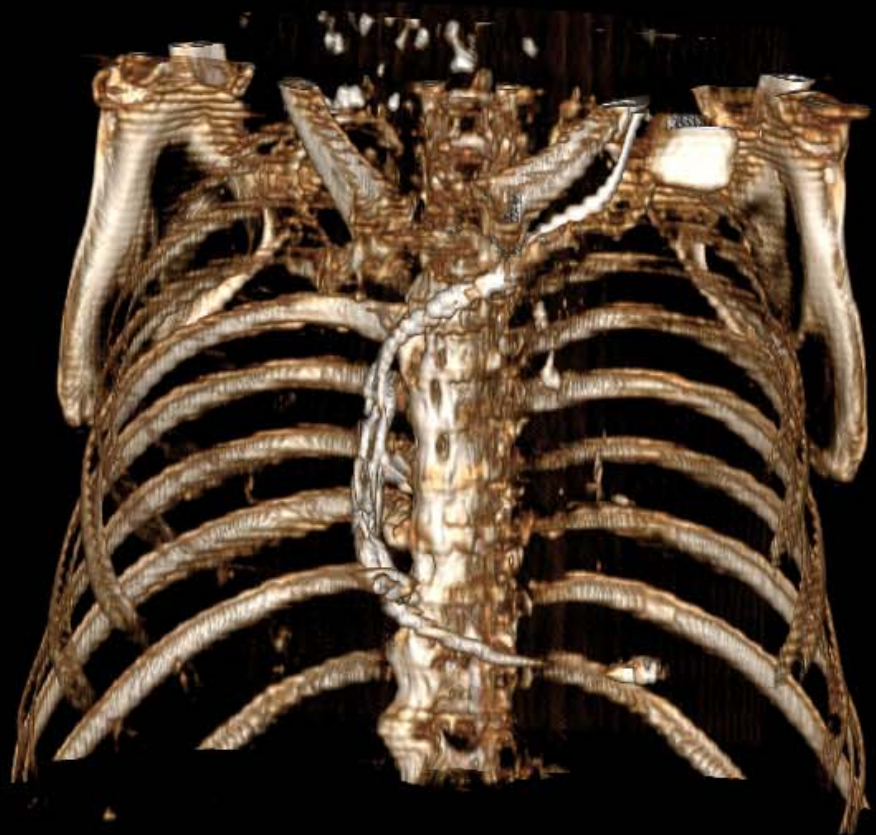


I

WW: 332

L-R: 0.0 S-I: 0.0

S



I

WW: 327

L-R: 7.2 S-I: 9.7 Ro

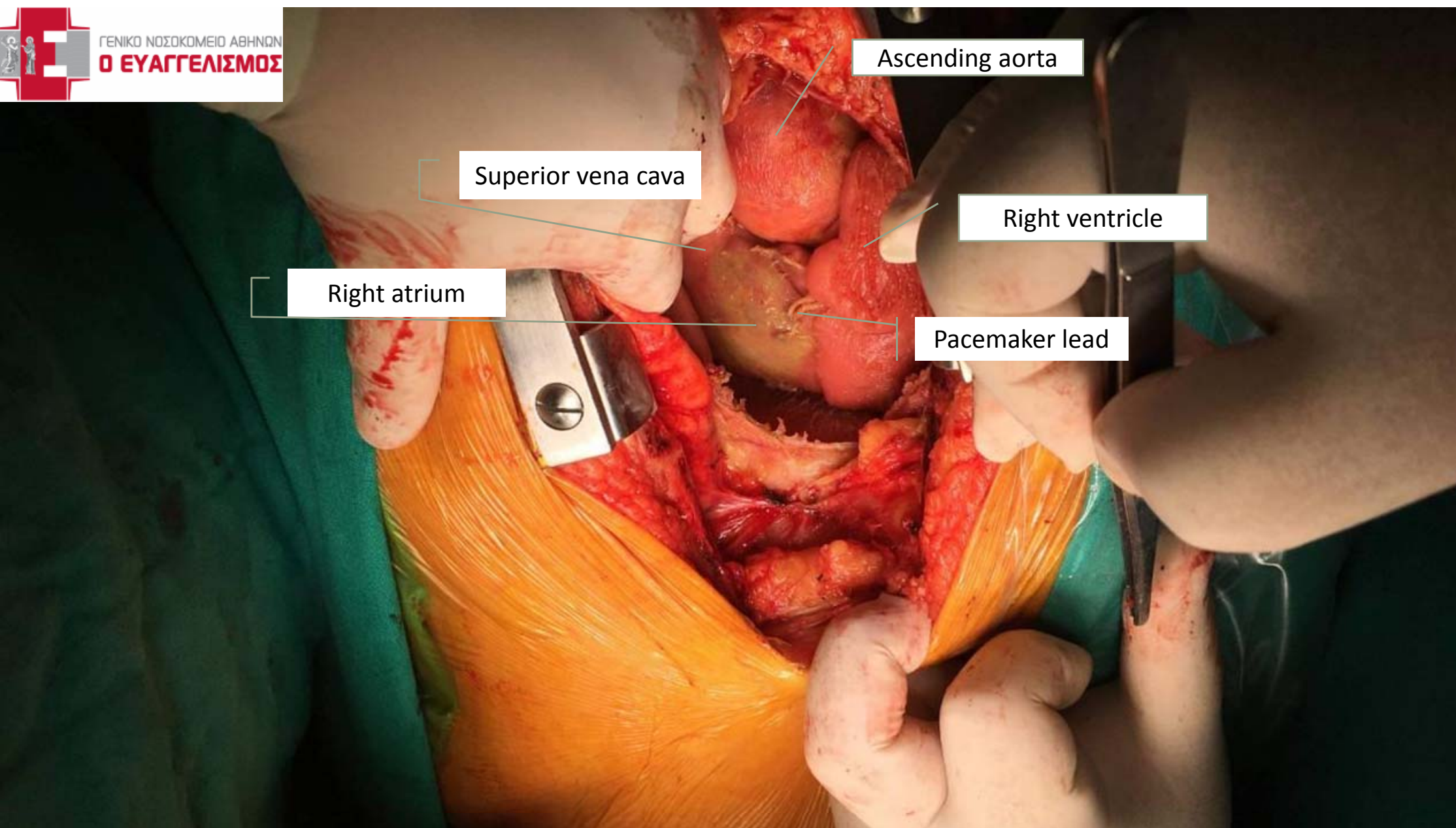
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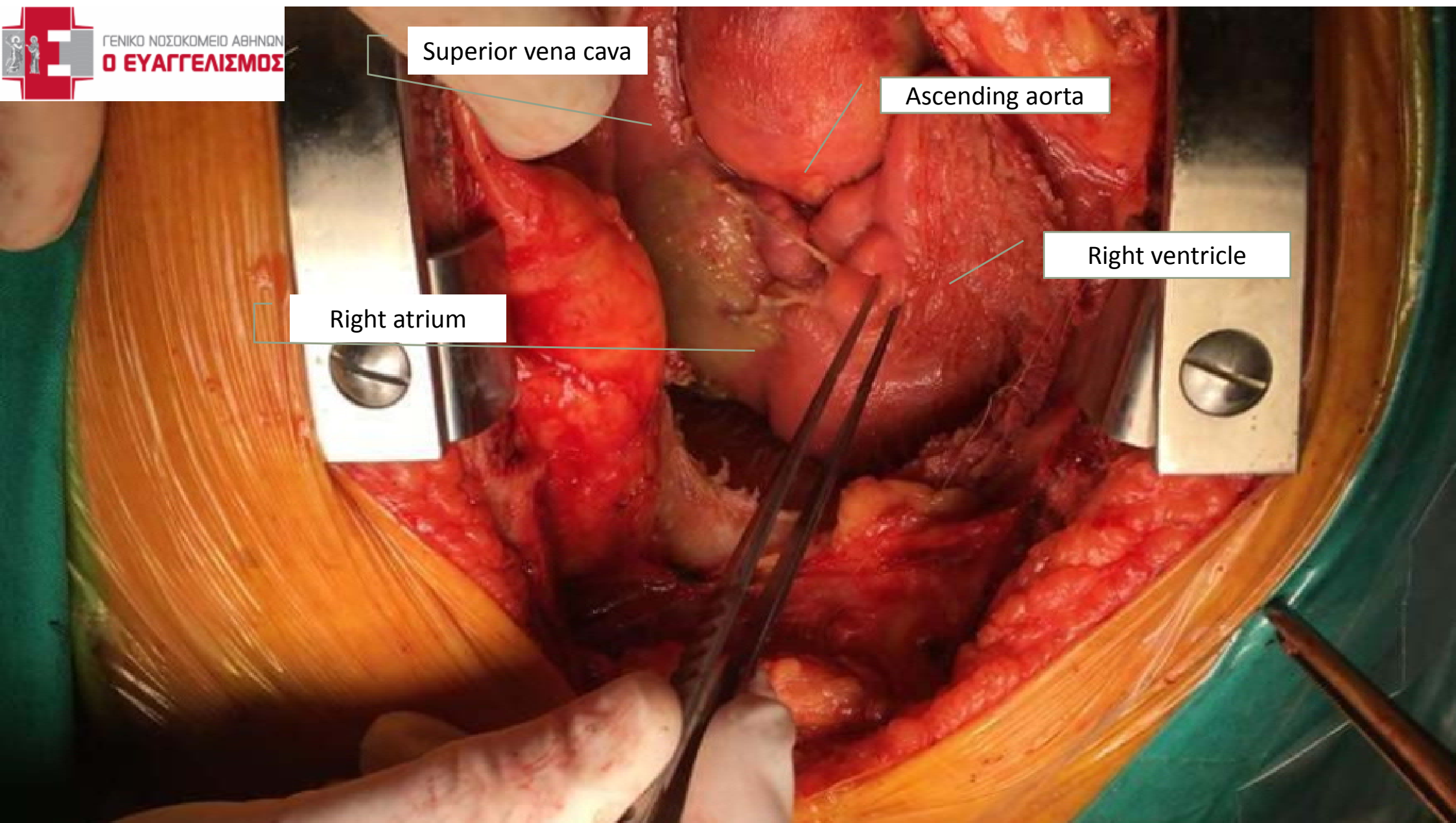
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L-R: 7.2 S-I: 9.7 Roll: -2.0

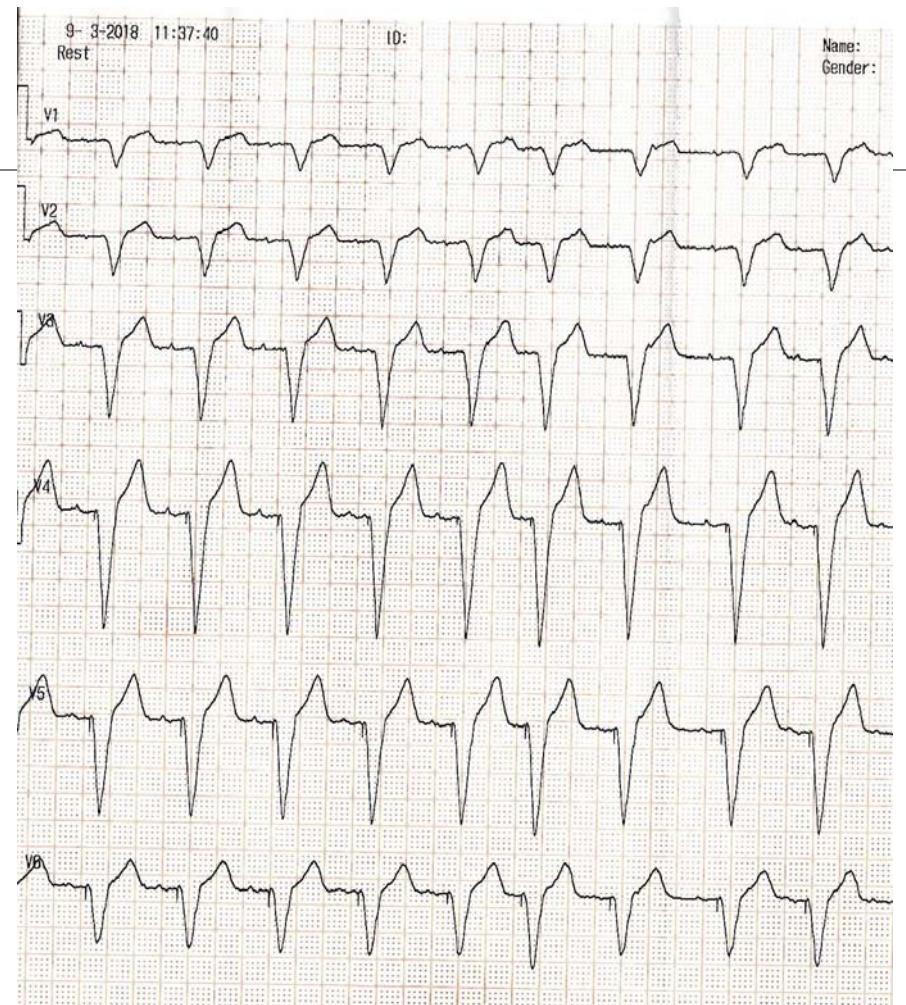
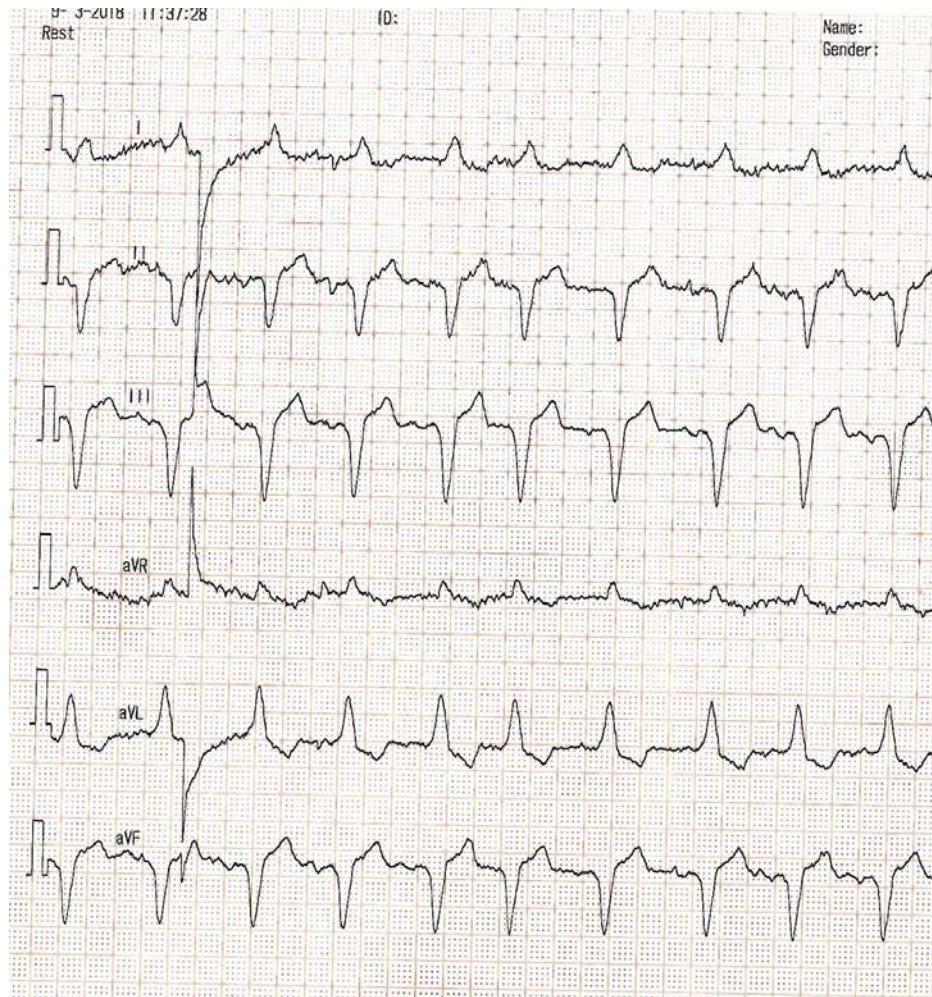


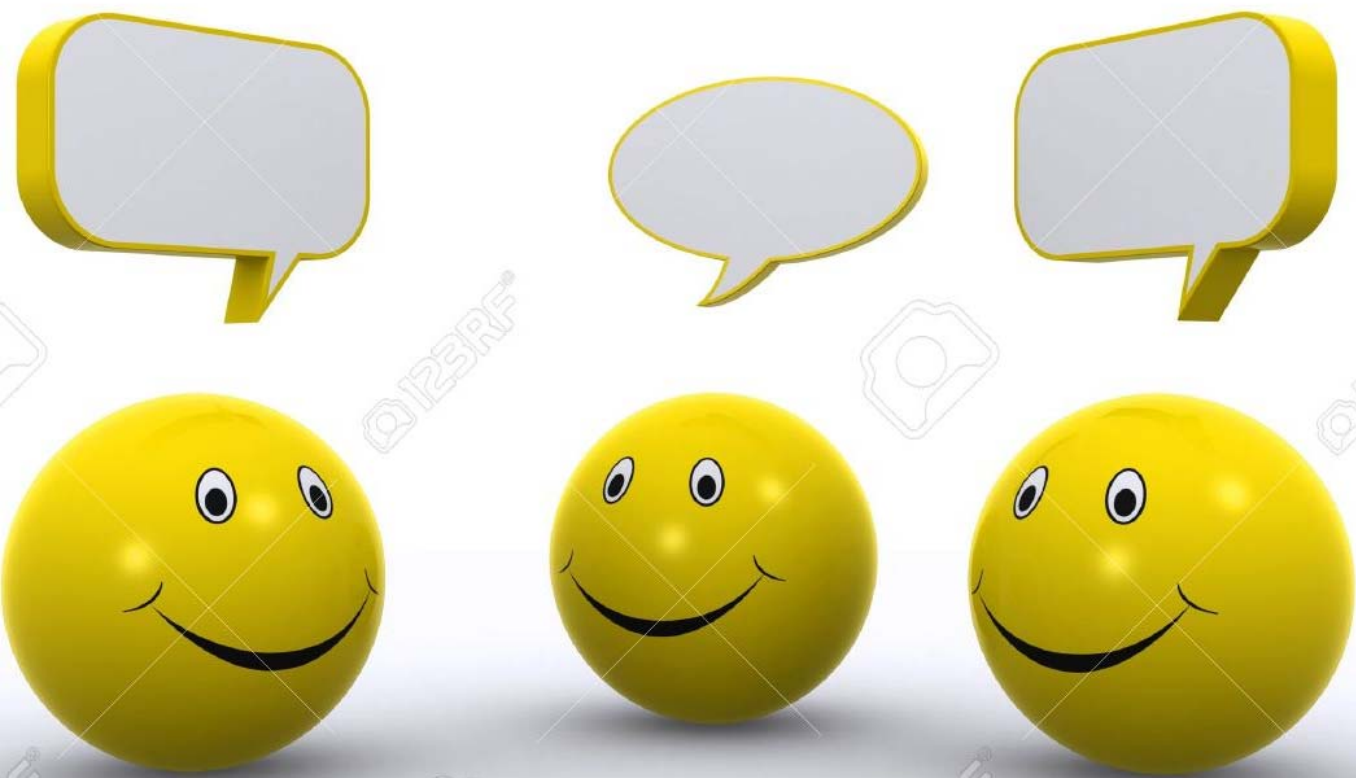


ΓΕΝΙΚΟ ΝΟΣΟΚΟΜΕΙΟ ΑΘΗΝΩΝ
Ο ΕΥΑΓΓΕΛΙΣΜΟΣ



VVD pacing





Discussion

Lead perforation

Device-related ventricular wall perforations are **acute**, **subacute**, or **chronic/delayed** when they occur within **24 hours**, **one month**, or **more than one month** after implantation, respectively

Lead perforation has a relatively rare complication rate of between 0.1%–0.8% for pacemaker leads and 0.6%–5.2% for implantable defibrillator leads

Pacing Clin Electrophysiol. 2005 Mar; 28(3):251-3

Cardiac perforation from atrial fixation electrode (usually the free wall of the atrium) is rare (0.6–1.2%), occurring during the procedure or within a few days, causing dyspnoea.

Heart. 2003 Apr; 89(4): 364

- Mild pain to severe life-threatening conditions like cardiac tamponade

Predictors of perforation

Mahapatra et al → In a large retrospective study of 4280 patients who underwent pacemaker insertions between 1995 and 2003, concluded that the strongest predictors were:

- ✓ **oral steroid use** (HR 4.1, 95% CI 1.1–10.0, $P=0.003$), during the seven days preceding the procedure and
- ✓ **temporary transvenous pacemaker** (HR 3.2, 95% confidence interval [CI] 1.6-6.2, $P = .001$)

Weaker predictors: helical screw ventricular leads, body mass index (BMI) <20, older age, and longer fluoroscopy times

Univariate model

Predictors of perforation

- ✓temporary pacemaker (HR 2.7, 95% CI 1.4-3.9, $P = .01$)
 - ✓helical screw leads (HR 2.5; 95% CI 1.4-3.8, $P = .04$), and
 - ✓steroids (HR 3.2, 95% CI 1.1-5.4, $P = .04$).
- ❖Right ventricular systolic pressure >35 mmHg was the only **protective** factor (HR 0.70, 95% CI 0.50-0.92, $P = .02$).

Multivariate model

Predictors of perforation

- ✓age >80 years (OR 3.84, 95% CI 1.14-12.87, P = 0.029)
- ✓female sex (OR 3.14, 95% CI 1.07-9.22, P = 0.037)
- ✓apical position of the right ventricular lead (OR 3.37, 95% CI 1.17-9.67, P = 0.024)

ACTIVE fixation pacing and defibrillation leads

Multivariate model

Predictors of perforation – model of leads

72 cases implanted with Medtronic CapSureFix 5086 MRI SureScan leads, the original MRI-compatible leads

VS

420 cases implanted with Medtronic SureScan leads 4076 and 5076, which were not specifically designed for MRI compatibility.

Perforations occurred in 5.5% versus 0.47% of the cases, respectively ($P = 0.005$).

REASON: This was partly attributed to a change in cable design and active fixation helix which was thought to increase complication rates

Predictors of perforation – model of leads

- The use of active fixation leads is associated with an increased risk of cardiac perforation
- No correlation was found between the perforation rate and any particular model of the implanted lead
- The number of perforations does not differ significantly between the pacemaker and implantable cardioverter defibrillator implantations

Diagnosis of lead perforation



Diagnosis - ECG



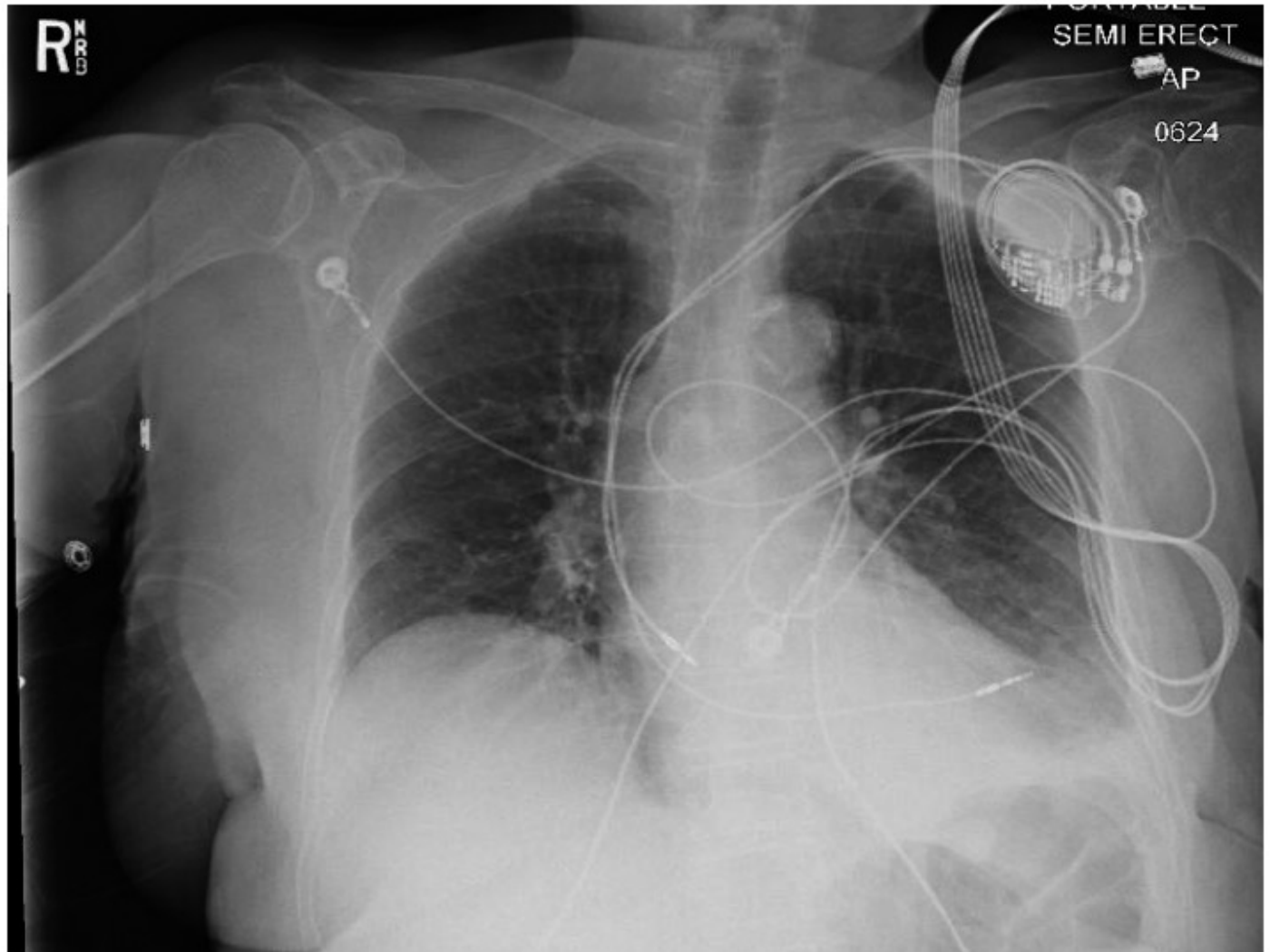
Diagnosis - Interrogation

	Normal values	Expected change in perforation	Why the parameter may change differently even in perforation
Impedance	400–1000 Ohms	Usually decreased	May increase if the lead ends in an air-filled space
Sensing (R-wave amplitude)	At least 5 mV	Usually decreased	May increase if the lead becomes parallel to the incoming electric current vector
Capture threshold	Less than 1 volt at a pulse width of 0.5 milliseconds	Usually there is loss of capture	May remain the same if the lead has not moved a long distance from the heart

1. Change in pacing parameters suggests lead dislodgement (not necessarily lead perforation).
2. Lack of change in pacing parameters does not exclude lead dislodgement (or perforation).
3. There is no consistent lead pacing parameters to rule in or out dislodgement/perforation.
4. Once a change in parameter is detected and lead dislodgement is suspected, clinicians should proceed to imaging studies to differentiate between lead dislodgement and perforation.

Diagnosis – x-ray

A chest X-ray of the patient on presentation revealing the right ventricular lead overlying the left.



Diagnosis – x-ray

Lateral chest X-ray film demonstrating the position of the lead. (a) Just after the surgery. The tip of the lead was in the correct position. (b) Four days after the surgery. The tip of the lead intruded into the chest wall.



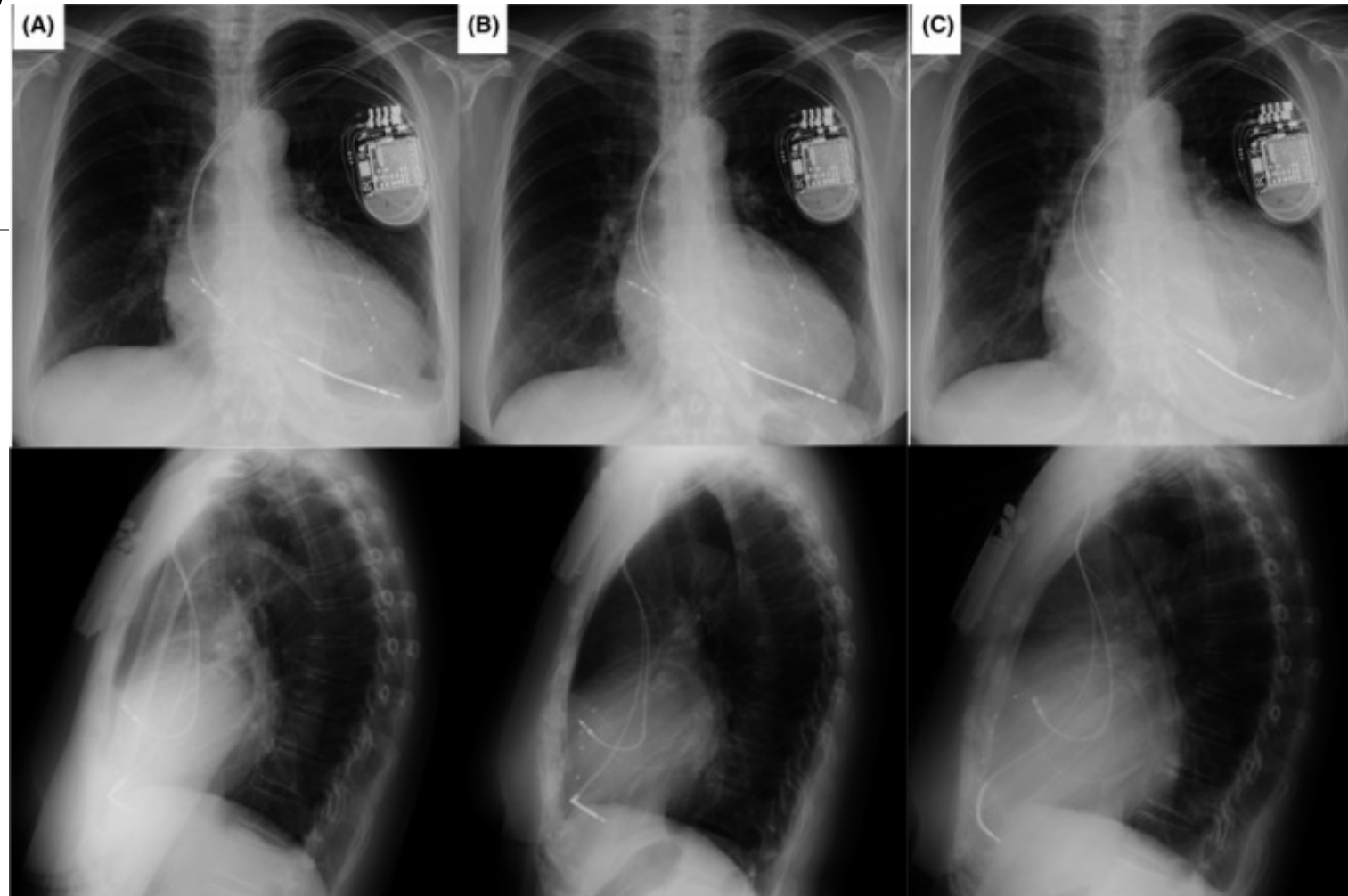
(a)



(b)

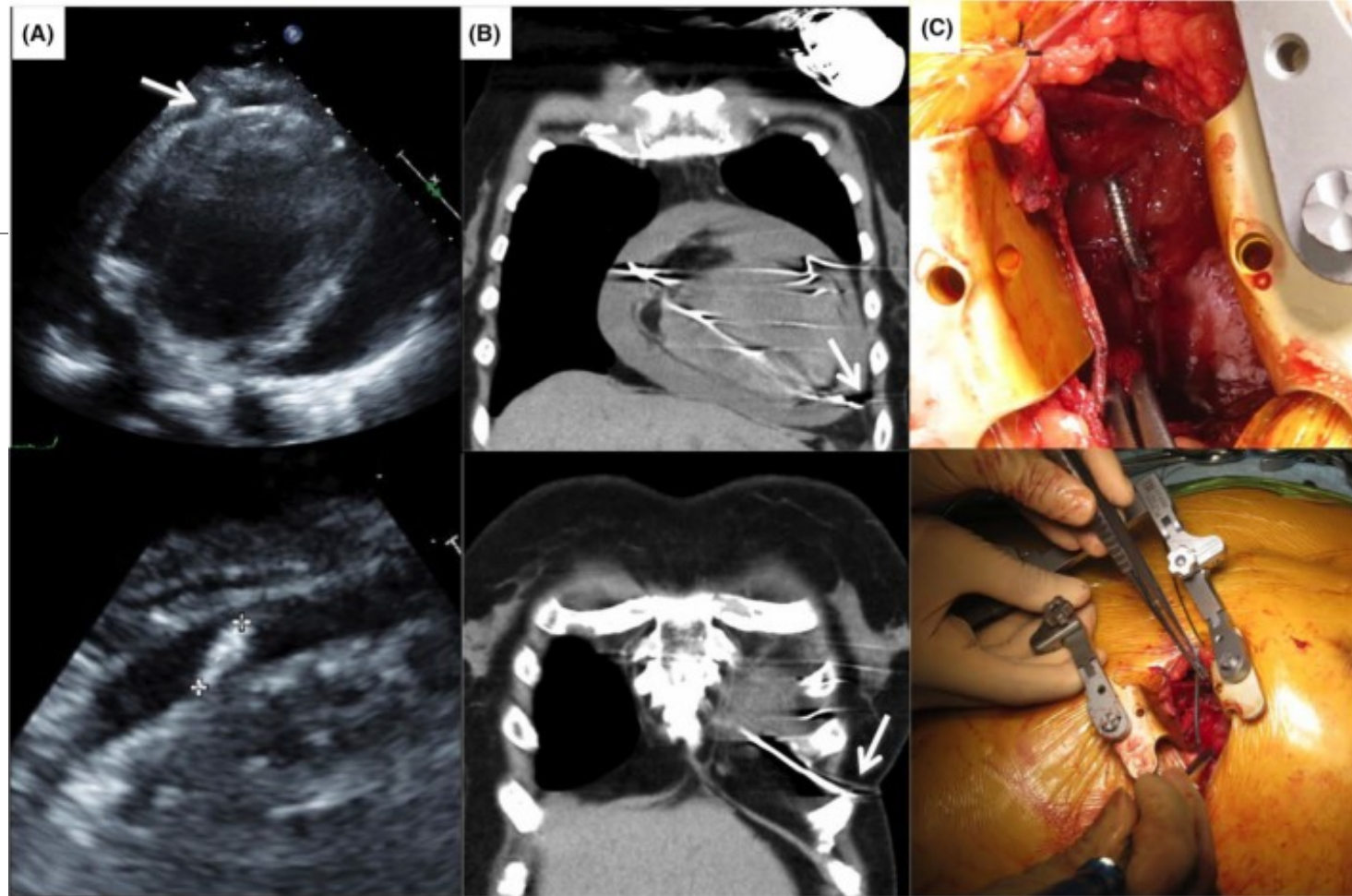
Diagnosis – x-ray

Serial posterior–anterior (upper row) and left lateral chest (bottom row) X-ray films showing the ICD lead position. (A) Films obtained at the time of the patient's initial discharge. (B) Films obtained at the time of the first outpatient visit after implantation. (C) Films obtained at the time of re-admission. At this time, the cardiothoracic ratio had clearly increased.



Diagnosis – ECHO

Investigation and confirmation of the cause of the patient's sudden complaints. (A) Echocardiogram showing severe pericardial effusion and the ICD lead (white arrow) extending beyond the ventricular apex. (B) Chest computed tomography image showing that the tip of the ICD lead (white arrow) had perforated the right ventricular wall and migrated beyond the epicardium. (C) Intraoperative photograph. Visual inspection confirmed that the ICD lead had perforated the right ventricular wall.



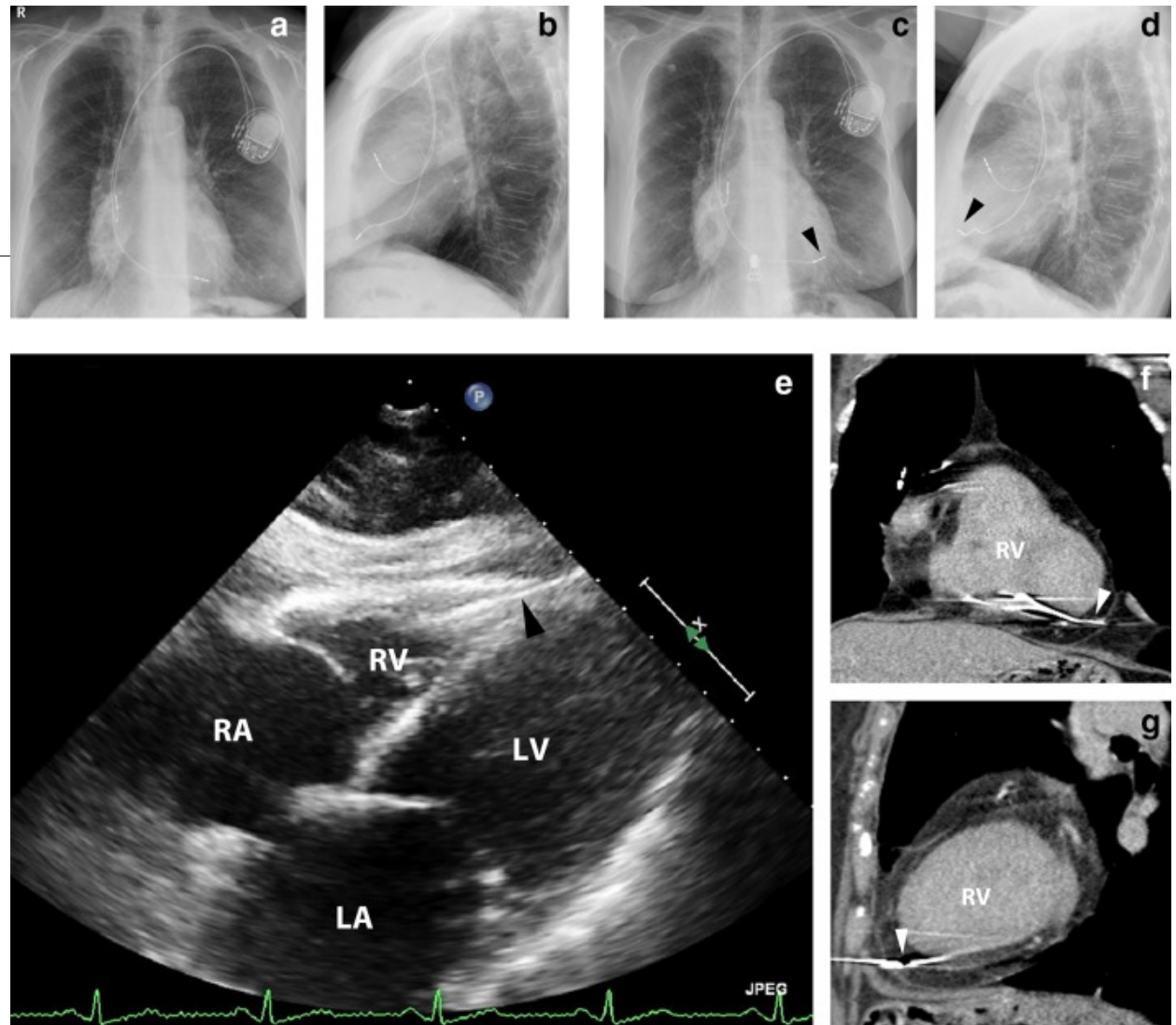
Diagnosis - ECHO

Zoom of right ventricle in the apical four-chamber view: lead tip visualized in the pericardial space, confirming perforation (arrow).



Diagnosis - ECHO

a Chest radiography [postero-anterior (PA) view] the day after pacemaker implantation. **b** Lateral view. **c** Chest radiography (PA view) upon presentation to the emergency room showing an altered position of the RV lead (*arrowhead*). **d** Lateral view (*arrowhead* shows altered lead position). **e** Transthoracic echocardiography (subcostal view) suggesting myocardial perforation of the RV lead through the RV apex (*arrowhead*), but without pericardial effusion, raising doubt as to whether the lead tip lay in the pericardial space. See also online video. *LA* left atrium, *LV* left ventricle, *RA* right atrium, *RV* right ventricle. **f** Thoracic computed tomography (coronal view) with lead tip clearly visible through the myocardium (*arrowhead*). *RV* right ventricle. **g** Thoracic computed tomography (sagittal view) showing lead tip running through myocardium (*arrowhead*). *RV* right ventricle

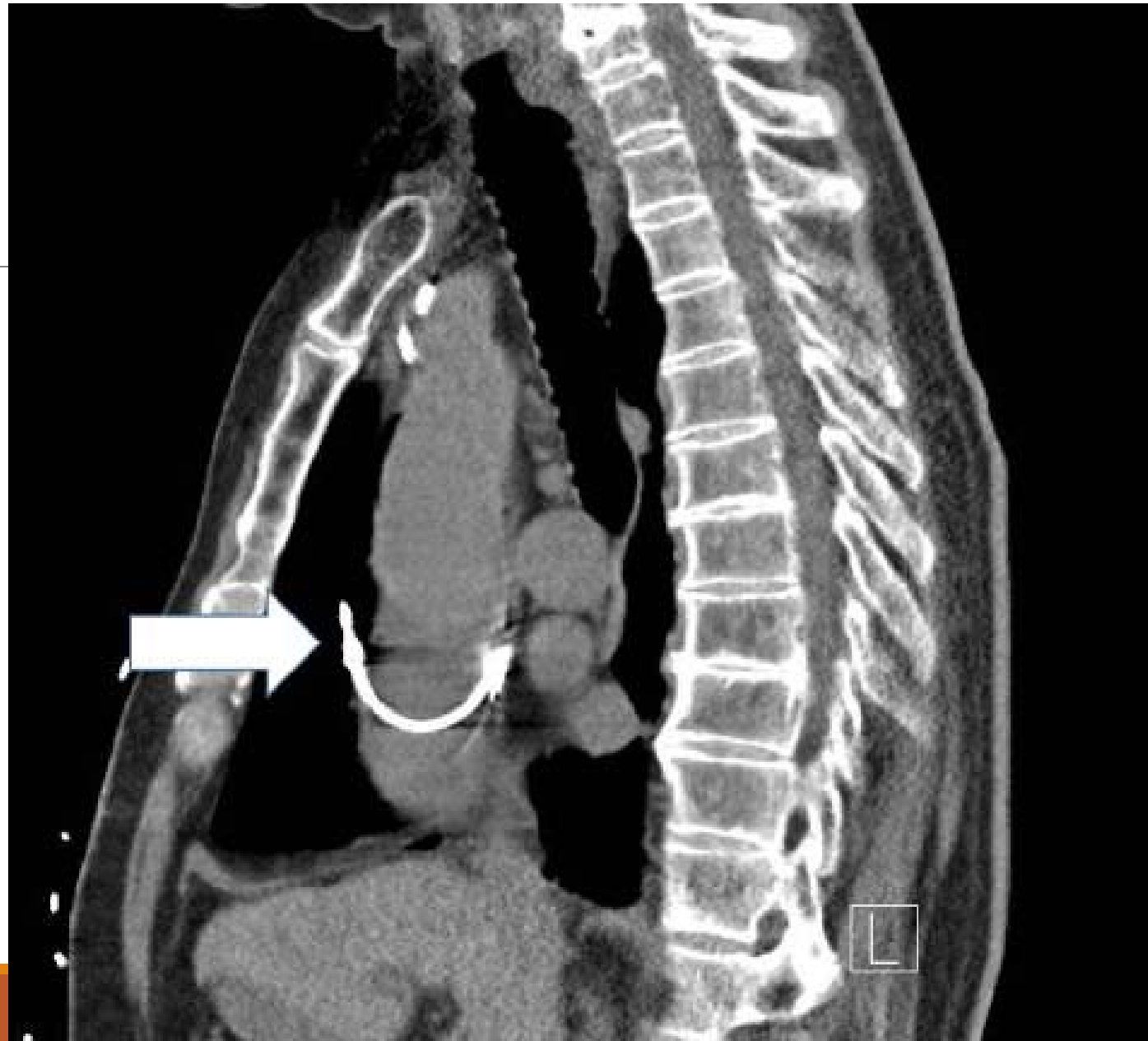


Diagnosis – CT scan

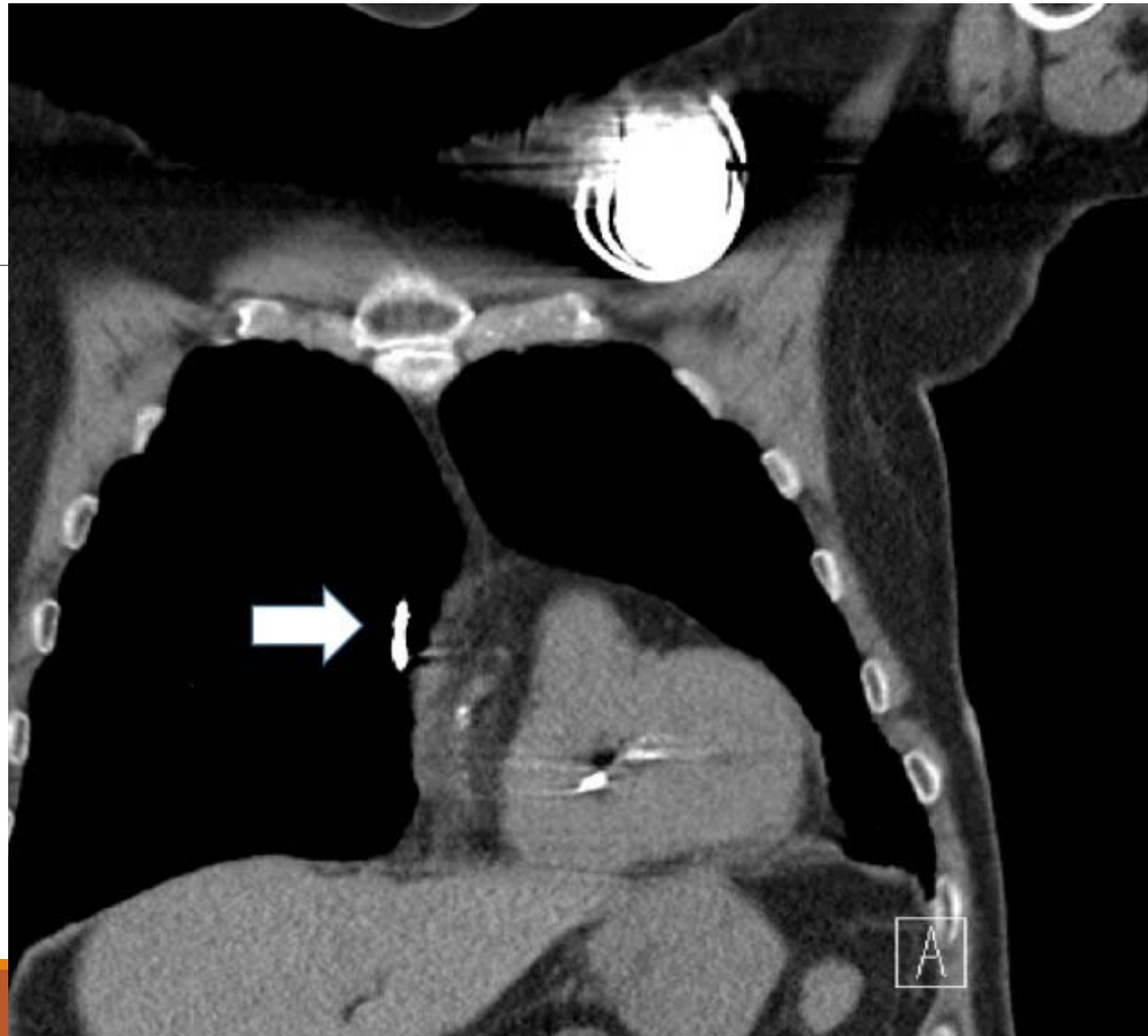
CT scan showing the tip of the right ventricular lead penetrating the anterior wall of the right.



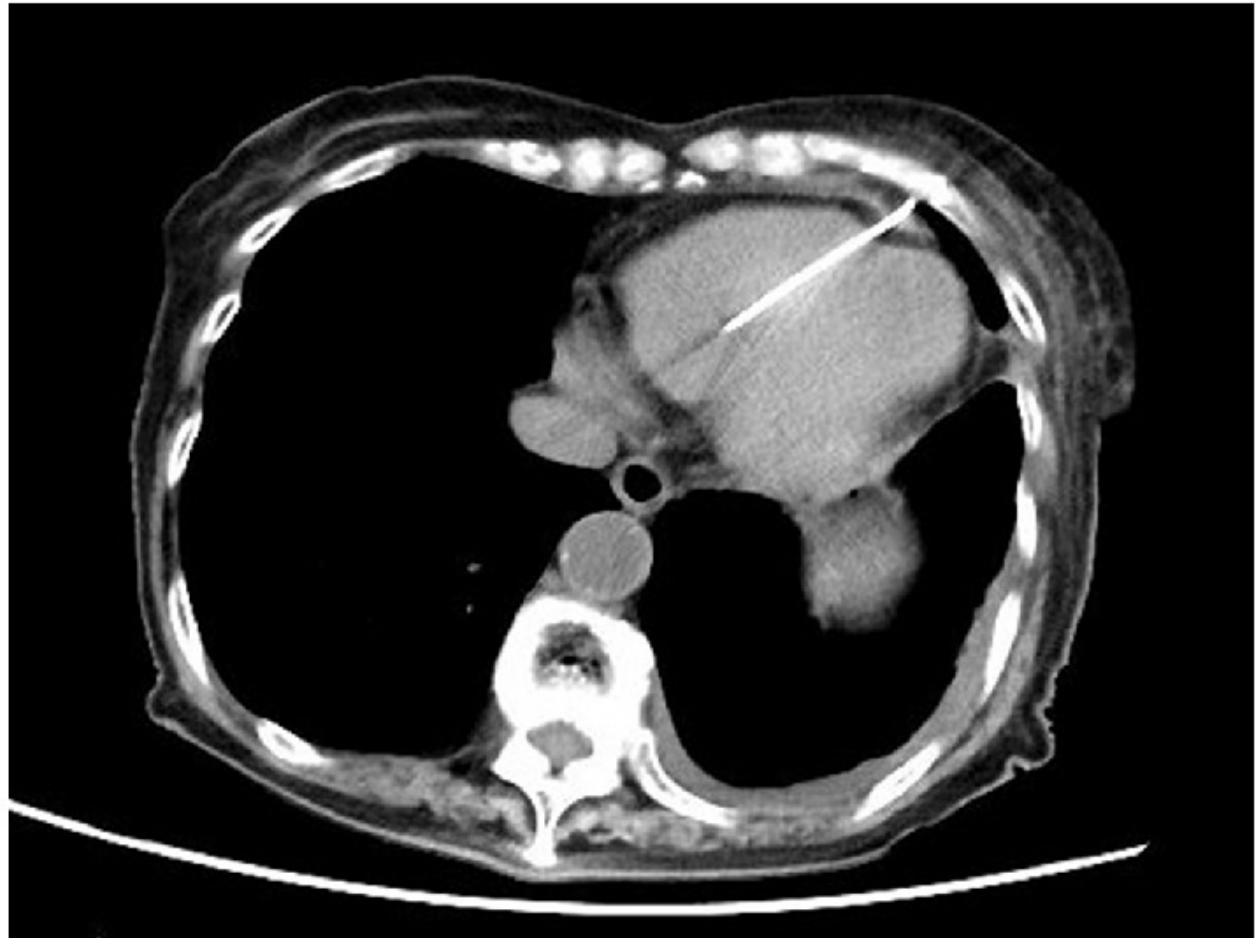
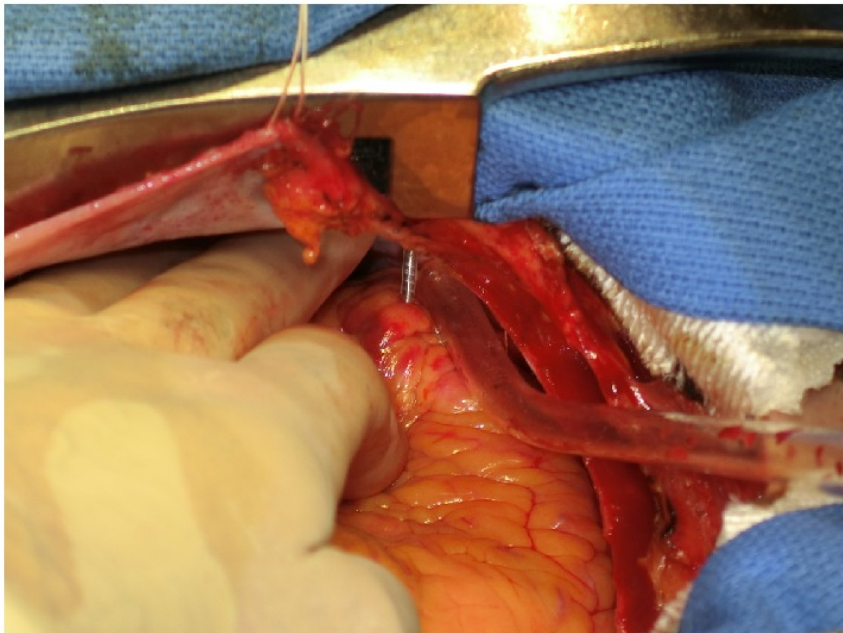
High-resolution computed tomography scan of the chest sagittal cut with the white arrow pointing at the tip of the atrial lead migrating into the right lung



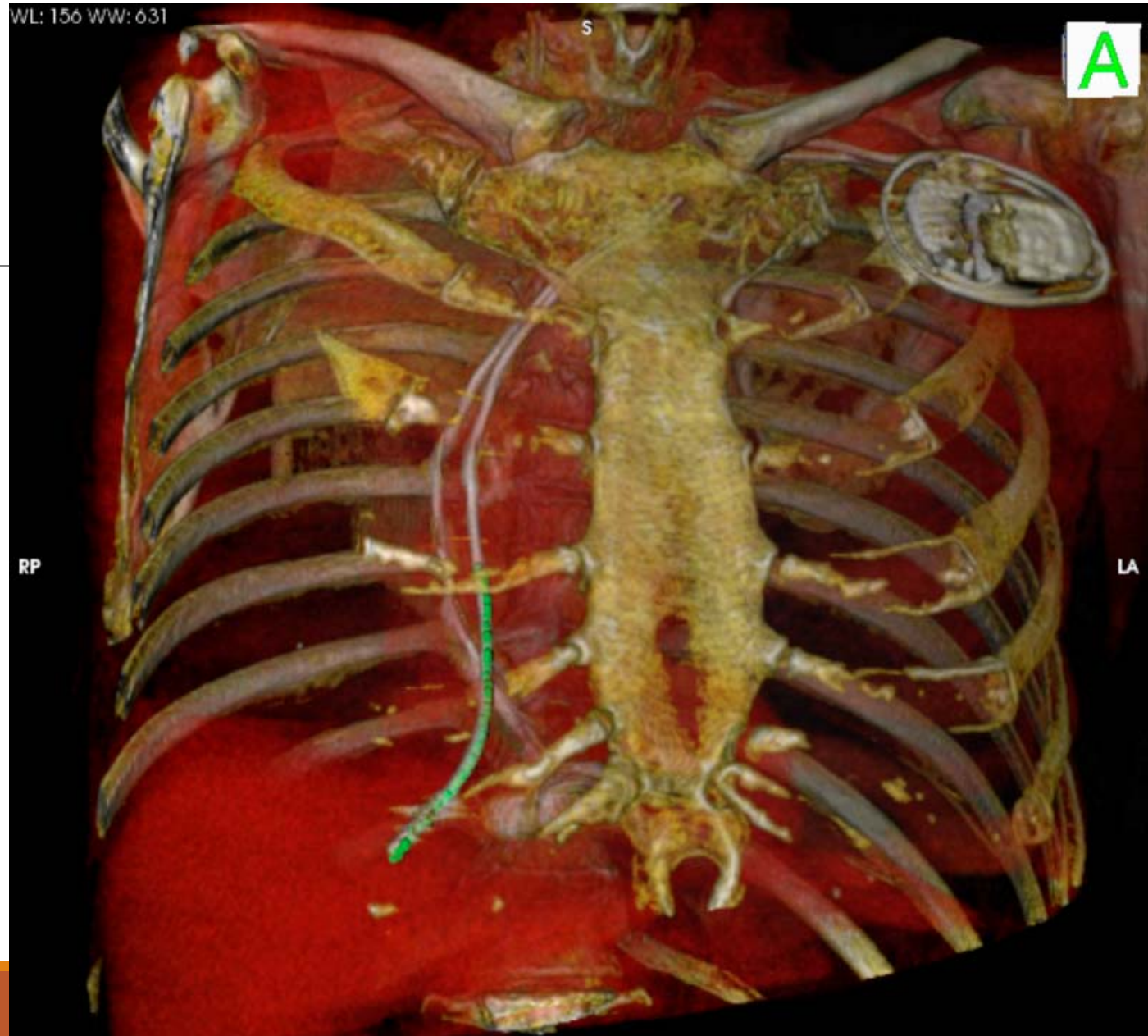
High-resolution computed tomography scan of the chest sagittal cut with the white arrow pointing at the tip of the atrial lead migrating into the right lung



Chest CT reveals
perforation of the right
ventricle by the lead.

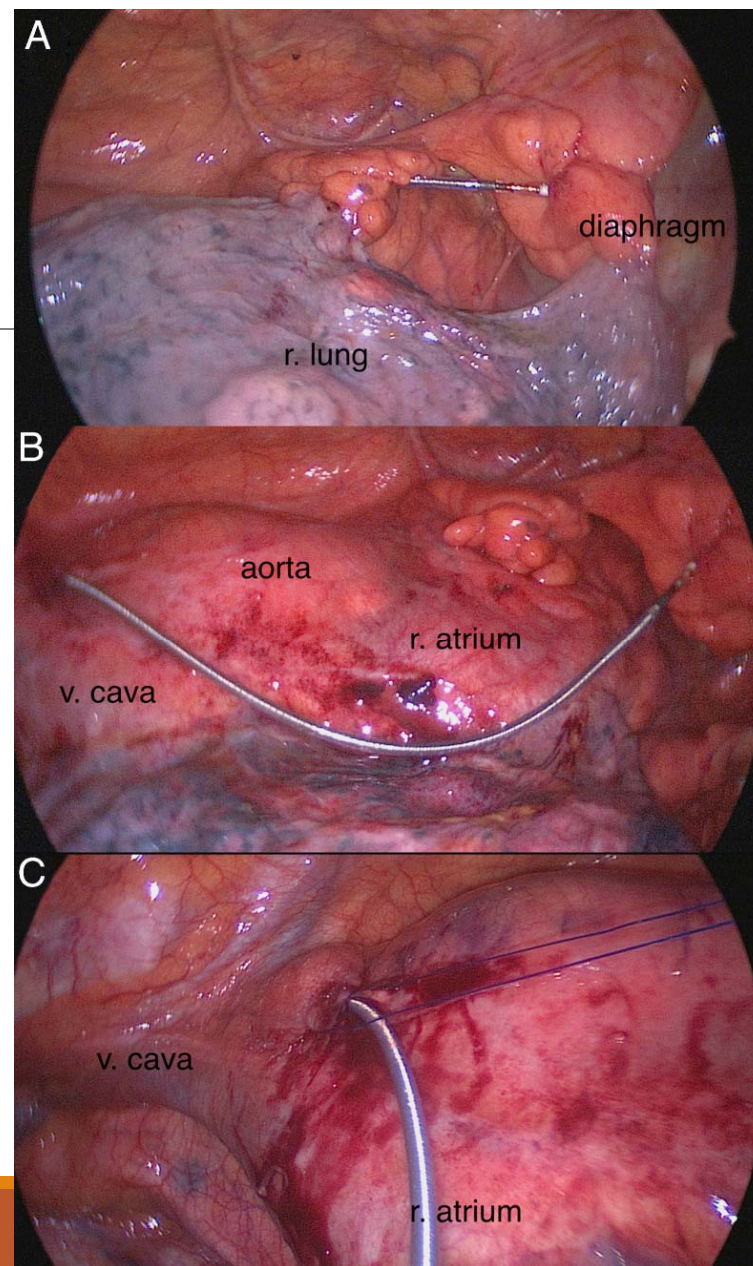


Computed tomographic 3-dimensional reconstruction scan showing the atrial lead migration into the right pleural cavity. LA = left anterior; RP = right posterior.



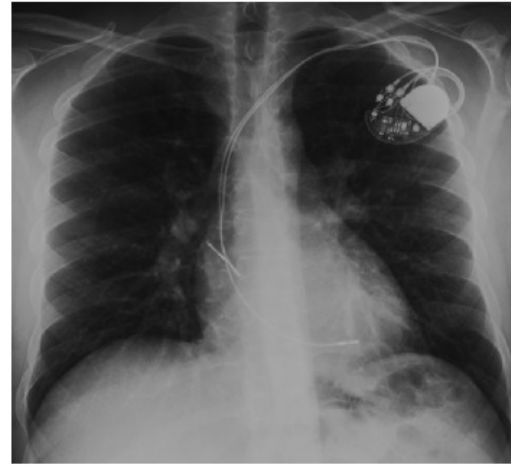
Intraoperative photographs.

A, B: Perforation of the extrapericardial part of the superior vena cava with pacemaker lead migration into the right pleural cavity. **C:** The suture placed around the vena cava perforation.

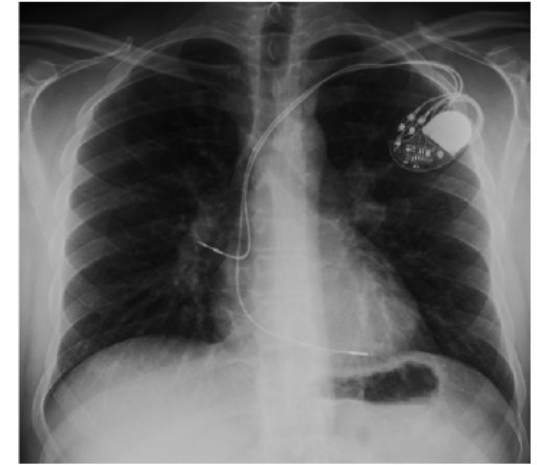


Atrial lead perforation

(a) Postimplant anteroposterior chest radiography showing the atrial lead positioned at the basal part of the right atrial appendage. (b) Anteroposterior chest radiography performed at 8 months showing a clear late migration of the atrial lead into the right lung. (c) Contrast-enhanced CT-scanner with maximal intensity projection (MIP) and (d) volume rendered reformatting (anterior view) demonstrating the migration of the atrial lead into the right lung. Notably the pericardium, pleura, and pulmonary parenchyma were normal. RA: right atrium; RV: right ventricle; PA: pulmonary artery.



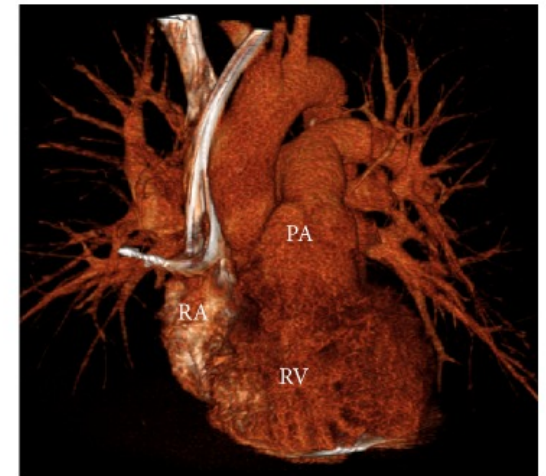
(a)



(b)



(c)



(d)

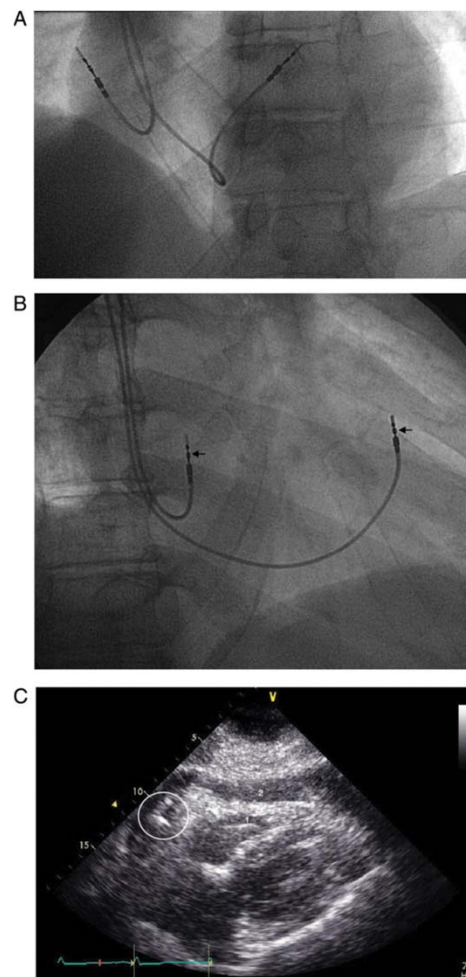
Management

Management strategies include:

- lead repositioning
- lead extraction or
- open heart surgery

- In **hemodynamically stable** patients, the preferred strategy is lead extraction under close echocardiographic monitoring with surgical backup followed by new lead placement in a different location.
- In cases of **hemodynamic instability, rapidly progressive pericardial effusion, or injury of surrounding organs**, surgical management is the recommended treatment. (*Arch Med Sci.* 2012 Feb 29; 8(1):11-3.)
- Some studies suggest that the extraction of a chronically perforated lead, without neither device malfunction nor resulting symptoms, is not mandatory (*Pacing Clin Electrophysiol.* 2007 Jan; 30(1):28-32)

Atrial lead perforation



From: Acute pericardial tamponade due to screw-in atrial lead heart perforation

Europace. 2011;14(3):453-455. doi:10.1093/europace/eur294

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Progressive Atrial lead perforation

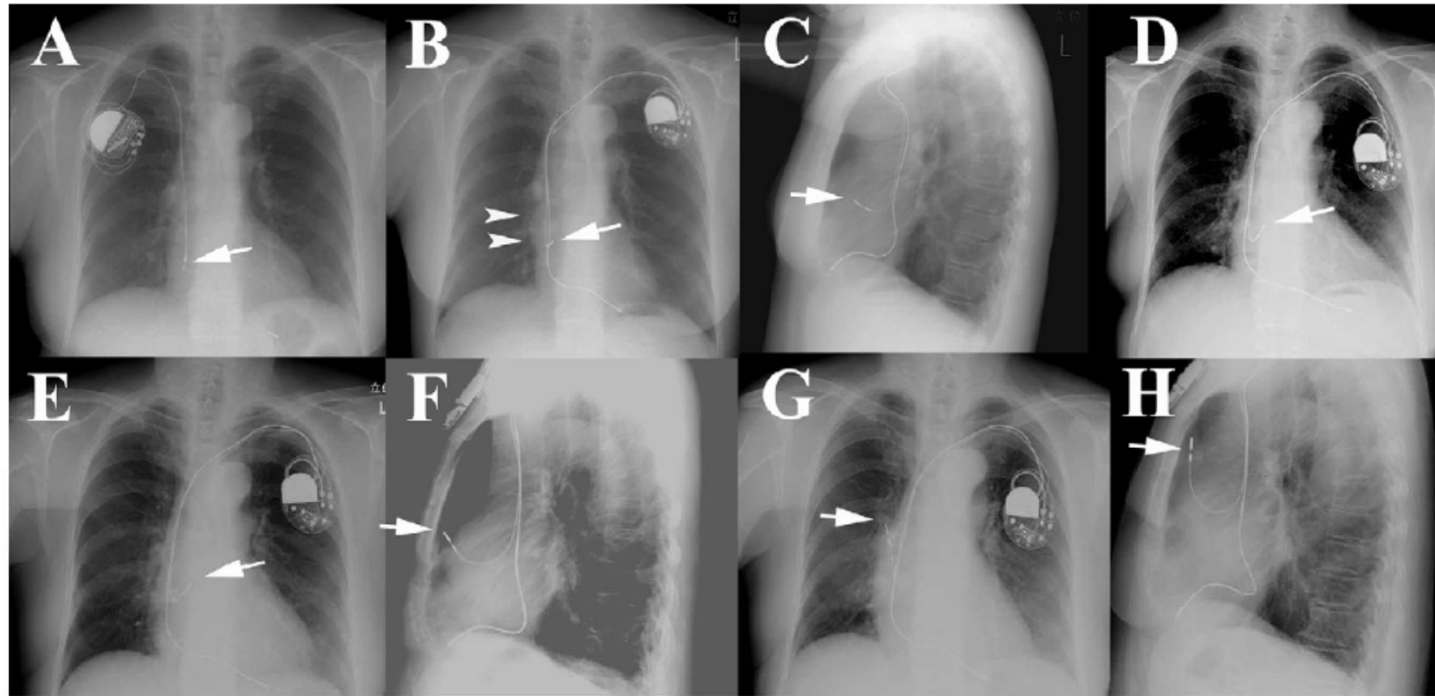


Figure 1 Chest X-rays. Compared to the image before the replacement of pacemaker (A), the image 1 week after the replacement (B) showed only a focal protrusion from the right side of cardiac silhouette (arrowheads) and the lateral image (C) did not show any abnormalities. The image 2 years later had no serial change (D), however 3 years and 9 months later, a lateral view (F) clearly showed atrial lead protrusion, while the lead changed to be tip-tilted on the frontal view (E). One year later, both of frontal (G) and lateral views (H) demonstrated the progression of atrial lead protrusion. The arrows indicate the distal tip of atrial lead.

Progressive Atrial lead perforation

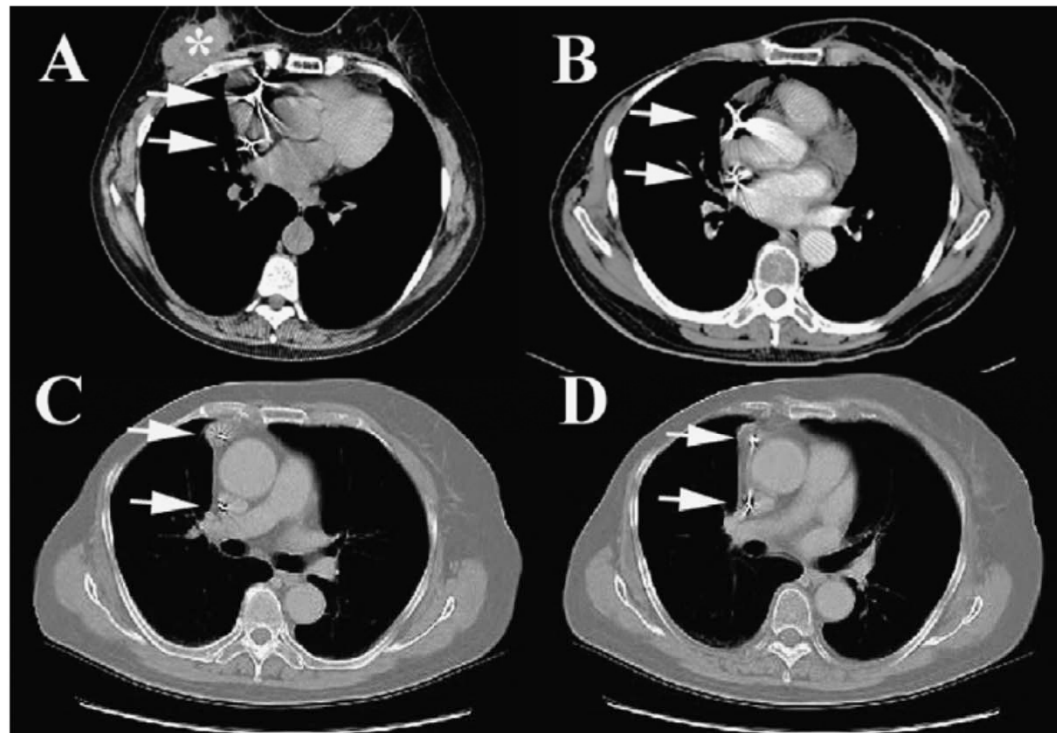
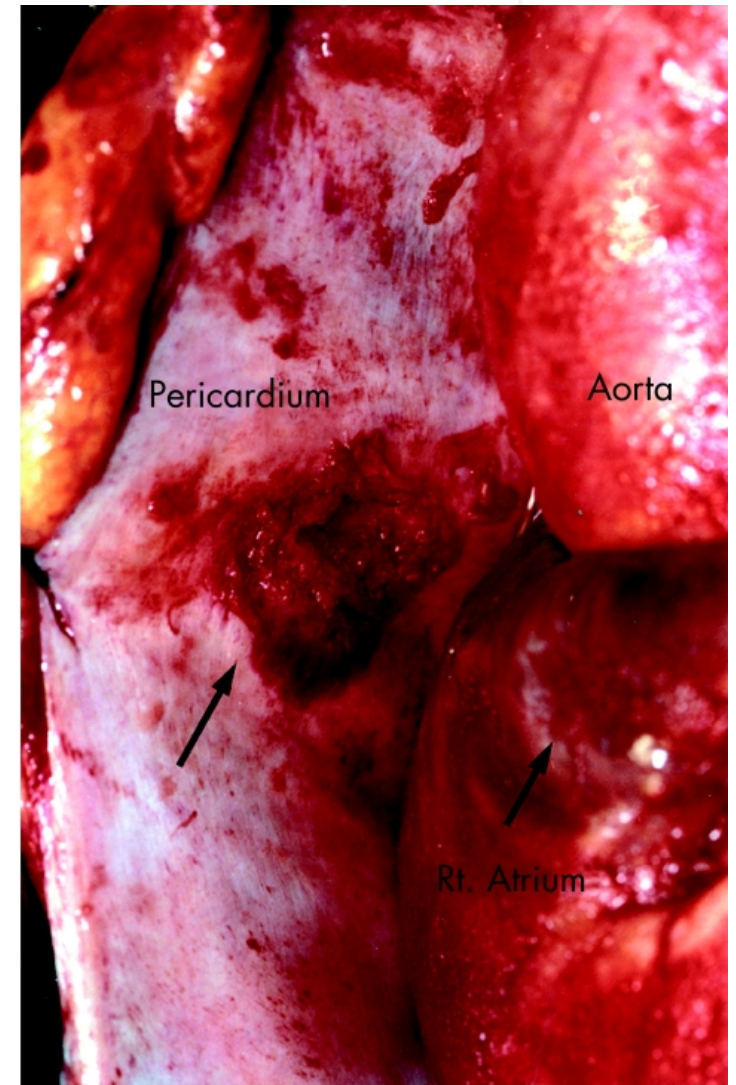


Figure 2 Computed tomography. (A) Before the replacement of the pacemaker, the scan showed right breast cancer (asterisk) and an atrial lead (arrows). (B) Nine months after the replacement, a new atrial lead (arrows) was screwed in almost the same position compared to the previous one and had perforated the right atrial appendage. (C, D) Four years later, the consecutive scans clearly showed the progression of the perforated atrial lead (arrows).

Delayed Atrial lead perforation

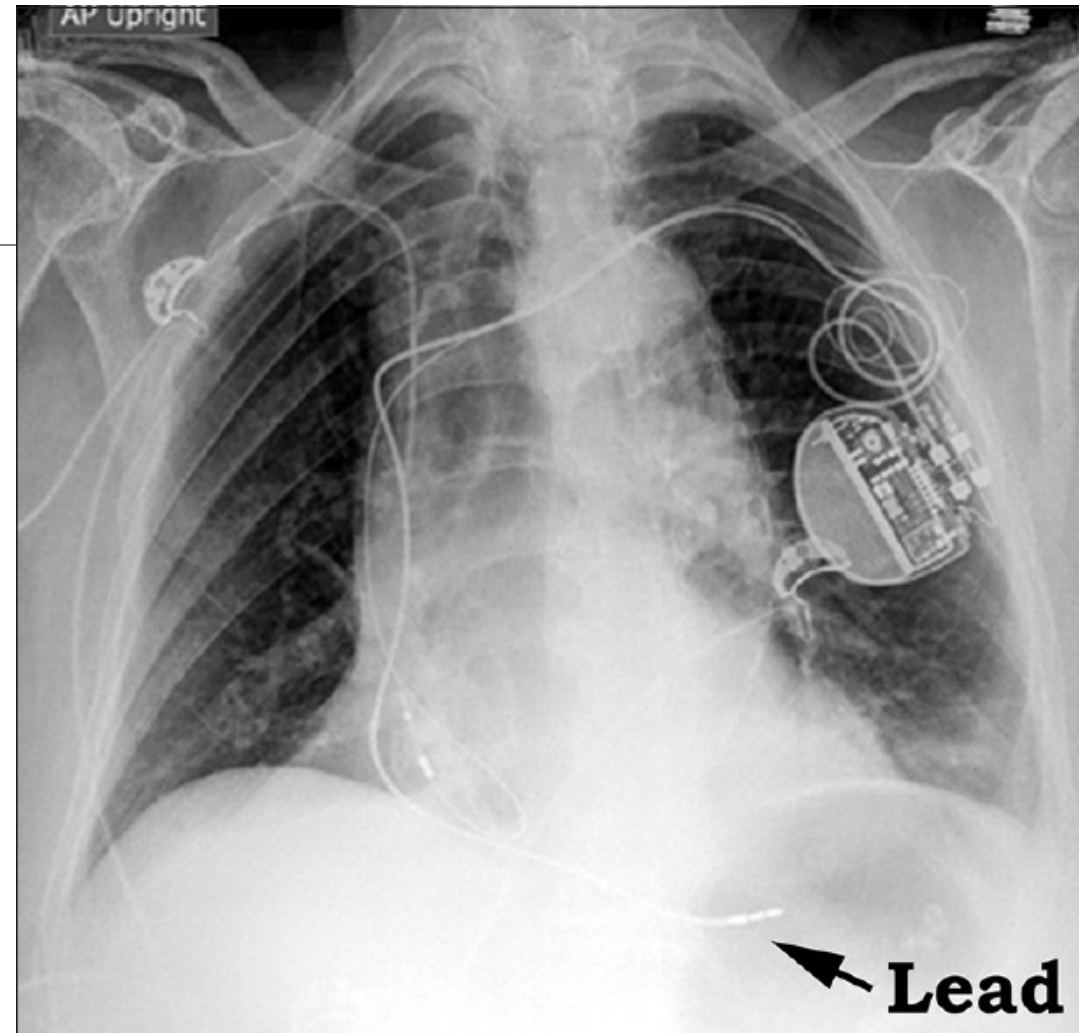
The presentation in this case was delayed and atypical with back and shoulder pain, probably caused by phrenic nerve and pericardial irritation.

Heart. 2003 Apr; 89(4): 364



LEAD PERFORATION Needs attention!

84-year-old female with a history of paroxysmal atrial fibrillation, left bundle branch block, deep vein thrombosis, Type II diabetes mellitus, hyperlipidemia, and hypertension → PM because of sick sinus syndrome with PAF



Needs attention!

On the 8th day status-postimplantation, she returned to the ED with moderately severe left anterior **chest pain adjacent to her pacemaker battery pocket** with **radiation around and underneath her left breast**.

On physical examination, there is significant **tenderness under the left breast**, which is reproducible upon palpation.

Routine laboratory studies and chest X-ray and rib films were interpreted as negative

Despite the absence of skin lesions with vesicles, she was given an initial diagnosis of shingles.

Needs attention!

Two days later, she returned to the ED agitated with increasing chest pain, dyspnea, nausea, and vomiting.

Nontender ecchymosis was noted over the area of the implanted pacemaker pulse generator on the left upper chest wall.

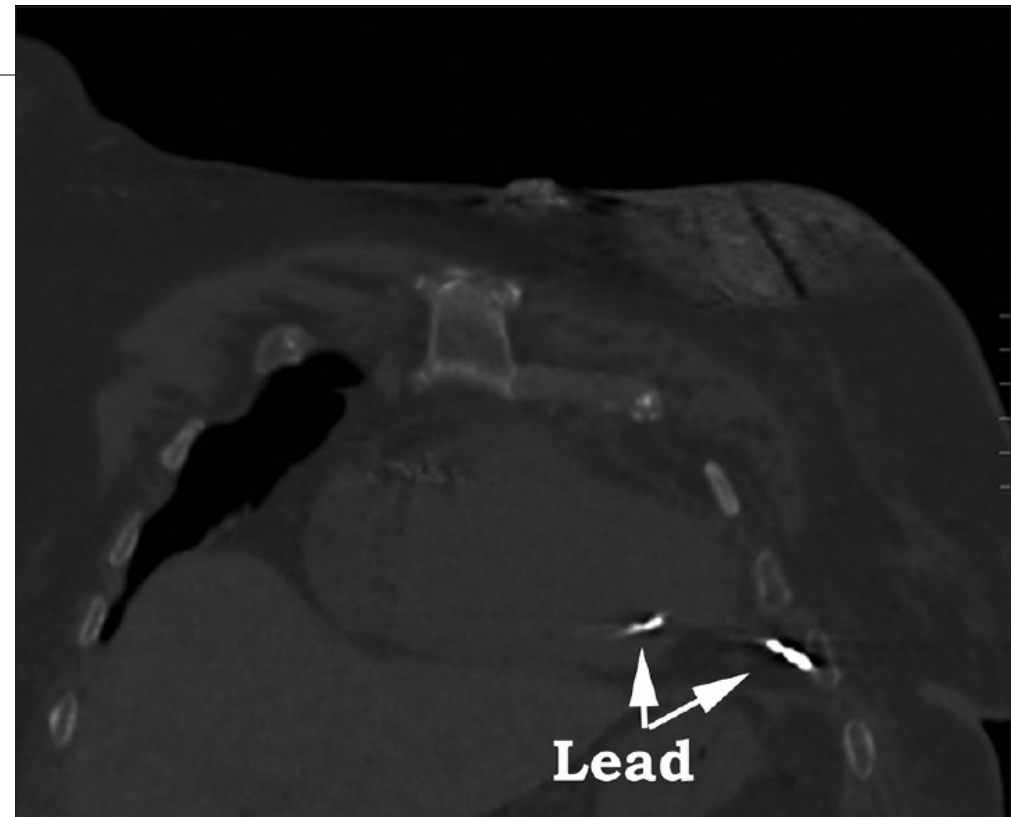
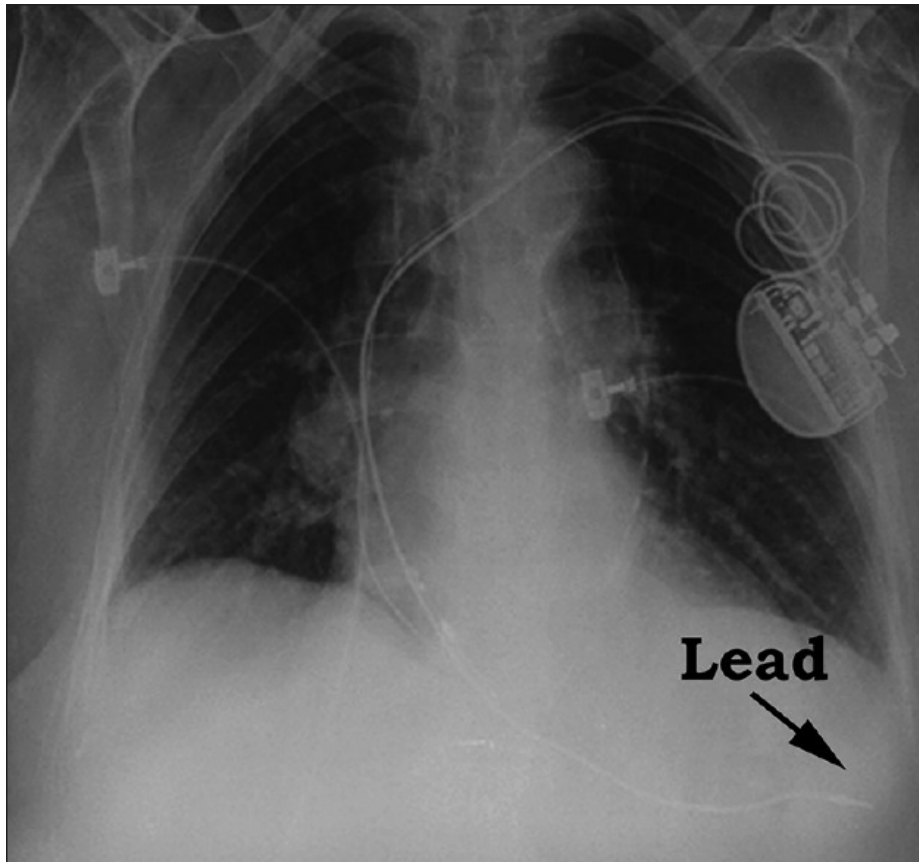
No incisional erythema, purulent discharge, or other signs of infection were noted.

Atypical tenderness to palpation and bruising were also noted in the left mid-axillary region

Needs attention!



Needs attention!



Needs attention!

She was taken to the OR, the pacemaker pocket was opened, and under combined fluoroscopic and transesophageal imaging, the lead was withdrawn into the right ventricle with gentle manual traction.

Hemodynamics remained stable after lead removal and imaging confirmed no evidence of pleural or pericardial effusion.

The lead was then reimplanted on the RV septum.

Rare cases - RCA perforation

72-years-old woman
with a pacemaker
implanted due to
complete AV block

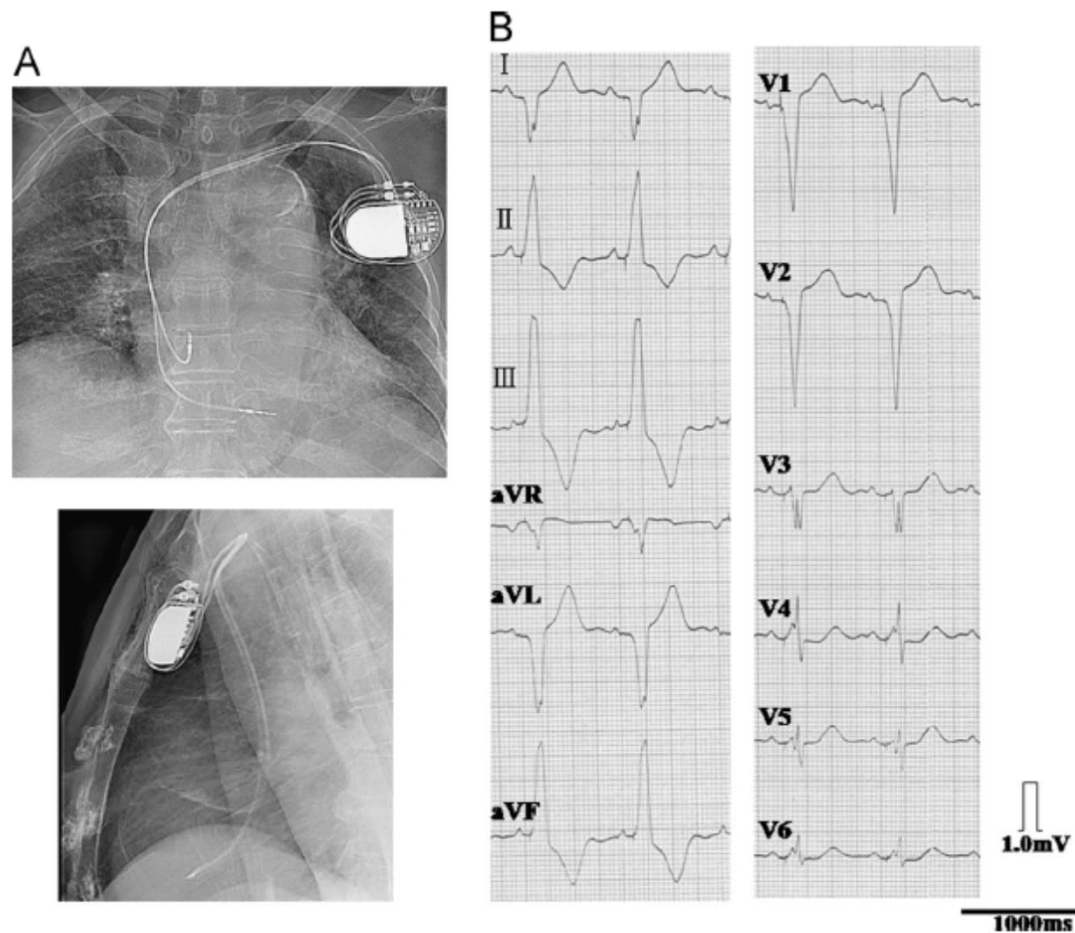


Fig. 1. (A) Posteroanterior and left lateral chest radiographs recorded in the operation room show that the screw-in atrial lead was located in the right atrial appendage and the screw-in ventricular lead was located at the right ventricular basal septum. (B) A 12-lead ECG recorded 40 min after the pacemaker implantation demonstrates that the pacemaker was functioning normally with atrial sensing followed by ventricular pacing.

Rare cases - RCA perforation

3,5 h after the procedure the patient developed hemodynamic instability

Echo → cardiac tamponade → pericardiocentesis → drainage 850ml of blood

The patient remained unstable

New echo → echodense mass at the pericardial space (thrombus)

Operating room → evacuation 1400 ml hemopericardium with thrombi while bright red blood was seen gushing out from the right coronary artery

Rare cases - RCA perforation

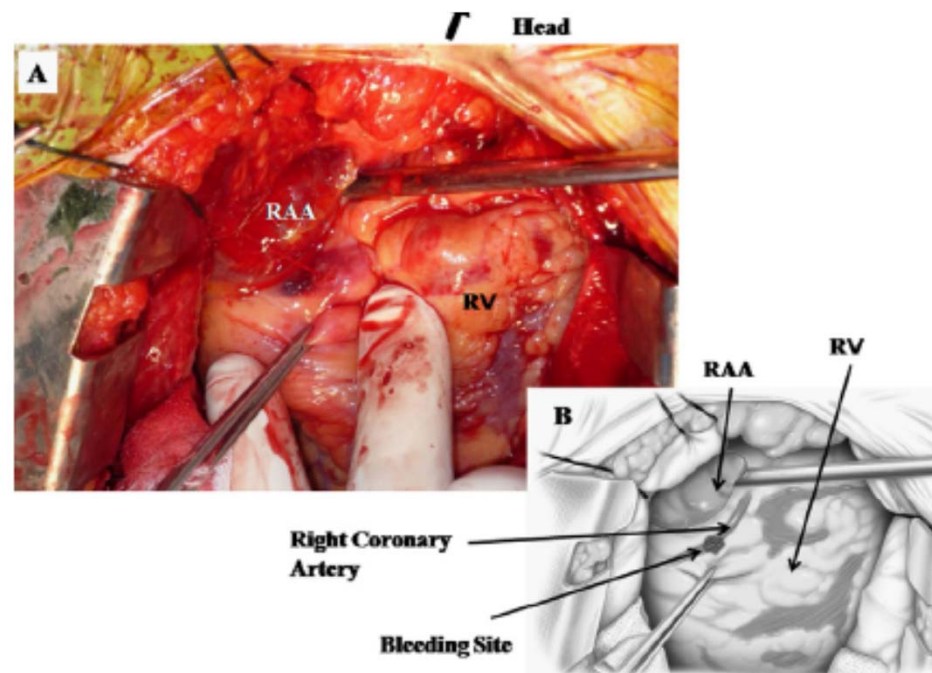


Fig. 2. (A) Intraoperative image of bleeding from the right coronary artery. After evacuation of 1400 mL of hemopericardium along with several thrombi, we determined that bright red blood was gushing out from the right coronary artery, which was located on the opposite side of the right atrial appendage to the atrial lead screw. (B) Intraoperative drawing corresponding to (A). Bleeding site and right coronary artery are drawn illustrated. RV, right ventricle; RAA, right atrial appendage.

Rare cases - RCA perforation

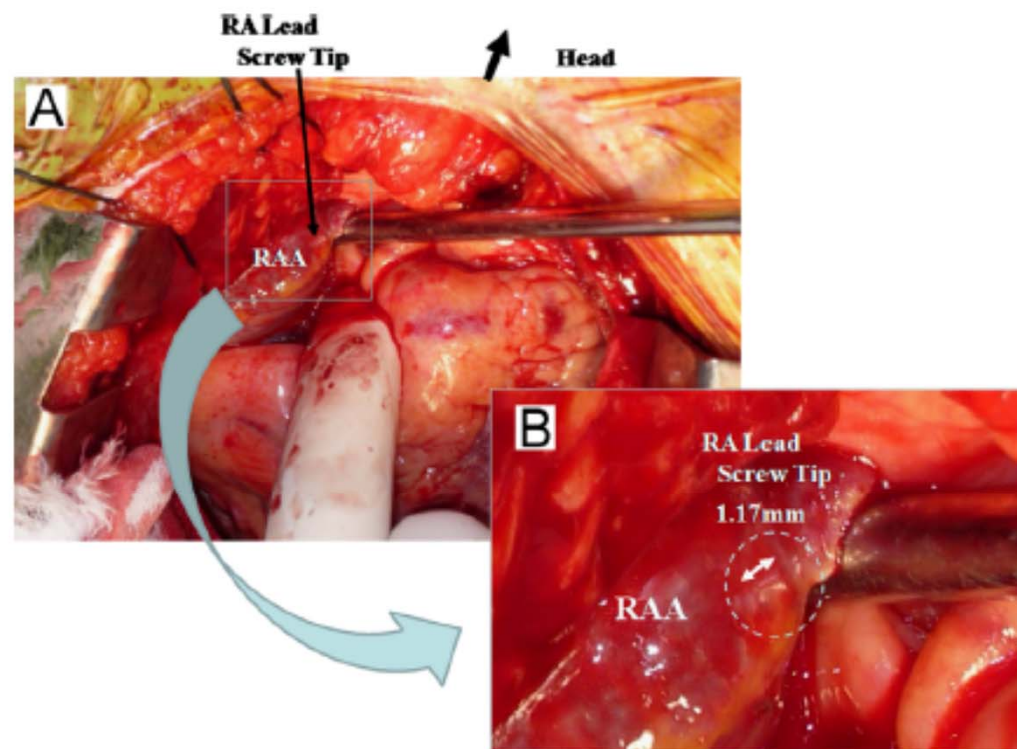


Fig. 3. (A) Intraoperative image showing the atrial lead screw penetrating the right atrial appendage, which was located on the opposite side from the bleeding site. There was no bleeding from the screw tip penetration site. (B) The magnification of (A) is shown. A semi-circular portion of the screw penetrated the atrial wall. The diameter of the screw was 1.17 mm. RAA, right atrial appendage; RA right atrium.

Rare cases – severe TR

70-years-old male

Admission for surgical repair of severe TR

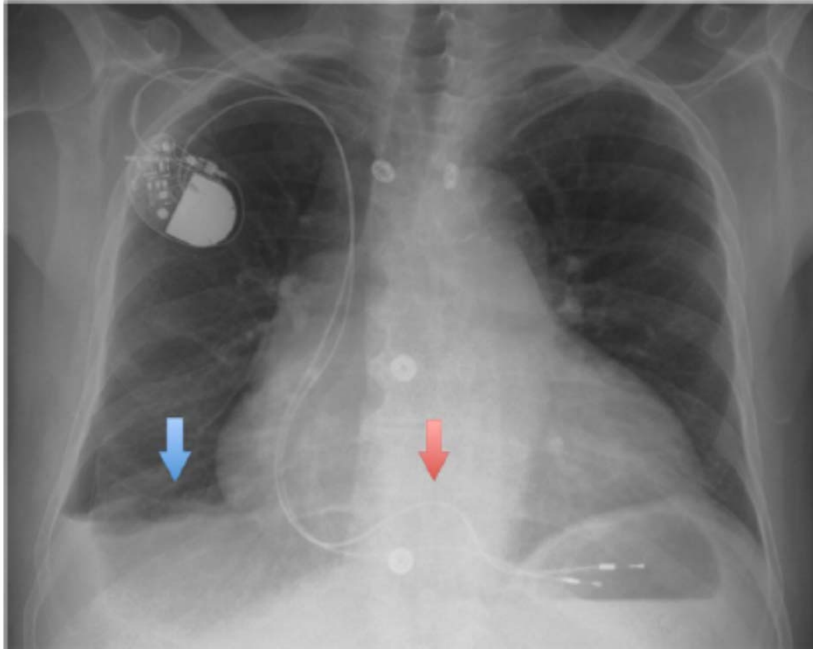


Figure 1 Preoperative chest X-ray. Blue arrow: pleural effusion; Red arrow: different course of the two leads through the tricuspid valve.

Four years earlier he had received a VVIR pacemaker with a passive lead (Refino 58 ER, Oscor; Palm Harbor, FL, USA) due to atrial fibrillation with atrioventricular conduction block. Three years later, another passively fixed ventricular lead had been placed due to a failure of the original pacemaker lead resulting in increasing impedance.

Rare cases – severe TR

70-years-old male

Admission for surgical repair of severe TR

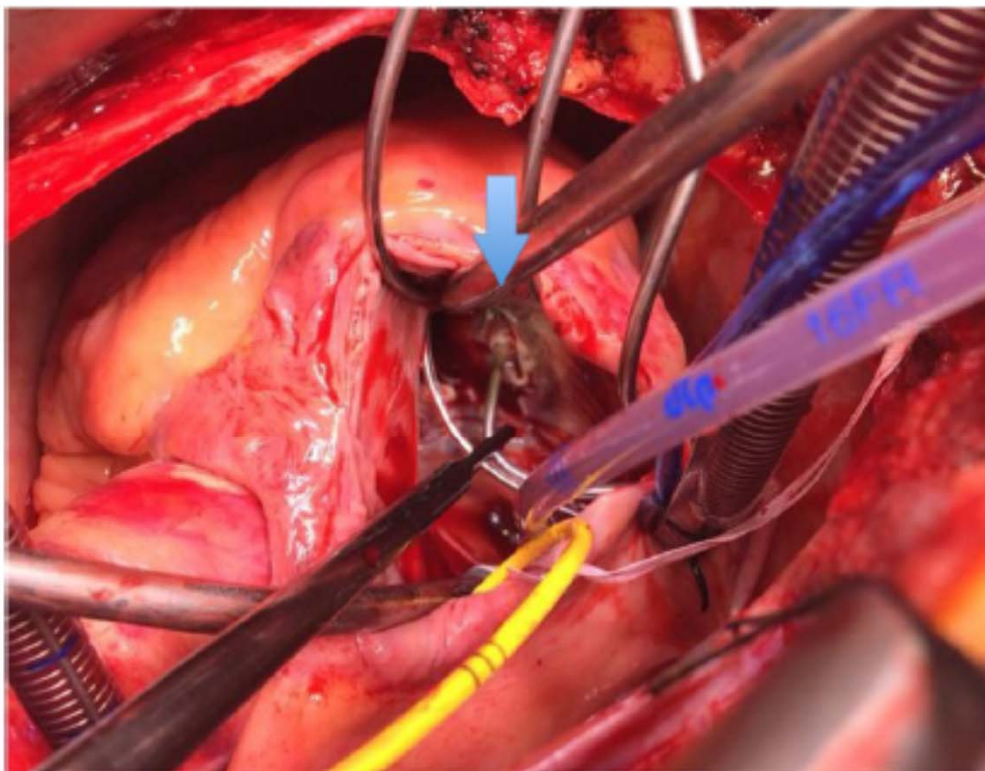


Figure 2 Intraoperative view of the perforating lead. Blue arrow: pacemaker lead perforating the papillary muscle.

Rare cases – severe TR

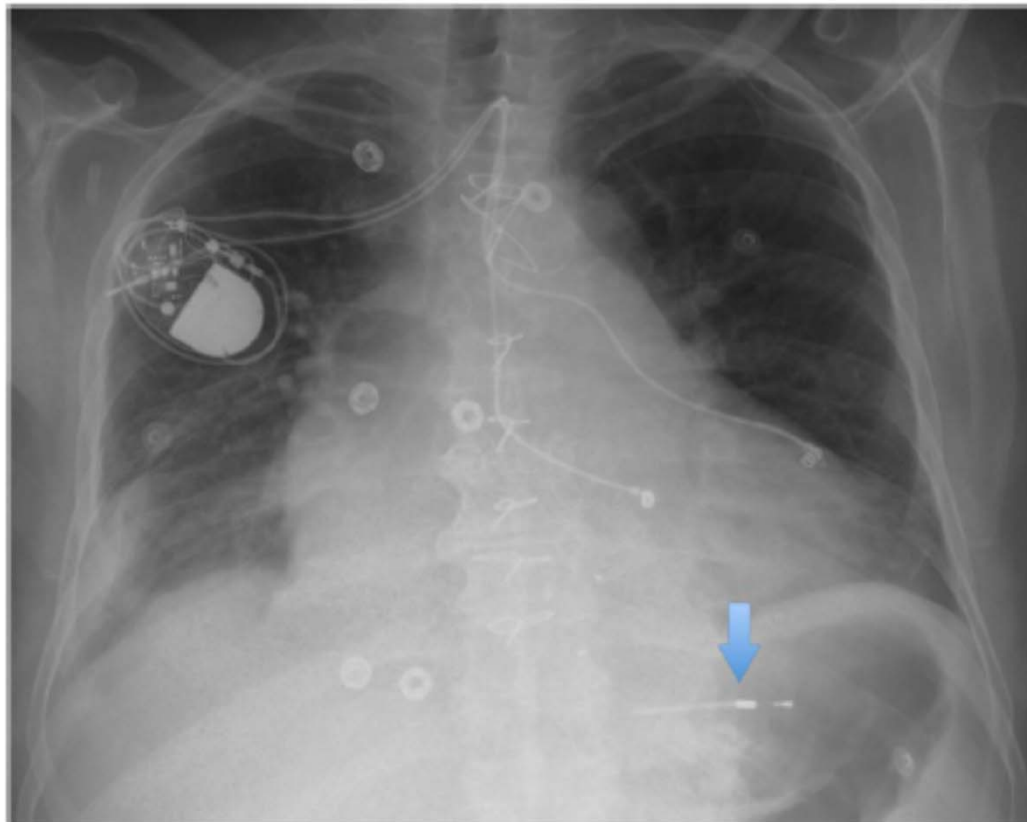
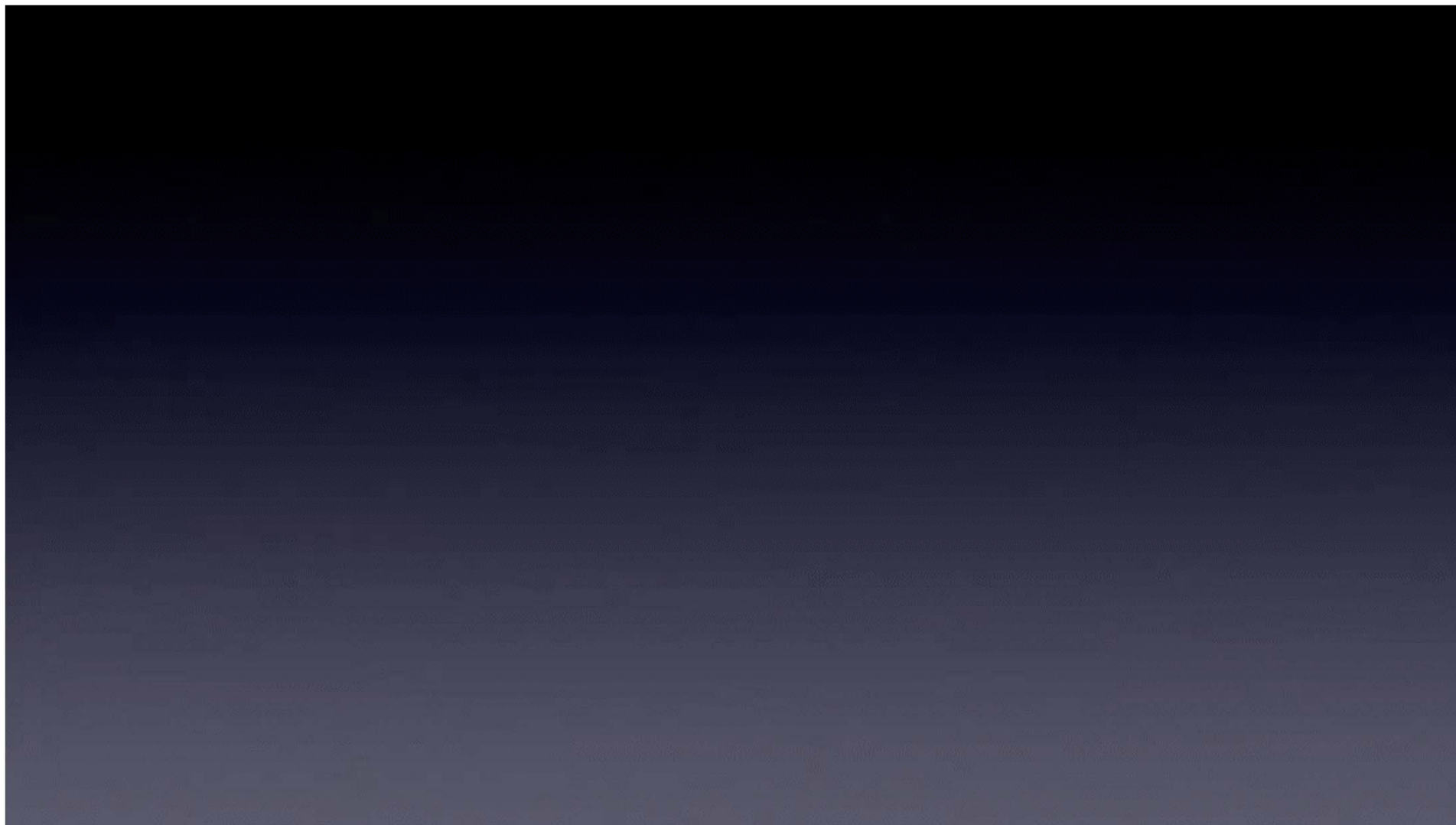


Figure 3 Postoperative chest X-ray. Blue arrow: residual lead fragment.

70-years-old male

Admission for surgical repair of severe TR

The valve was replaced with a stented bioprosthesis



Rare cases – aortic wall perforation

A 72-year-old woman, particularly short, obese and displaying kyphosis, with moderate aortic regurgitation, severe mitral regurgitation, and an ascending aortic aneurysm, underwent implantation of a single-chamber pacemaker for severely symptomatic complete atrioventricular block and atrial fibrillation

Rev Port Cardiol. 2016 Mar;35(3):179.e1-4

Rare cases – aortic wall perforation

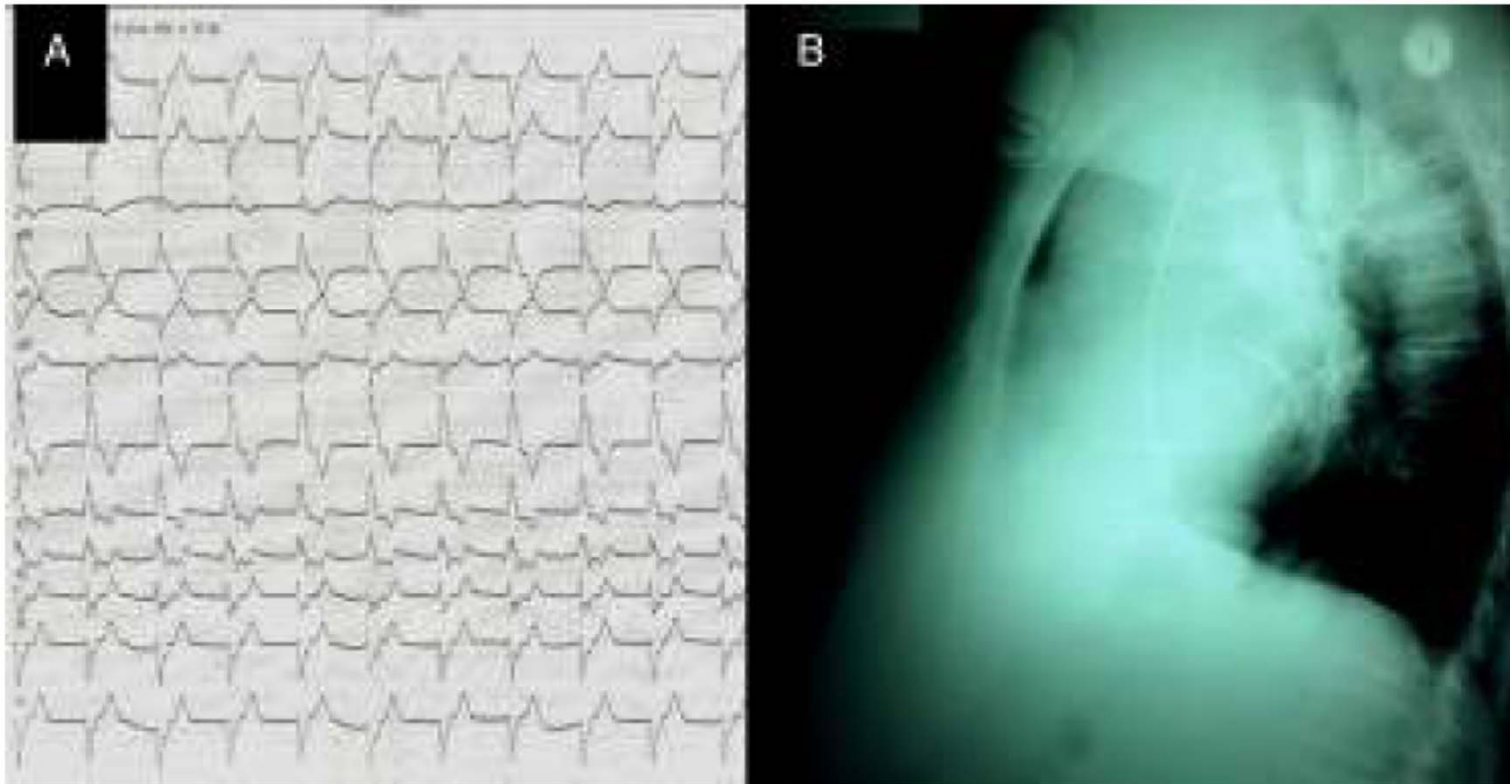


Figure 1 (A) Right bundle branch block pattern of the paced rhythm electrocardiogram; (B) lateral chest radiograph showing posterior orientation of the pacing lead.

Coronary Sinus????

No! aortic wall perforation!

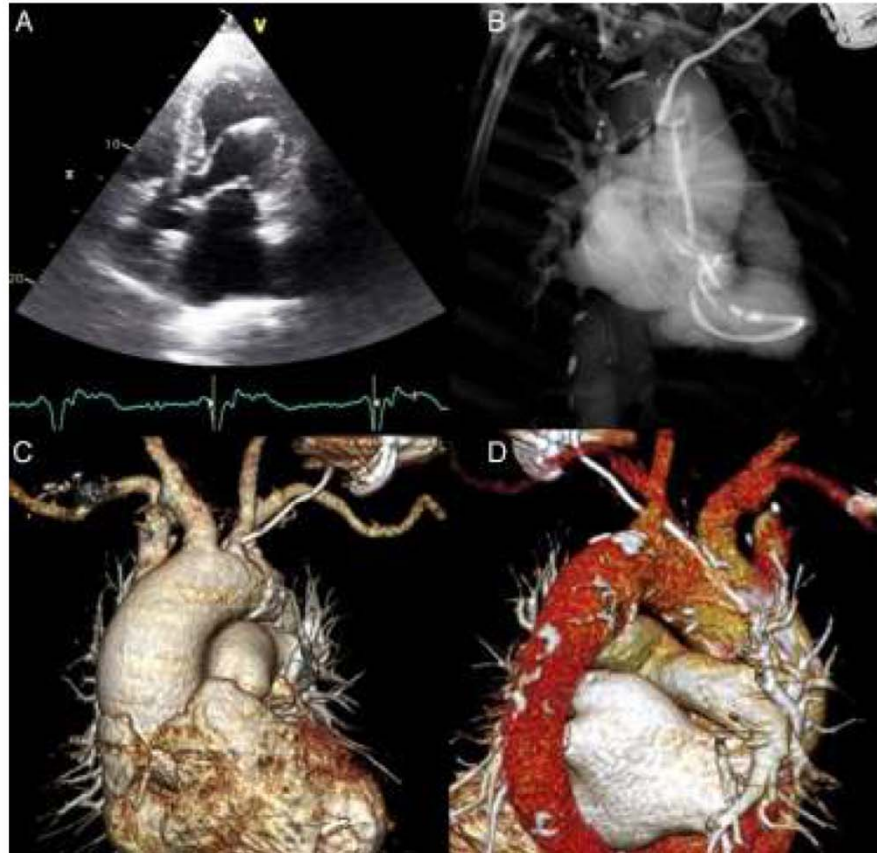



Figure 2 (A) Transthoracic echocardiography, apical 4-chamber view, showing the pacing lead passing through the aortic valve to insert in the left ventricular lateral wall; (B) thoracic computed tomography angiography (CTA), maximum intensity projection image, showing the entire trajectory of the pacing lead through the aneurysmal ascending aorta, aortic valve and left ventricle; (C) volume-rendered thoracic CTA showing pacing lead perforating the atheromatous aortic arch; (D) volume-rendered thoracic CTA showing perforation site between the left common carotid artery and the brachiocephalic trunk.

No! aortic wall perforation!

The patient showed no clinical manifestation of this complication and refused any surgical intervention, including lead removal. She remained on heart failure medication and oral anticoagulation. No clinical or echocardiographic worsening related to the lead's position occurred during 12 months of follow-up. Chronic sensing and pacing parameters remained within normal ranges.

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Thank you!!



**Diagnosis of
lead
perforation
needs
attention!!!**

Pacemaker pocket infection



19.01.2018 9:35:38
B KARDIOLOGIKH

Location:
Order Number:
Visit:
Indication:
Medication 1:
Medication 2:
Medication 3:

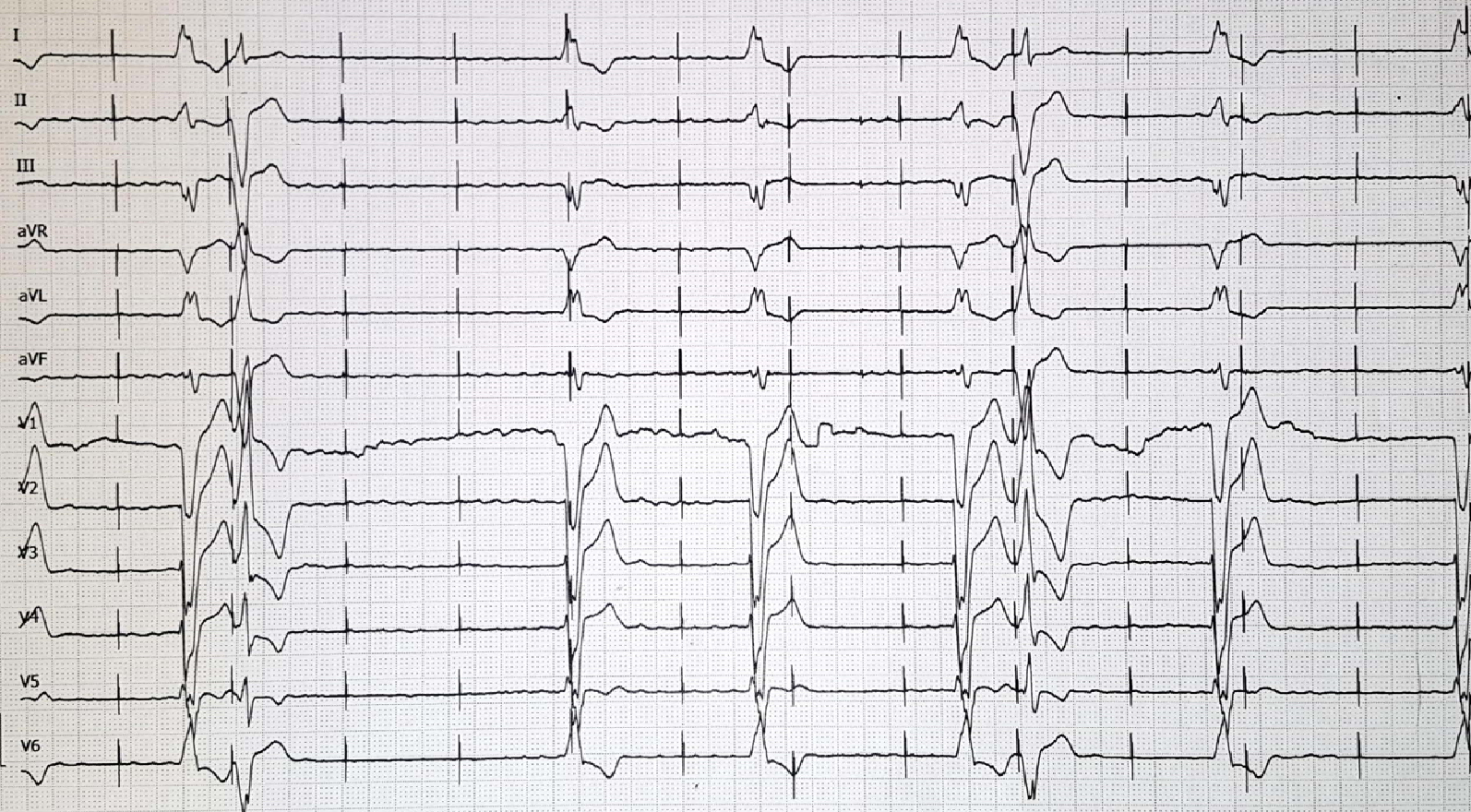
Room:

55 bpm

Technician:
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ΝΤΩΝΤΟΡΟΣ

ΝΤΩΝΤΟΡΟΣ ΑΝΔΡΕΑΣ (στην τω αρεαίατα)



GE MAC2000

1.1

12SL™ v241

25 mm/s 10 mm/mV

ADS

0.56-100 Hz 50 Hz

Rhythm

