

Echocardiography fails to detect an extensive aortic root abscess in a patient with infective endocarditis: a case report

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Background

Echocardiography plays a central role in the diagnosis of infective endocarditis (IE). In recent years, additional imaging techniques have begun to challenge the conventional approach. We present a case where the use of transthoracic/transoesophageal echocardiography (TTE/TOE) in suspected IE failed to identify an extensive periannular abscess, later identified by ¹⁸F-fluorodeoxyglucose–positron emission tomography (FDG–PET), requiring urgent intervention.

Case summary

A 69-year-old man with symptomatic *Streptococcus sanguinis* bacteraemia and a bicuspid aortic valve was found to have new-onset left bundle branch block that progressed to complete heart block. After starting on IV Penicillin G and having a temporary pacemaker inserted, his clinical condition improved. Transthoracic echocardiography and TOE showed no evidence of abscess. However, persistent first-degree atrioventricular block raised clinical suspicion of a possible extended infection. Subsequent FDG–PET revealed focal activity around the aortic root that extended inferiorly into the interatrial septum, consistent with active infection and possible abscess. Composite aortic root replacement with insertion of a mechanical prosthesis was carried out, revealing extensive IE and multiple periannular abscesses.

Discussion

As guidelines grapple with evolving understandings of how best to define the optimal imaging approach for the management of complicated IE, the results of this case clearly show the importance of heightened clinical suspicion and need for prompt operative intervention when faced with patients who present with predisposing conditions and concern for advanced conduction disease. Clinicians and researchers are encouraged to learn from the potential near-miss of an extensive periannular abscess to help guide guideline-development of imaging in complicated IE and prevent adverse outcomes in patients with similar presentations.

Keywords

Endocarditis • Abscess • Transoesophageal echocardiography • Transthoracic echocardiography • Guidelines • Case report

ESC Curriculum

2.1 Imaging modalities • 2.2 Echocardiography • 4.11 Endocarditis

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Learning points

- Complete heart block in patients with pre-existing aortic valve pathology and positive blood cultures should be considered indicative of infective endocarditis (IE) with an aortic root abscess until proven otherwise.
- A high-index of clinical suspicion in the management of suspected IE is imperative, regardless of what diagnostic studies show, given a continued risk for active infection and related sequelae (e.g. difficult to visualize abscesses).
- Updated guidelines defining the optimal imaging approach for patients with complicated IE are needed, reflective of evolving understandings of more advanced multimodal imaging techniques.

Introduction

Echocardiography plays a central role in the diagnosis of infective endocarditis (IE), serving as a major diagnostic criteria in the modified Duke criteria (Table 1).¹ The European Society of Cardiology (ESC),² American College of Cardiology/American Heart Association,³ and American College of Radiology⁴ recognize echocardiography as an important first step in determining the prognosis of patients with suspected IE. Echocardiography also has documented utility in ascertaining the success of medical management for IE and evaluating options before, during, and after surgery.⁵ In recent years, additional imaging techniques [e.g. multidetector computed tomography (MDCT), ¹⁸F-fluorodeoxyglucose–positron emission tomography (FDG–PET), white blood cell scintigraphy, and brain/cardiac magnetic resonance imaging (MRI)] have begun to challenge the conventional approach.^{2,6–9} Proponents of their use highlight echocardiography's limitation in identifying, among other things, abscesses in the setting of difficult-to-visualize locations (e.g. aortic root) and bulky calcification.^{7,10,11} Here, we present a case where the use of transthoracic/transoesophageal echocardiography (TTE/TOE) in suspected IE failed to identify an extensive periannular abscess, later identified by FDG–PET, requiring urgent intervention.

Timeline

Hospital day 1	Admission with flu-like symptoms, new-onset left bundle branch block Blood-cultures positive for <i>Streptococcus sanguinis</i> bacteraemia
Hospital day 2	Progression to complete heart block Cardiac catheterization: no coronary obstruction Transthoracic echocardiography heavily calcified bicuspid aortic valve Magnetic resonance imaging brain: septic emboli
Hospital day 3	Started on IV Penicillin G Temporary pacemaker placed Transferred to the cardiac care unit of our hospital

Continued

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Hospital day 4	Transoesophageal echocardiography: vegetations on the aortic side of the aortic valve Subsequent blood-cultures no growth
Hospital day 5	Temporary regain of atrioventricular (AV)-conduction Transferred to cardiology floor
Hospital days 6–10	Intermittent reversion to complete heart block, persistent first-degree AV block Daily echocardiogram monitoring and observation
Hospital day 11	¹⁸ F-fluorodeoxyglucose positron emission tomography: infective endocarditis, likely abscess
Hospital day 15	Surgical aortic valve and root replacement, permanent pacemaker placement
Hospital day 26	Discharged on a 4-week course of IV Penicillin G

Case presentation

A 69-year-old man with a past medical history notable for a bicuspid aortic valve, poor oral dentition, and hypertension presented to another institution with five days of fatigue, myalgia, poor appetite, and flu-like symptoms (temperature 38.2°C/100.7°F). He was found to have leucocytosis [$15.0 \times 10^3/\text{mm}^3$ (normal range: 4.5–11.0 $\times 10^3/\text{mm}^3$)] and new-onset left bundle branch block (LBBB) that progressed to complete heart block, requiring a temporary pacemaker. Cardiac catheterization to rule out coronary obstruction showed no obstructive lesions and mild atherosclerosis. Transthoracic echocardiography revealed extensive aortic-valve calcification but did not show an obvious vegetation or abscess. Three sets of blood cultures (Day 1: two abnormal, Day 3: one abnormal) established *Streptococcus sanguinis* bacteraemia. A brain MRI performed due to altered mental status led to the diagnosis of septic emboli. It identified multiple small rounded foci of restricted diffusion in the bilateral cortices (including the anterior, middle, and posterior cerebral arteries) and left cerebellum associated with mild vasogenic oedema. The patient was started on IV Penicillin G (4 million units every four hours) and transferred to the cardiac care unit of our hospital.

At our hospital, TOE revealed small mobile echodensities on the aortic-side of the aortic valve, concerning for vegetation, but no

Table 1 Diagnosis of infective endocarditis, modified Duke criteria (adapted from Li et al.¹)

<p>Definite IE</p> <p><i>Pathologic criteria</i></p> <p>(1) Micro-organisms demonstrated by culture or histologic examination of a vegetation, a vegetation that has embolized, or an intracardiac abscess specimen OR</p> <p>(2) Pathologic lesions, vegetation, or intracardiac abscess confirmed by histologic examination showing active endocarditis</p> <p><i>Clinical criteria</i></p> <p>(1) Two major criteria OR</p> <p>(2) One major criteria and three minor criteria OR</p> <p>(3) Five minor criteria</p> <p>Possible IE</p> <p>(1) One major criteria and one minor criteria OR</p> <p>(2) Three minor criteria</p> <p>Rejected diagnosis of IE</p> <p>(1) Firm alternate diagnosis explaining evidence of IE OR</p> <p>(2) Resolution of IE syndrome with antibiotic therapy for ≤ 4 days OR</p> <p>(3) No pathologic evidence of IE at surgery or autopsy, with antibiotic therapy for ≤ 4 days OR</p> <p>(4) Does not meet criteria for possible IE</p> <p>Major diagnostic criteria</p> <p><i>Blood-culture positive for IE</i></p> <ul style="list-style-type: none"> • Typical microorganisms consistent with IE from two separate blood-cultures: <i>Streptococcus viridians</i>, <i>Streptococcus bovis</i>, HACEK organisms (<i>Haemophilus</i> species, <i>Aggregatibacter</i> species, <i>Cardiobacterium hominis</i>, <i>Eikenella corrodens</i>, or <i>Kingella</i> species), <i>Staphylococcus aureus</i>, or community-acquired <i>Enterococcus</i> without a primary focus OR • Microorganisms consistent with IE from persistently positive cultures: (i) ≥ 2 positive cultures from blood samples drawn >12 h apart, (ii) all of three, or (iii) a majority of ≥ 4 separate cultures with the first and last drawn at least 1 h apart OR • Single positive culture for <i>Coxiella burnetii</i> or antiphase I IgG antibody titre $>1:800$ <p><i>Evidence of endocardial involvement</i></p> <p><i>Echocardiogram positive for IE</i></p> <ul style="list-style-type: none"> • TOE recommended in patients with prosthetic valves with at least 'possible IE' based on clinical criteria or complicated IE (paravalvular abscess); TTE first test in all other patients • Positive if evidence of (i) oscillating intracardiac mass on valve or supporting structures, in the path of regurgitant jets, or on implanted material in the absence of an alternative anatomic explanation, (ii) abscess, or (iii) new partial dehiscence of a prosthetic valve <p>New valvular regurgitation, worsening or changing of pre-existing murmur not sufficient</p> <p>Minor diagnostic criteria</p> <p><i>Predisposition, predisposing heart condition, or injection drug use</i></p> <p>Fever, temperature $>38^{\circ}\text{C}$ (100.4°F)</p> <p><i>Valvular phenomena</i></p> <ul style="list-style-type: none"> • Major arterial emboli, septic pulmonary infarcts, mycotic aneurysm, intracranial haemorrhage, conjunctival haemorrhages, or Janeway lesions <p><i>Immunologic phenomena</i></p> <ul style="list-style-type: none"> • Glomerulonephritis, Osler's nodes, Roth's spots, or rheumatoid fever <p><i>Microbiologic evidence</i></p> <ul style="list-style-type: none"> • Positive blood-culture but does not meet a major diagnostic criterion or serological evidence of active infection with an organism consistent with IE

evidence of abscess (Figure 1A–C, Videos 1 and 2). Three sets of blood cultures showed no bacterial growth (negative days 4–6). The patient's leucocytosis improved ($10.9 \times 10^3/\text{mm}^3$). He was temporarily able to regain atrioventricular (AV) conduction, changing from complete heart block to LBBB and first-degree AV block with significantly prolonged PR-intervals (>400 ms). He was transferred to the cardiology floor.

On the floor, telemetry showed intermittent complete heart block. Figure 2A–D documents progression on electrocardiogram. Given continued conduction abnormalities, clinical concern was raised that the patient could have developed a periaortic abscess not observed on TTE/TOE. After consultation and extensive discussion with our cardiothoracic surgery, electrophysiology, and infectious disease teams, the decision was made to observe the patient and

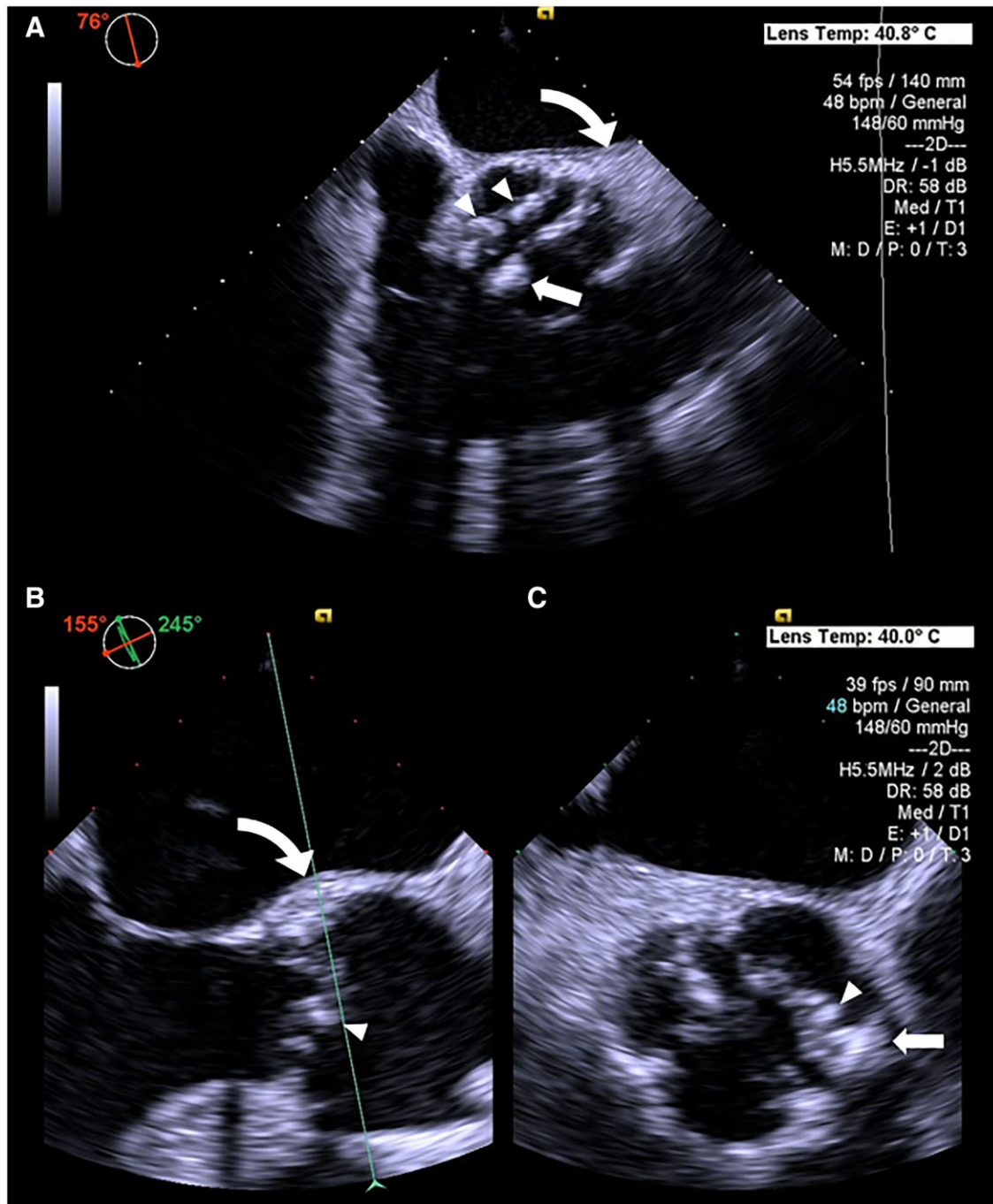


Figure 1 (A) Mid-oesophageal aortic valve short-axis view from transoesophageal echocardiogram showing a Sievers Type 1 bicuspid aortic valve with fusion of the right coronary and non-coronary cusps, aortic valve calcifications (arrowheads), and a mobile echodensity on the aortic side of the valve (arrow), concerning for vegetation. (B) Mid-oesophageal aortic valve long-axis and (C) corresponding short-axis views also show aortic valve calcifications (arrowheads) and mobile vegetation (arrow). While no clear evidence of aortic abscess was found on the initial transoesophageal echocardiogram read, in retrospect, there is mild thickening of the membranous septum (curved arrow) that could represent a phlegmon and portend the development of an abscess. Video clips show highlights from the transoesophageal echocardiogram imaging.

monitor daily electrocardiograms. From day 8 onwards, he remained in sinus rhythm with first-degree AV block. PR-intervals fluctuated (338–363 ms) but did not demonstrate further advanced conduction disease. The temporary pacemaker was removed on day 11. During

this time, the patient's clinical condition remained stable with no fever, leucocytosis, or valvular complications. However, due to remaining clinical concern, FDG-PET was ordered. It revealed focal activity around the aortic root that extended inferiorly into the

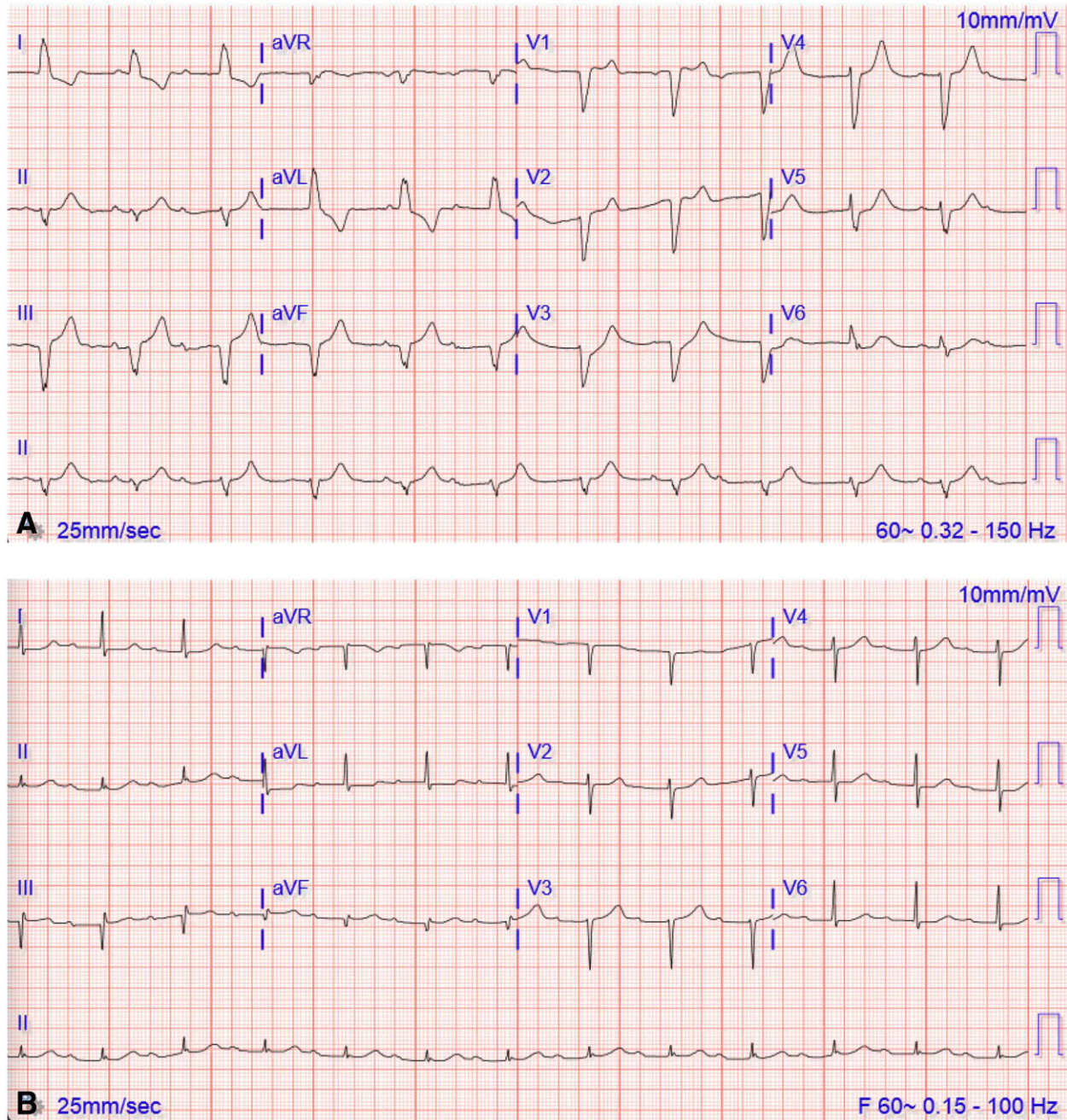


Figure 2 Progression of conduction abnormalities captured on electrocardiogram. On admission to another institution (A: Day 1), electrocardiogram showed sinus rhythm with complete heart block, wide QRS complexes, left axis deviation, and new-onset left bundle branch block. On admission to the cardiology floor of our hospital (B: Day 5), electrocardiogram showed sinus rhythm with prolonged PR-intervals (332 ms shown). While on the cardiology floor (C: Day 5), complete heart block transiently resumed. Following cardiac surgery (D: Day 16), electrocardiogram showed an atrial-ventricular dual-paced rhythm consistent with the patient's implanted permanent pacemaker.

interatrial septum, consistent with active infection of the aortic valve/myocardium and possible abscess (Figure 3A–D). Given these findings and the presence of conduction disease, the patient was scheduled for urgent composite aortic root replacement and transferred to surgery.

In the operating room (Figure 4A–D), the patient was found to have an extensive bacterial infection within his aortic root and destroyed aortic annulus with two clear pus-pockets: one below the left coronary ostium eroding the muscle (1 cm × 7 mm × 4 mm) and one at the membranous septum representing an abscess (2 cm × 1 cm ×

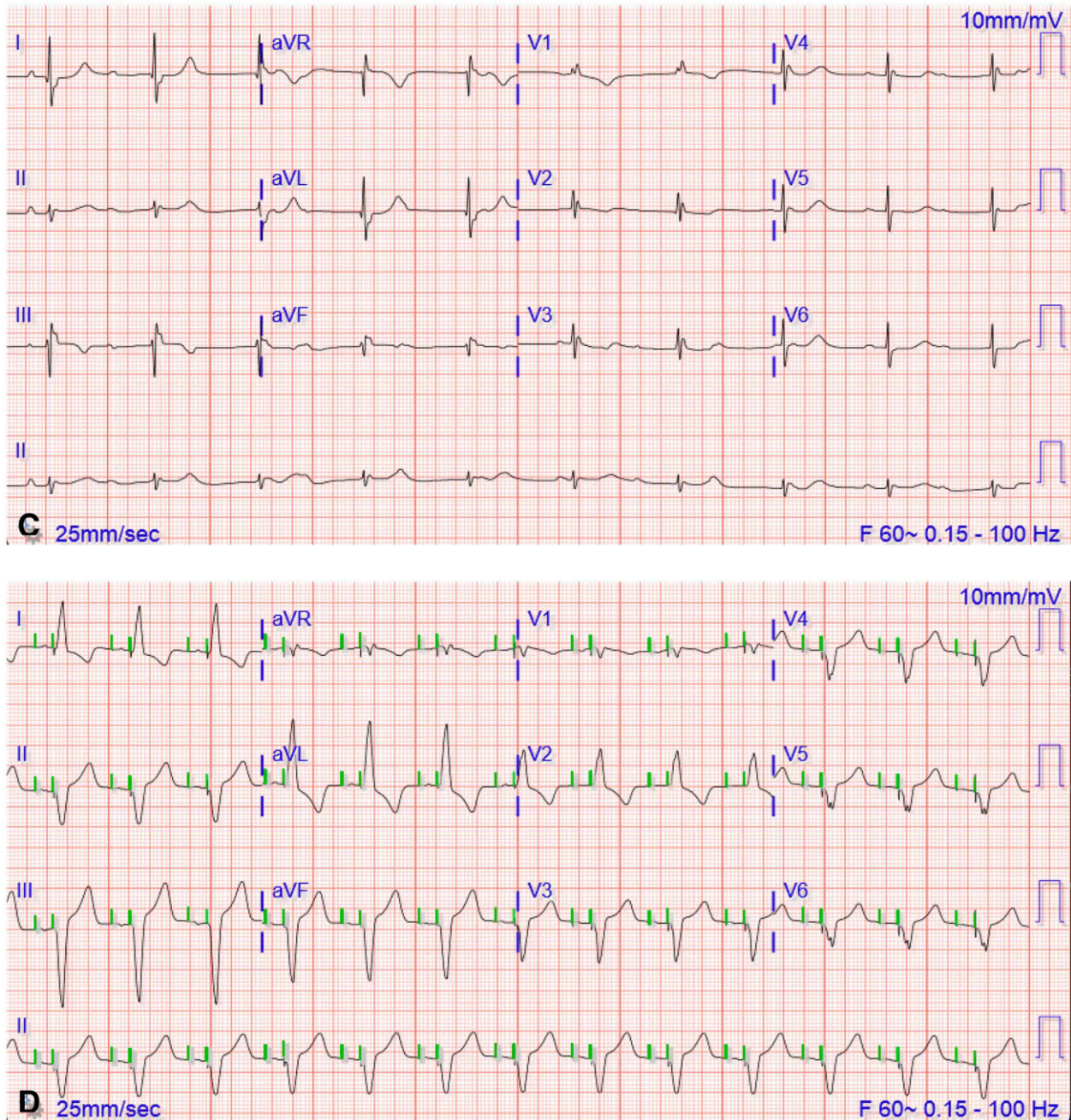


Figure 2 (Continued).

1 cm). Transection of the aorta revealed two areas of abscess: one in the left coronary cusp below the left coronary ostia (10 mm × 5 mm × 4 mm) and one with a pus-cavity in the membranous septum near the junction of the right coronary and non-coronary cusp (20 mm × 30 mm × 10 mm). Infected material was excised. The aortic valve was replaced with a mechanical prosthesis, and a pericardial patch connecting the aortic root and ascending aorta was used to reconstruct the left ventricular outflow tract. A permanent pacemaker was

implanted. Following the operation, the patient was managed in the cardiothoracic surgery intensive care unit (Days 16–18) and cardiology floor (Days 19–26). He was discharged to short-term rehabilitation on a 4-week course of IV Penicillin G (4 million units every four hours).

When last seen by outpatient cardiology 6 months after hospitalization, the patient was reported to be doing well. He continues to endorse dyspnoea on exertion but was otherwise without cardiac

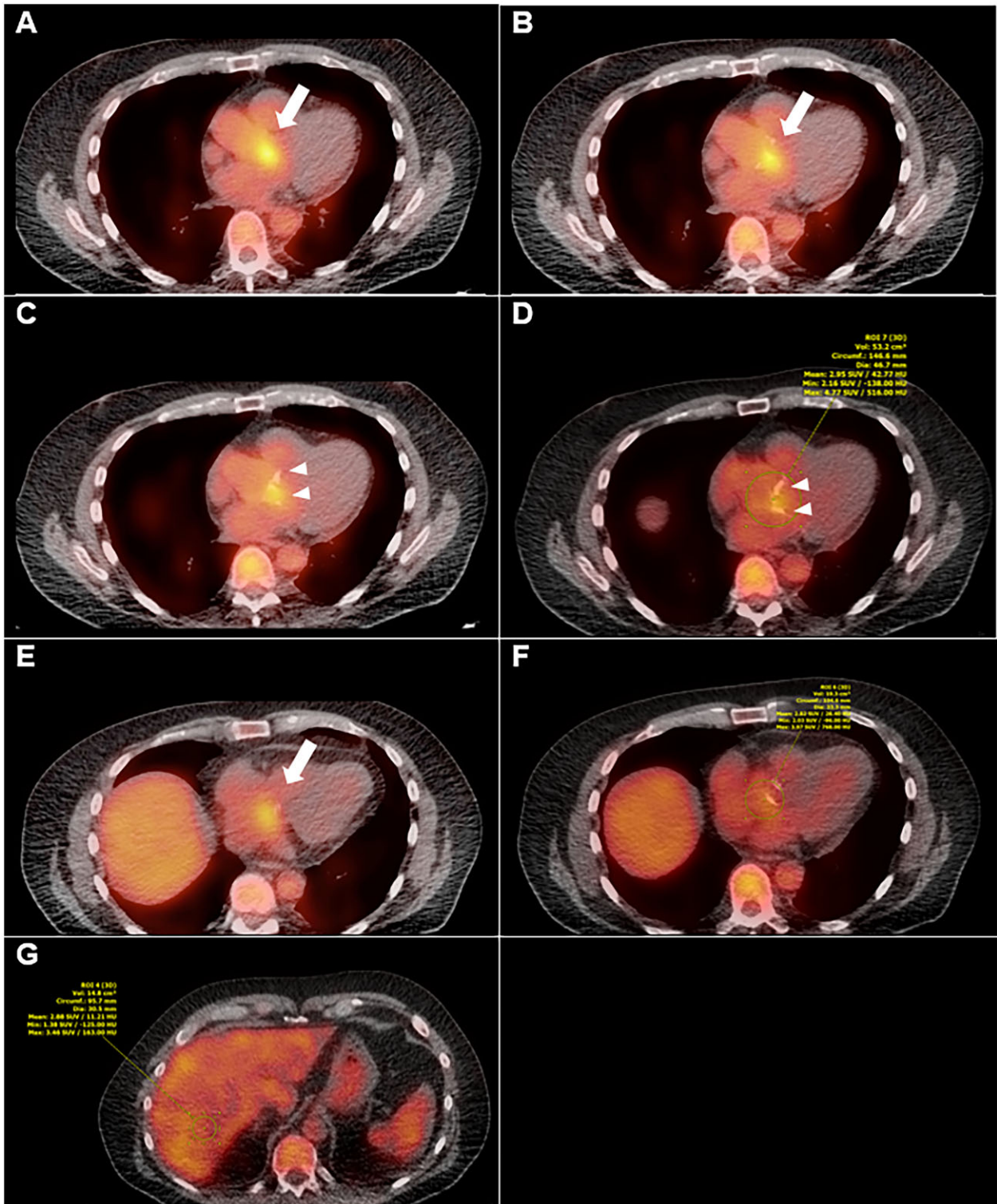


Figure 3 Cardiac ^{18}F -fluorodeoxyglucose positron emission tomography can through the heart showing aortic calcifications (arrowheads) and two areas (A–D; E, F) of focal activity around the aortic root extending inferiorly into the membranous septum (arrow). Since the degree of focal cardiac activity (SUV-max 4.8) was higher than that of normal liver parenchyma (G; SUV-max 3.5), infection of the aortic valve with possible interatrial abscess was suspected.

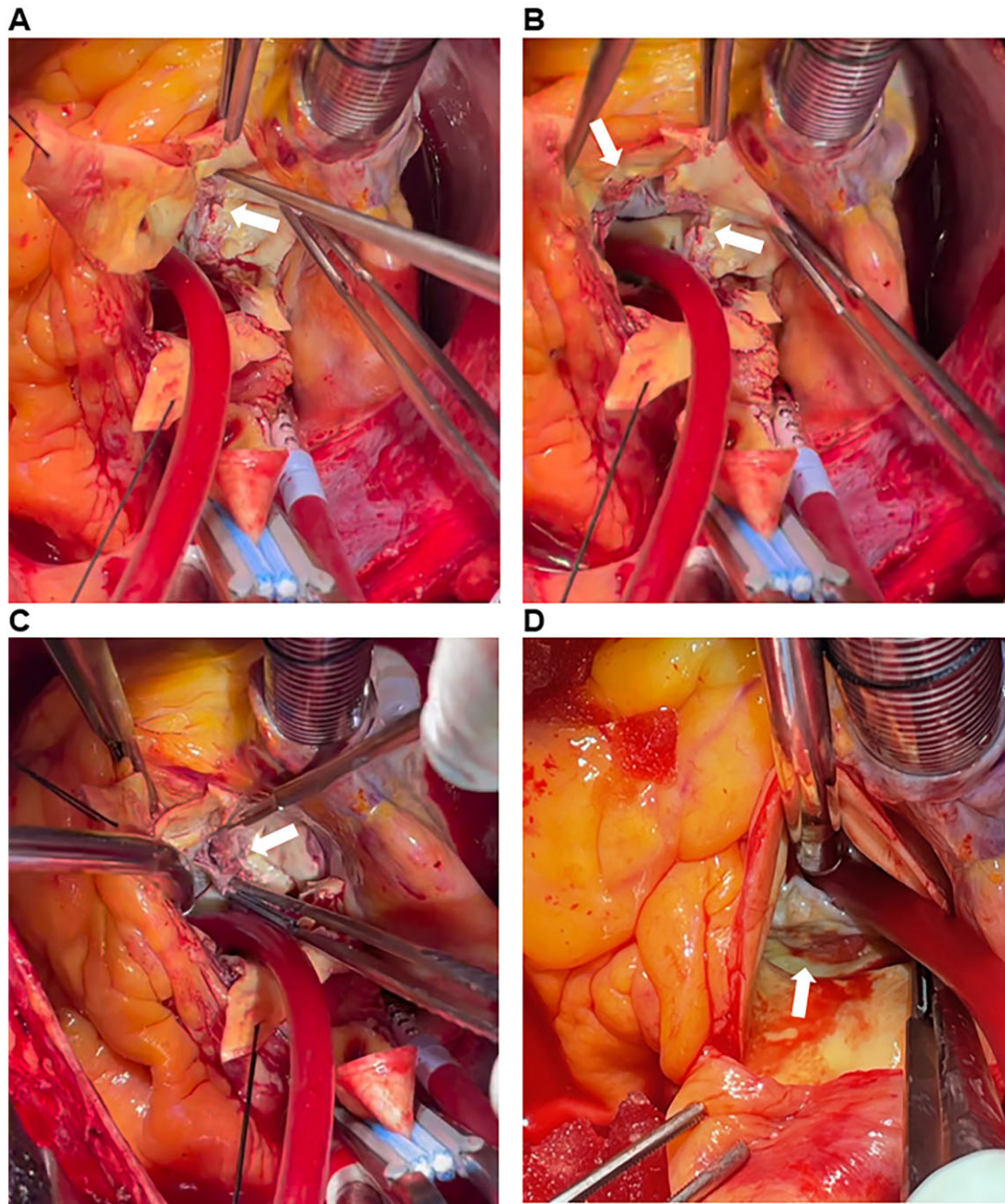


Figure 4 Intraoperative photos showing the extent of active infective endocarditis in the area of the aortic root extending into the membranous septum (A–C) and presence of a clear abscess (D). For orientation, the bottom of the photos is superior (toward the patient’s head), and the top of the photos is inferior (toward the patient’s feet). An aortic cross-clamp can be seen in blue.

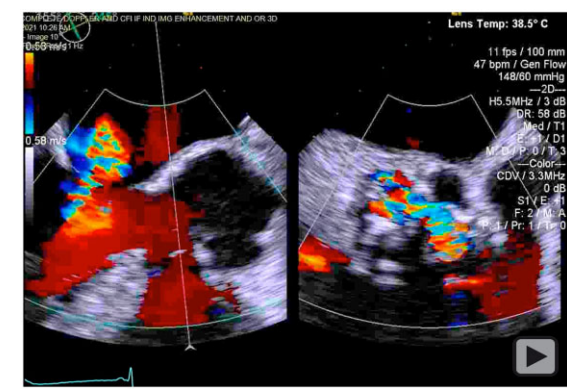
complaints. He has recovered well from surgery and is compliant with his medications.

Discussion

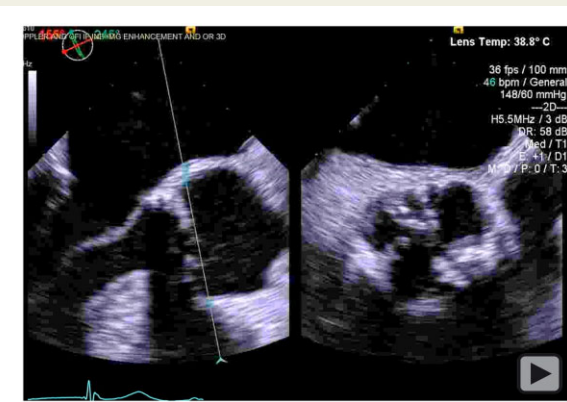
The results of this case show that when risk factors for IE are known (e.g. bicuspid aortic valve, active infection), a reversal in clinical signs (e.g. fever subsiding, blood cultures clearing) does not

necessarily mean that the infectious process resolved. Maintained clinical suspicion alone enabled us to catch a potentially life-threatening abscess that objective signs and guideline-directed^{1–4} imaging failed to detect. Such an outcome leads to three important lessons:

- (1) Complete heart block in patients with pre-existing aortic valve pathology and positive blood cultures should be considered indicative of IE with an aortic root abscess until proven otherwise.



Video 1 Shows a mid-oesophageal aortic valve long axis and corresponding short-axis view demonstrating turbulent flow through the aortic valve on colour Doppler with evidence highlighted in the still images of [Figure 1](#) suggesting calcifications and mobile vegetation.



Video 2 Shows the same images as [Video 1](#) without the overlain colour Doppler flow. Presented is a mid-oesophageal aortic valve long axis and corresponding short-axis view with evidence highlighted in the still images of [Figure 1](#) suggesting calcifications and mobile vegetation.

- (2) A high index of clinical suspicion in the management of suspected IE is imperative, regardless of what diagnostic studies show, given a continued risk for active infection and related sequelae (e.g. difficult-to-visualize abscesses).
- (3) Updated guidelines defining the optimal imaging approach for patients with complicated IE are needed, reflective of evolving understandings of more advanced multimodal imaging techniques.

For many patients with suspected IE at risk for abscess development, the first conduction abnormality observed is first-degree AV block.^{2,3} Presentation of more advanced complete heart block usually develops later in the evolution of a potential abscess. When faced

with first-degree AV block, daily monitoring of PR intervals on electrocardiograms is considered routine standard of care.^{2,3} What is interesting about its use in this case of a transferred patient with (i) apparent clinical improvement, (ii) initially negative TTE/TOE reads, and (iii) progression from complete heart block back to first-degree AV block is the emphasis that it places on the need to maintain clinical suspicion of potential abscess formation.

Retrospective review of the patient's TOE images looking for evidence of early abscess development revealed abnormal thickening of the membranous septum that could represent a phlegmon and portend the development of an abscess. Had such findings been initially seen, they should have alerted us to the high possibility of abscess development and prompted further dedicated imaging. However, even in the absence of positive findings on TTE/TOE, this case highlights the importance of maintained clinical suspicion and the potential need for investigation with more advanced imaging techniques when presented with a new unexplained LBBB and prolonged PR intervals. For advanced imaging, we opted to use FDG-PET given its ability to present metabolic imaging data and, thereby, higher sensitivity in detecting new and developing abscesses.⁷⁻⁹ It is possible that repetition of a third TTE/TOE at that point would have yielded similar conclusions given that seven additional days had passed (hospital day 2: TTE, hospital day 4: TOE, hospital day 11: FDG-PET).

The limitation of echocardiography in initially detecting periannular abscesses is not new. Prior studies suggest sensitivity for abscess detection as low as 28–36% for TTE and 80–100% for TOE, with corresponding specificities of 99% and 95%.⁷ Presence of prosthetic valves, electrophysiological devices, difficult-to-visualize-anatomic locations, and calcification have been shown to reduce diagnostic accuracy, rendering TTE futile and dropping the sensitivity of TOE to as low as 48%.^{7,10,11} Such findings have opened the door for the introduction of more advanced multimodal imaging techniques. ESC acknowledged this potential in their 2015 guidelines, stating that 'the addition of the results of these imaging modalities may improve the sensitivity of the modified Duke criteria in difficult cases'.² While the exact form that such additions should take remains uncertain,⁷⁻⁹ research suggests that MDCT outperforms TTE and TOE for abscess detection with a sensitivity >97% (specificity 75%).⁷ ¹⁸F-fluorodeoxyglucose positron emission tomography has been reported to outperform all three for early abscess detection,⁷⁻⁹ leading to its use in this case. Additional advantages and limitations of various imaging modalities are presented in [Supplementary material](#) online, [Table S1](#). While TTE/TOE remains the first-line choice for the diagnosis of IE,¹ recognition of its limitations has increasingly led to calls for the subsequent use of complementary imaging.⁷⁻⁹ One potential stepwise approach⁸ is outlined below:

- Initial assessment remains based on the modified Duke criteria, including collection of blood cultures and performance of TTE/TOE.
- If a diagnosis of IE is rejected and clinical suspicion is low, no further investigations are required.
- If a diagnosis of IE is definite, patients should be further investigated for silent emboli using computed tomography or FDG-PET as well as brain MRI for possible cerebral involvement as

warranted by a given patient's clinical picture (e.g. clinical suspicion of neurological or embolic complications).

- If a diagnosis of IE is possible or rejected but clinical suspicion is high, patients should have echocardiography and blood cultures repeated (ideally after 5–7 days)² and physicians should employ an early multimodal imaging approach to assess for silent emboli and metastatic infections (including further cardiac imaging if TTE/TOE is negative).²

As guidelines grapple with evolving understandings of how best to define the optimal imaging approach for the management of complicated IE and incorporate information from multiple imaging modalities,^{1–4} the results of this case show the importance of heightened clinical suspicion and need for prompt intervention when faced with patients like ours who present with known predisposing conditions and concern for advanced conduction disease. Periannular abscesses with myocardial extension are notoriously difficult to treat. They are challenging to visualize with echocardiography, carry a high-mortality risk, and can face recurrence in >8.7% of cases.^{12,13} For such patients, early detection with appropriate imaging and operative intervention are key given the radical excision needed to reconstruct the valve structures and left ventricular outflow tract. In reading this case, clinicians and researchers are encouraged to learn from the potential near-miss of an extensive periannular abscess. The results are hoped to help guide ongoing guideline development of imaging in complicated IE and prevent adverse outcomes in patients with similar presentations.

Lead author biography



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Supplementary material

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

Slide sets: A fully edited slide set detailing this case and suitable for local presentation is available online as [Supplementary data](#).

Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: None declared.

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