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RHYTHM DISORDERS AND ELECTROPHYSIOLOGY

CASE REPORT: CLINICAL CASE

Fungal Leadless Pacemaker Endocarditis Managed by Percutaneous Vacuum-Assisted Evacuation of Vegetation, Pacemaker Extraction, and Replacement

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ABSTRACT

Leadless cardiac pacemakers (LCPs) mitigate the risks of traditional transvenous devices such as lead fracture and infection. Two LCPs are clinically available, using either a helix or tined active fixation approach. There are rare reports of LCP infection—all involving the tined device. We report the first pathologically confirmed fungal endocarditis involving a helix-based LCP. This was successfully managed by catheter-based mechanical vacuum evacuation of the vegetation, followed by device extraction and replacement. (JACC Case Rep. 2024;29:102586) © 2024 The Authors. Published by Elsevier on behalf of the American College of Cardiology Foundation. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

HISTORY OF PRESENTATION

A 59-year-old male with drug refractory persistent atrial fibrillation with severe left atrial dilatation underwent atrioventricular (AV) nodal ablation and placement of a helix-tipped leadless cardiac pacemaker (LCP). Three months later, the LCP was explanted and repositioned for elevated right ventricular (RV) thresholds. Four months later, he presented to an outside institution with weakness and fevers and was empirically treated with broad-spectrum antibiotics. Fevers persisted for nearly 6 weeks with negative cultures despite escalating antibiotic therapy. Ultimately, a transesophageal echocardiogram performed showed a large mobile echo density (2.0 × 1.5 cm) involving the LCP extending into the RV outflow tract. He was transferred to our tertiary care center for further management.

LEARNING OBJECTIVES

- To understand the potential for leadless pacemaker infections with *Candida albicans*.
- To comprehend the potential role of mechanical vacuum aspiration in the diagnosis and treatment of cardiac-implantable electrical device–related endocarditis.

PAST MEDICAL HISTORY

The patient's medical history was significant for drug refractory persistent atrial fibrillation for which he underwent AV nodal ablation and placement of a helix-tipped LCP. Before his presentation, he required explantation and repositioning of the device

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ABBREVIATIONS AND ACRONYMS

AV = atrioventricular

LCP = leadless cardiac pacemaker

RV = right ventricle

3 months post-implantation for elevated RV thresholds. He also had a history of ischemic stroke with residual right-sided weakness, chronic kidney disease, and diabetes mellitus.

DIFFERENTIAL DIAGNOSIS

The differential diagnosis for new echo densities on an intracardiac device included thrombi, infectious vegetations, nonbacterial endocarditis, or malignancy.

INVESTIGATIONS

Upon presentation, the patient was hemodynamically stable except for recurrent fevers. Blood count revealed leukocytosis (13,500 leukocytes/μL). Electrocardiogram showed ventricular paced rhythm. Transthoracic imaging failed to reliably confirm the echo density presence; however, a repeat transesophageal echocardiogram revealed a large pedunculated multilobular mobile mass (4.6 × 1.0 cm) attached to the LCP and tricuspid subvalvular apparatus, extending and abutting into the pulmonic valve (Figure 1). Computed tomography scan confirmed bilateral pulmonary emboli. Repeat blood cultures showed negative growth.

MANAGEMENT

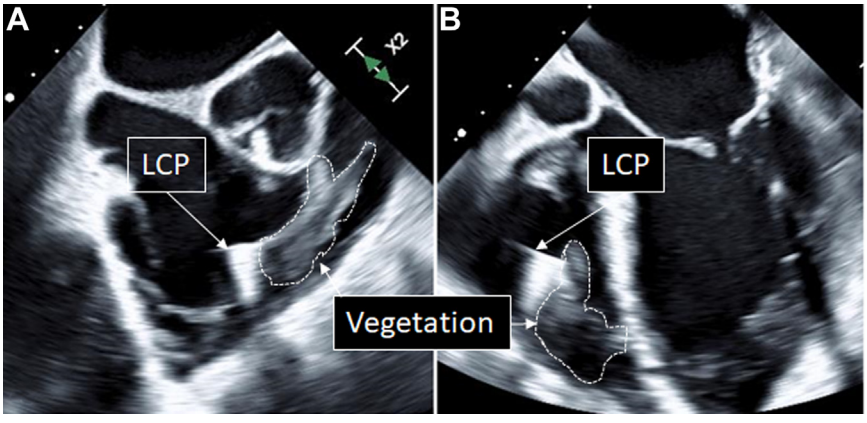
The patient was continued on empiric broad-spectrum antimicrobials including daptomycin and aztreonam. Despite this, he remained febrile. Surgical intervention was considered; however, given the lack of significant tricuspid valvular regurgitation, the decision was made to attempt a percutaneous approach of source-control and pathological diagnosis. Using intracardiac echocardiography guidance, we performed percutaneous vacuum-assisted venous drainage (AngioVac, Angiodynamics) of the mass, which was attached to the LCP, the RV, and subvalvular tricuspid apparatus.

In brief, the drainage device was advanced into the RV via femoral venous access. Once near the LCP, device suction was initiated to rapidly aspirate the densities which were removed in the filter system before blood was returned. Multiple aspirations were required to remove a small residual mobile echo density on the tricuspid valve subvalvular apparatus (Figure 2). The LCP was then unscrewed and readily removed using the retrieval tool (Abbott Laboratories). Although the patient had a junctional escape rhythm, this was believed to be unstable in the setting of prior AV-nodal ablation and a new tined LCP was implanted Micra, Medtronic). The patient tolerated the procedure without hemodynamic complications. Pathology and cultures of the mass were positive for *Candida albicans* for which intravenous caspofungin was initiated. The patient defervesced and was discharged.

DISCUSSION

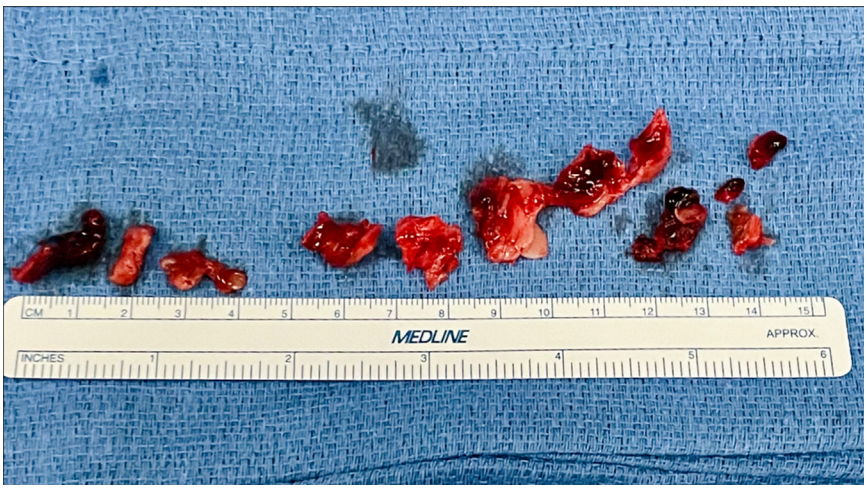
The LCP has emerged as a safe and effective alternative to traditional transvenous pacemakers in patients with high infection risk who have indications for ventricular pacing. The smaller LCP device area, ability for device encapsulation, turbulent flow hemodynamics within the RV, and decreased operator contact during device implantation all confer

FIGURE 1 Transesophageal Echocardiography Images



(A, B) Transesophageal echocardiographic views of the large vegetations attached to the leadless pacemaker and extending from the tricuspid valve to the pulmonary valve. LCP = leadless cardiac pacemaker.

FIGURE 2 **Gross Images of Extracted Material**



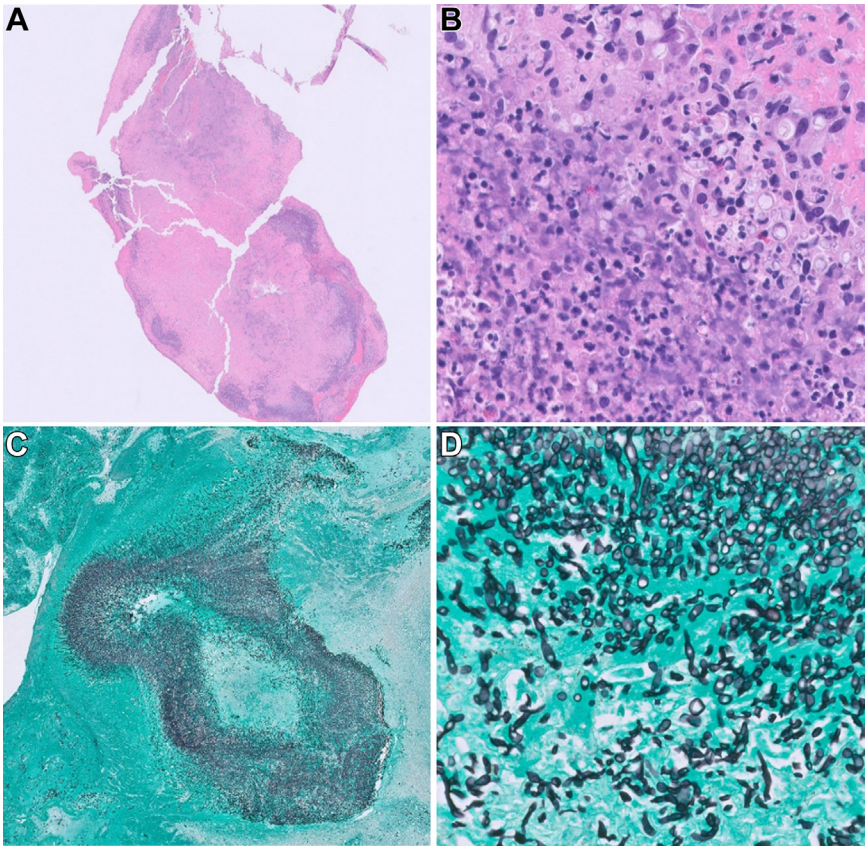
Gross image of vegetations aspirated using the AngioVac system.

protection against bacterial seeding. Prior studies involving LCPs have shown low incidences of post-implantation bacteremia or endocarditis, which have mostly been unrelated to the device.[1-2] To date, there are no published infections involving helix-based devices. However, 4 cases of endocarditis involving the tined-based LCP have been reported since its introduction in 2016.[3-6] Of those cases, 3 occurred within 1-month post-implantation at which time full device endothelization was not expected. The fourth case occurred in an immunocompromised dialysis patient on leflunomide—an agent known to disrupt tissue endothelization. One of the previously reported LCP-related infections was due to *Candida albicans*.[5] Candida infective endocarditis is a rare (2%-4%) but highly fatal complication with a >30% in-hospital mortality rate, as positive fungal blood culture appears much later during the clinical course which makes diagnosis challenging.

Best practices for the management of infected LCPs are actively being investigated. For device-related endocarditis involving the traditional transvenous pacemaker, current guidelines recommend immediate extraction. In general, pacemaker reimplantation is recommended after blood culture has been negative for at least 2 weeks if vegetations were visualized given the risk of reinfection. A temporary pacing wire could be used to bridge this period; however, given this patient's history of high RV thresholds, the concern for loss of capture using a temporary pacing system made this option less appealing. On the contrary, LCP implantations have shown resistance towards re-infections even when implanted before or during pacemaker extraction and thereby can serve as an alternative to delayed reimplantation, especially in the setting of continued antibiotics.[7-8]

In recent years, the percutaneous vacuum-assisted venous drainage system has been used in patients with right-sided infective endocarditis as an alternative to the surgical approach, especially if at high operative risk for tricuspid valve vegetation debulking. This approach has been reported in 301 patients from 44 studies with 89.2% procedural and 79.1% clinical success.[9] More recently, percutaneous vacuum-assisted drainage has shown success in debulking of large transvenous device-related infective vegetation followed by device extraction in a 13-patient study.[10] Our case shows that LCP infections can also be successfully addressed with percutaneous aspiration when there is no indication for concomitant surgical valvular replacement. Given the 10.1% rate of procedural-related complications, percutaneous vacuum-assisted venous drainage of vegetation should be performed with cardiac surgical support due to potential serious complications including vascular or myocardial injury, pericardial tamponade, pulmonary embolism or vegetation embolization, and tricuspid valve injury.[9] Therefore, use of the percutaneous vacuum-assisted venous drainage system should be determined on a

FIGURE 3 Histopathology of Extracted Material



(A, B) Low and high power of the right ventricular tissue hematoxylin and eosin stain, respectively. (C, D) Low and high power of the right ventricular tissue Grocott's methenamine silver (GMS). The fungus morphology is best visualized on the high-power GMS.

case-by-case basis, and further clinical study of its efficacy and safety profile is still needed.

FOLLOW-UP

The patient remained afebrile post procedure and progressively improved on antifungal treatment. Intraoperative RV tissue samples and LCP tip were sent for surgical pathology and culture analysis with evidence of the fungus visualized on both specimens (Figure 3). He was discharged 2 weeks later.

CONCLUSIONS

Leadless device-related infection remains extremely rare with only 4 prior published cases to date. We reported the first incidence of fungal endocarditis involving the helix-based LCP managed successfully with aspiration of vegetations using the percutaneous vacuum-assisted venous drainage system, and simultaneous extraction of the infected helix-based LCP and implantation of a tined-based LCP.

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Dr Dukkipati has received consulting fees from Biosense Webster; has received payment for equity in Farapulse Boston Scientific; and has equity with Manual Surgical Sciences. Dr Reddy has received consulting fees from Abbott and Medtronic as related specifically to this paper; unrelated to this work; has received consulting fees from and has equity in Ablacon, Acutus Medical, Affera-Medtronic, Apama Medical-Boston Scientific, Anumana, APN Health, Aquaheart, Atacor, Autonomix, Axon Therapies, Backbeat, BioSig, CardiaCare, CardioNXT/AFTx, Circa Scientific, CoRISMA, Corvia Medical, Dinova-Hangzhou DiNovA EP Technology, East End Medical, EPD-Philips, EP Frontiers, Epix Therapeutics-Medtronic, EpiEP, Eximo, Farapulse, Field Medical, Focused Therapeutics, HRT, Intershunt, Javelin, Kardium, Keystone Heart, Laminar Medical, LuxMed, Medlumics, Middlepeak, Neutrace, Nuvera-Biosense Webster, Oracle Health, Restore Medical, Sirona Medical, and SoundCath, Valcare;

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REFERENCES

1. El-Chami MF, Soejima K, Piccini JP, et al. Incidence and outcomes of systemic infections in patients with leadless pacemakers: data from the Micra IDE study. *Pacing Clin Electrophysiol*. 2019;42:1105-1110.

2. Ngo L, Nour D, Denman RA, et al. Safety and efficacy of leadless pacemakers: a systematic review and meta-analysis. *J Am Heart Assoc*. 2021;10:e019212.

3. Koay A, Khelae S, Wei KK, Muhammad Z, Mohd Ali R, Omar R. Treating an infected transcatheter pacemaker system via percutaneous extraction. *HeartRhythm Case Rep*. 2016;2:360-362.

4. Ellison K, Hesselson A, Ayoub K, Leung S, Gurley J. Retrieval of an infected leadless pacemaker. *HeartRhythm Case Rep*. 2020;6:863-866.

5. Bernardes-Souza B, Mori S, Hingorany S, Boyle NG, Do DH. Late-onset infection in a leadless pacemaker. *JACC Case Rep*. 2022;4:101645.

6. Patel H, Harrell S, Hreibe H, Sharkawi M, AlJaroudi W. A rare case of persistent bacteremia: leadless micra pacemaker endocarditis. *Case Rep Cardiol*. 2023;2023:8326020.

7. Chang D, Gabriels JK, Soo Kim B, et al. Concomitant leadless pacemaker implantation and lead extraction during an active infection. *J Cardiovasc Electrophysiol*. 2020;31:860-867.

8. Breeman KTN, Beurskens NEG, Driessen AHG, Wilde AAM, Tjong FVY, Knops RE. Timing and mid-term outcomes of using leadless pacemakers as replacement for infected cardiac implantable electronic devices. *J Interv Card Electrophysiol*. 2023;66:1477-1485.

9. Mhanna M, Beran A, Al-Abdouh A, et al. AngioVac for vegetation debulking in right-sided infective endocarditis: a systematic review and meta-analysis. *Curr Probl Cardiol*. 2022;47:101353.

10. Tarzia V, Ponzoni M, Evangelista G, et al. Vacuum-implemented removal of lead vegetations in cardiac device-related infective endocarditis. *J Clin Med*. 2022;11:4600.

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