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Candida tropicalis defibrillator endocarditis: A case report and review of current literature

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ABSTRACT

We provide a review of current literature and report on a case of electronic device infective endocarditis with *C. tropicalis*. A 64-year-old man presented for revision of his implantable cardioverter defibrillator. Echocardiography revealed extensive vegetations attached to the Eustachian valve and in the right ventricular apex. Microbiological findings presented *C. tropicalis* on the explanted material. The patient refused additional surgical intervention. We successfully treated the patient with liposomal Amphotericin B and Flucytosine for 8 weeks.

1. Introduction

Endocarditis is a severe infectious disease with a high proportion of fatal courses [1–7]. In-hospital mortality ranges from 12% to 17% for native valve endocarditis, 23%–26% for prosthetic valve endocarditis, 10% for cardiac implantable electronic device infective endocarditis (CIED-IE), and 8% for right-sided endocarditis. There are numerous factors known to increase mortality, such as heart failure, renal failure, diabetes, male sex, and higher age. Moreover, hospital-acquired endocarditis, endocarditis location, cardiac resynchronization therapy as well as persistent infection, and cardiac, hemodynamic and neurological complications are relevant risk factors [3,5–11].

Around 70% of endocarditis cases are native valve endocarditis and 21%–25% are prosthetic valve endocarditis. Other than that, CIED-IE accounts for about 5% of all endocarditis cases. Likewise, right-sided endocarditis, mainly caused by CIED-IE, accounts for 8.5% [3,4,8]. In recent decades, the number of CIED-IE has increased in a more progressive manner than the number of device implantations [12,13]. This highlights the healthcare burden of CIED-IE [14]. Certain risk factors such as renal insufficiency, male sex, anticoagulant use, long-term corticosteroid treatment, number of pacing leads, device revision and prior device procedures are associated with the incidence of CIED-IE. Perioperative antibiotic use has a protective effect [15–19]. Regarding aetiology, *S. aureus*, coagulase-negative staphylococci, and viridans group streptococci are the most common pathogens for endocarditis. However, about 2% account for fungal endocarditis [3–6,10,20]. The majority of fungaemia cases are contributed to *C. albicans* (52.1%) and *C. glabrata* (28.0%) whereas *C. tropicalis* only accounts for about 4.1% [21]. Thus, *Candida* species are the most common cause of fungal endocarditis. In particular, *C. tropicalis* causes up to 9% of *Candida* endocarditis and up to 13% of *Candida* CIED-IE [22,23]. Nevertheless, *Aspergillus* species may also account for 11–24% of fungal endocarditis cases [20,24]. The sensitivity of blood cultures to detect *Candida* is 50–70% [25] which may result in blood culture negative infective endocarditis and thus in a postponed start for optimal therapy.

Candida endocarditis is difficult to treat and often associated with a poor outcome. Baddley et al. showed a significant difference in mortality among *Candida* patients and patients with non-fungal endocarditis of 30.3% vs. 17.0%, respectively [22]. Others described mortality rates of 33.3% in fungal endocarditis compared to 14.8% in non-fungal endocarditis and 46.6% in *Candida* endocarditis compared to 16.1% in non-*Candida* endocarditis [3,26].

In this case report we present a rare case of *C. tropicalis* implantable cardioverter defibrillator endocarditis combined with an endocarditis affecting the right ventricular lead, the right ventricle and the Eustachian valve.

2. Case

The patient, a 64-year-old man with one vessel coronary artery disease, chronic kidney disease and paroxysmal atrial fibrillation presented for a right ventricular lead revision of his single chamber

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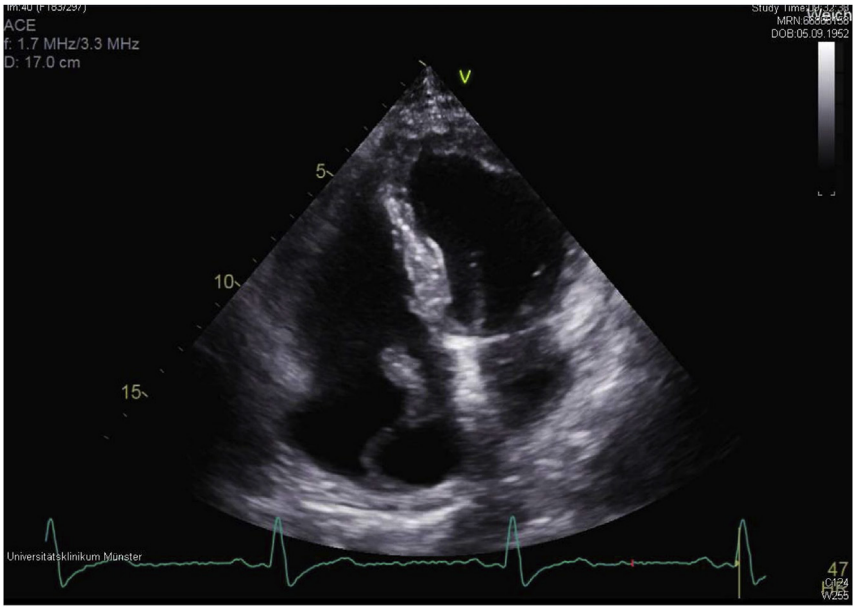

Fig. 1. Floating mass on the Eustachian valve measuring 40 × 17 mm.

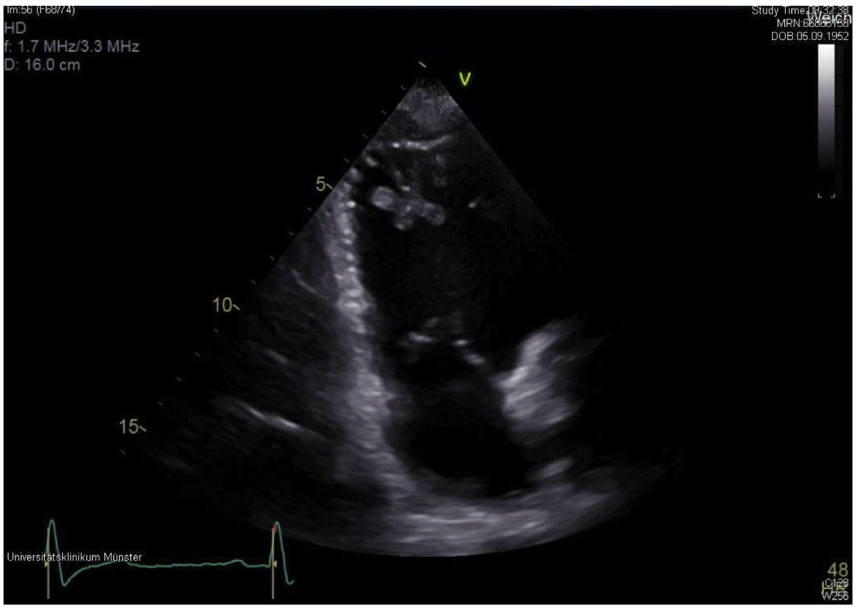

Fig. 2. Mass of 22 × 15 mm in the apex of the right ventricle.

implantable cardioverter defibrillator due to loss of sensing.

14 months earlier, the patient underwent cardiopulmonary resuscitation due to ventricular tachycardia. He was treated on the intensive care unit in an external hospital for 42 days. He was mechanical ventilated for the first 28 days and catecholamine therapy was required for the first 13 days. Continuous venovenous hemodiafiltration was performed from day 3 to day 14 due to sepsis with multiple organ failure. The patient developed a prolonged pneumonia, which was caused by chlamydia (Serological testing day 24) and treated with Piperacillin/Tazobactam, Ciprofloxacin and Clarithromycin. Due to colonic diverticular bleeding eight erythrocyte concentrates were transfused. The patient developed a *C. tropicalis* sepsis. *C. tropicalis* was detected in faecal and blood cultures 17 days after the survived sudden cardiac death and was treated with Caspofungin for 2 weeks. Following the antifungal therapy, blood cultures were negative. An implantable cardioverter defibrillator was implanted for secondary prevention. One appropriate shock was applied due to ventricular fibrillation 5 weeks after implantation. 7 months later, the right ventricular lead showed a loss of sensing and was replaced. At that time, a transthoracic echocardiography showed no abnormalities.

On admission, 14 months after the survived sudden cardiac death and 7 months after the first replacement of the ICD, there was a moderate rise in the C-reactive protein level (2.0 mg/dl) and a slightly reduced glomerular filtration rate (71 ml/min). Otherwise, laboratory findings and clinical examination as well as chest X-Ray were inconspicuous. Surprisingly, a pus-filled ICD pocket was observed during surgery. The extracted lead was covered with thin vegetations. Implantation of a new internal cardio defibrillator was postponed. A large floating mass on the Eustachian valve measuring 40 × 17 mm (Fig. 1) and a smaller floating mass located in the right ventricular apex measuring 22 × 15 mm (Fig. 2) was detected by echocardiography (day 0).

To detect *C. tropicalis* on the ICD and its lead the matrix-assisted laser desorption ionization-time of flight mass spectrometry (Bruker

Table 1
C. tropicalis Eustachian valve IE.

Reference	Age/ Gender	Medical history	Symptoms	Diagnostics	Complications	Therapy	Outcome
[60]	54/M	Carcinoid disease, postoperative CVC after right hemicolectomy and right hepatectomy	Fever, dyspnoea 6 months after surgery	BC: *C. albicans* Vegetation: *C. albicans* TOE: 3 cm vegetation on EV, PV and TV regurgitation due to carcinoid heart disease	–	Thoracotomy incl. PV/TV replacement Caspofungin i.v. for 3 months	No follow up
[61]	53/M	IDA, *S. aureus* IE and PV replacement	Fever, chest pain	BC: *C. albicans* HP: *C. albicans* TOE: 18 × 13 mm on EV and multiple vegetations on PV (largest 33 × 24 mm)	Pulmonary embolism	Excision of EV vegetation, PV replacement Antifungal therapy unknown	No follow up
Bauer et al., 2019	64/M	Survived SCD due to VF, single lead ICD 14 months earlier, replacement due to loss of sensing 6 months earlier, CAD, paroxysmal AF, CKD	Asymptomatic	ICD and lead: *C. tropicalis* TTE/TOE: 40 × 17 mm on EV, 22 × 15 mm in RV	Pulmonary embolism	Percutaneous explantation Liposomal Amphotericin B 5 mg/kg/d for 28 days and 3 mg/kg/d due to nephrotoxicity for 28 days Flucytosine 25 mg/kg q.i.d. for 56 days LifeVest Bridging and s-ICD Implantation 1 month after antifungal therapy	14 months Follow up without relapse

AF – Atrial fibrillation; CVC – central venous catheter; EV – Eustachian valve; F – female; HP – Histopathology ICM – Ischemic cardiomyopathy; IDA – intravenous drug abuse; M - male; PV – Pulmonary valve; RA – Right atrium; RV – Right ventricle; SCD – Sudden cardiac death; TTE – transthoracic echocardiography; TOE – transoesophageal echocardiography; TV – Tricuspid valve; VF – Ventricular fibrillation.

MALDI-Biotyper) was used (day −2). Moreover, susceptibility was detected for Amphotericin B, Fluconazole, Voriconazole, Prosaconazole, Anidulafungin, Caspofungin and Micafungin (VITEK® 2 ID Card). Blood cultures taken on day −1, +10, +19, +22, +23, +27, +33, +39 and + 47 showed no fungaemia.

We initiated an antifungal treatment (day 0) with liposomal Amphotericin B 5 mg/kg/d and Flucytosine 25 mg/kg (q.i.d.). Due to an acute infusion-related reaction to liposomal Amphotericin B associated with leg and lower back pain, we successfully administered Clemastine 2 mg and Ranitidine 50 mg prior to infusion. The patient refused an operative revision of the vegetations.

After +7 days of treatment, the floating masses were markedly reduced in size. Transthoracic echocardiography showed to be superior in visualizing the floating masses compared to transoesophageal echocardiography. At day +9 of antifungal treatment, a thoracic computer tomography showed no signs of thromboembolic events or miliary pulmonary infiltration. At day +15, an asymptomatic elevation of the systolic right ventricular pressure (50 mmHg), which was possibly caused by pulmonary embolism, was observed in a transthoracic ultrasound. During the stay, the C-reactive protein levels were slightly elevated (1.0 mg/dl – 6.1 mg/dl) whereas leucocytes, blood sedimentation rate, and the procalcitonine level were normal. Blood cultures were taken on a regular basis but revealed no fungaemia. The patient developed two febrile episodes due to lower urinary tract infections caused by *E. faecalis* and *E. faecium* (day +9 and + 22). Consequently, the patient was treated with Piperacillin/Tazobactam 3.0 g/1.5 g t.i.d. (day +9 to +16 and day+22 to +24) and Levofloxacin 250 mg q.d. (day +24 to +29) following the resistogram. Further urological assessments showed no abnormalities. Furthermore, funduscopic examination showed no signs of chorioretinitis. While on treatment with liposomal Amphotericin B and Flucytosine, creatinine levels rose continuously from 1.1 mg/dl to 1.7 mg/dl. At day +27, we reduced the dose of liposomal Amphotericin B from 5 mg/kg to 3 mg/kg. Following dose reduction, creatinine levels remained constant. The floating masses in the right ventricle and on the Eustachian valve reduced continuously on day +15, +22, +29, +36, +43 and + 54. On day +54 the Eustachian valve mass was cleared. The mass in the apex of the right ventricle measured 3 × 2 mm. After +8 weeks of antifungal therapy with liposomal Amphotericin B and Flucytosine, we discharged the patient with a wearable cardioverter defibrillator and without further antifungal prophylaxis.

4 weeks following hospital dismissal, we saw the patient again for subcutaneous ICD implantation to avoid further lead complications. Transthoracic and transoesophageal echocardiography showed no intracardiac vegetations. The floating structures on the Eustachian valve and in the right ventricle could not been visualized. Blood tests showed no signs of infection and creatinine was 1.3 mg/dl. Blood cultures taken showed no signs of fungaemia or bacteraemia.

Follow-ups at 2, 6 and 14 months after the antifungal treatment showed no evidence of vegetations in transthoracic echocardiography.

3. Discussion

As demonstrated earlier, *Candida* IE in particular and fungal IE in general present very severe infectious diseases with poor outcome and multiple complications. Lefort et al. indicated a rate for embolic complications in 73% of Candida IE [27] whereas Baddley et al. did not observe an increased risk for embolization in fungal IE [22]. In CIED-IE lead, vegetation size and mobility do not correlate with the occurrence of pulmonary embolism. Only systemic embolism increases the overall mortality [28]. Nevertheless, large vegetations, as described in our case, may increase the risk for fulminant pulmonary embolism [28]. Yet, there is a significant number of silent pulmonary as well as systemic embolisms [19,29–31]. The risk for an embolism reduces continuously over time after initiation of medical treatment with having the lowest risk 2 weeks following the initiation of causative medical

Table 2
C. tropicalis CIED-IE.

Reference	Age/ Gender	Medical history	Device	Symptoms	Diagnostics	Complications	Therapy	Outcome
[62]	71/M	DM, CHF, obstructive uropathy, recurrent urinary tract infections, complete heart block	9 months VVI-PM	Fever, confusion	UC: Yeast Autopsy: 20 × 20 mm vegetation on lead, involved RA, TV, IVC. Consolidation in left lower lung Microscopic: Many colonies of *Candida* organisms in vegetation, myocardium, lung	CHF	Broad-spectrum antibacterials	Patient deceased
[63]	65/M	CVA, IV catheter-related *C. albicans* fungaemia 6 months before device infection	8 years PPM	Fever, confusion, urine / faecal incontinence	BC: *C. albicans* TTE: 50 × 20 × 20 mm mass attached to pacer wire extending from RA to RV	Gastrointestinal bleeding, hypotension, pulmonary embolism	Broad-spectrum antibacterials followed by Amphotericin B. Thoracotomy: 50 × 30 × 20 mm fungal embolus in main PA	Patient deceased during surgery
[64]	56/M	Heart block	5 years PPM	Fever, cough, dyspnoea	BC: *C. albicans* TTE: Multiple large RA masses prolapse into RV, possible adherence to pacer wire HP: Consistent with *Candida*	Subtotal occlusion of left PA	Amphotericin B (2 g total) Right atriotomy and pulmonary arteriotomy, removed PPM leads and fungus ball from left main PA	2 years follow up without relapse
[65]	75/M	DM, sick sinus syndrome	2 years PPM	Blurred vision	*BC: C. tropicalis* TTE: 30 mm vegetation on pacer wire below TV, within RV	Endophthalmitis, multiorgan failure	Amphotericin B + Flucytosine Refused surgery to remove PPM	Patient deceased with multiorgan failure
[66]	56/M	Chronic bronchitis, sinus dysfunction	4 years PPM 3 months PPM/wire (pouch infection)	Fever, dyspnoea	BC: *C. albicans* TTE: RA mass Vegetation and lead: *C. albicans* Femoral catheter: *C. albicans*	Left PA occlusion	Right atriotomy – removed vegetation, wires and PPM Amphotericin B 0.5 mg/kg/d + Flucytosine for 18 days, followed by oral Fluconazole 400 mg/d, followed by 200 mg/d for 7 months	7 months follow up without relapse
[67]	56/M	Sick sinus syndrome	PPM	Fever, dyspnoea	BC: *S. epidermidis* and *C. albicans* Echo: Vegetation on lead Lead: *S. epidermidis* and *C. albicans*	–	Antibiotic (not defined) Surgical removal of PPM	Survived
[68]	72/M	Bradycardia – tachycardia syndrome	< 1 month DDD-PM	–	TOE: Vegetation on TV Lead: *C. glabrata*	–	Endovascular extraction of PPM *C. glabrata* infection uncontrolled Antimicrobial therapy not defined	Patient deceased after 2 months with active *Candida* endocarditis
[69]	77/M	DM, CAD, sick sinus syndrome	5 months PPM	Fever, dyspnoea, lethargy	BC: *C. tropicalis* TTE: TV vegetation Vegetation: *C. tropicalis*	Multiorgan failure	Amphotericin B 0.6 mg/kg/d Thoracotomy – vegetation on TV, inter-atrial septum and on PPM lead, removed vegetation and lead Liposomal Amphotericin B 3 mg/kg/d due to renal failure	Patient deceased with multiorgan failure after surgery
[70]	87/M	CML, renal neoplasm, prosthetic AV	16 years PPM	Fever, renal insufficiency	BC: *C. albicans* and *C. glabrata* UC: *C. albicans* TTE/TOE: 70 mm vegetation on pacer wire Autopsy: Vegetation on lead with *C. albicans* and *C. glabrata*	Fatal stroke on day 63	Fluconazole 5 mg/kg/d, then 10 mg/kg/d Not a surgical Candidate	Patient deceased with fatal stroke
[71]	49/M	DM, CAD, CHF, VT	1 year ICD	Fever, dyspnoea, cough	BC: *C. albicans* TTE: 35 mm vegetation on ICD lead Vegetation: *C. albicans*	–	Amphotericin B 8 weeks followed by Fluconazole 400 mg/d p.o. Thoracotomy	6 months follow up without relapse
[72]	63/M	CAD, CHF, VT	10 months ICD	Fatigue	BC: *C. albicans* TTE/TOE: Vegetations on			

(*continued on next page*)

Table 2 (*continued*)

Reference	Age/ Gender	Medical history	Device	Symptoms	Diagnostics	Complications	Therapy	Outcome
					atrial ICD lead (largest 16 mm) Lead and pocket: *C. albicans*	Hypotension, atrial lead fracture with embolization into left PA, septic shock	Percutaneous explantation Received fluconazole, then liposomal Amphotericin B	After improvement patient deceased with *P. aeruginosa* sepsis
[73]	56/M	Rheumatic heart disease, cardiomyopathy, VT	12 years ICD 1 week Generator	Fever, sweat, hypotension, ICD pocket dehisced	BC: *C. parapsilosis* TOE: 18 mm vegetation on lead	–	Fluconazole i.v. 6 weeks Explantation LifeVest and Reimplantation 6 weeks after antifungal therapy Fluconazole 400 mg/d lifelong	No follow up
[74]	76/M	Colorectal cancer, CVC, parenteral nutrition, abdominal surgery before CIED-IE	PPM	–	BC: *C. parapsilosis* Echo: Vegetation on lead	Possible cerebral embolus	PPM removal Fluconazole for 42 days	Patient deceased secondary to abdominal surgery complications
[26]	38/M	Mechanical AV replacement	3 months PPM	Fever	Echo: Multiple vegetations on lead Lead: *C. parapsilosis*	–	PPM removal Caspofungin for 6 weeks, followed by 12 weeks oral Fluconazole and Posaconazole	14 months follow up without relapse
[75]	19/M	Complete heart block with epicardial PPM age 5, endocardia replacement due to car accident and following long lasting intensive care unit stay	1 year PPM	Fever, cough, haemoptysis	BC: *C. albicans* TTE: Mass on PPM lead	Multiple pulmonary embolisms, sepsis	Thoracotomy, explanation and epicardial reimplantation of PM Caspofungin and Fluconazole for 8 weeks	3 months follow up without relapse
[76]	69/F	COPD Gold IV, DM, hypertension, paroxysmal AF, pulmonary hypertension, sick sinus syndrome, sepsis and mechanical ventilation (20 days on ICU) after 2 weeks DDD-PM implantation	2 weeks DDD-PM	Fever	BC: *P. mirabilis* and *C. albicans* CVC tip: *C. albicans* TOE: With vegetation on PM lead during 2nd Anidulafungin therapy	Pneumonia, pericardial infusion, respiratory insufficiency and mechanical ventilation, flaccid tetraparesis	Anidulafungin (200 mg day 1, then 100 mg/d) for 3 days followed by Fluconazole 800 mg/d for 2 weeks 6 days later positive blood cultures Anidulafungin (200 mg day 1, then 100 mg/d) followed by Fluconazole Anidulafungin (200 mg day 1, then 100 mg/d) after TOE findings until 16 days after negative BC	Follow up (time frame not given): no relapse
[23]	80/M	CAD, COPD, AF, complete heart block	12 years PPM 8 years Generator	Chills, confusion	BC: *C. parapsilosis* TOE: 5 × 5 mm mobile mass on lead, fibrinous strands on TV Vegetation: *C. parapsilosis*	Left main PA embolus and left lower lung infarct	Amphotericin B, maintained for 3 weeks after percutaneous explantation	1 year follow up without relapse
[77]	75/F	Gallbladder removal and gut perforation 34 months earlier	62 months DDD-PM	Fever	BC: *C. albicans* Vegetation and lead: *C. albicans* TTE/TOE: 20 mm vegetation on the atrial lead Intra-cardiac echocardiography: 50 mm vegetation in the RA	Complete obstruction of the SVC	Fluconazole 400 mg q.d. for 10 days Micafungin 100 mg/d for 45 days Percutaneous explantation Reimplantation 10 days later (BC negative) and Micafungin for further 15 days	6 months follow up without relapse
[78]	62/M	CHF, DM, CAD, HCV infection	11 months ICD	Fever, dyspnoea on exertion, chest pressure	BC: *Candida albicans* TOE: 40 mm mass on ICD lead	–	Fluconazole 400 mg/d Thoracotomy, ICD explanation Discharged day 3 Procedure: 6 weeks of Fluconazole 200 mg before reimplantation	No follow up
[79]	68/F	Not given	2 years DDD-PM 1 year Generator and lead	Fever	BC: *MRSA* and *C. tropicalis* TOE: With vegetations on atrial and ventricular leads (largest 25 × 8 mm)	–	Thoracotomy, explantation, epicardial pacemaker Vancomycin and Amphotericin B for 6 weeks	28 months follow up without relapse
[80]	60/F	Sarcoidosis, DM, CKD, reduced LV-EF, episodes of non-sustained VT, 9 months	26 months single lead ICD	Fever, cough, chest pain	BC: *C. albicans* Vegetation: *C. albicans*		Thoracotomy, Micafungin 2 weeks followed by Fluconazole for 6 weeks	Relapse after 7 months; successfully

(*continued on next page*)

Table 2 (*continued*)

Reference	Age/ Gender	Medical history	Device	Symptoms	Diagnostics	Complications	Therapy	Outcome
		earlier several abdominal surgeries with infection and positive BC for *C. albicans*			TTE: 20,9 × 44,9 mm vegetation on ICD lead	Relapse of fungaemia and vegetation on the TV after 7 months	*Relapse:* Vancomycin and Ceftriaxone for 6 weeks (BC negative) 4 weeks later sputum and *BC* positive for *C. albicans:* 1 week Micafungin followed by 6 weeks of Amphotericin B No reimplantation due to improved LV-EF	treated 2 years follow up without relapse
[81]	86/M	DM	3 years PPM	Fever	BC: *C. tropicalis* TTE/TOE: Multiple vegetations on the PM electrode	–	Caspofungin (70 mg day 1, followed by 9 days 50 mg/d) Followed by 15 days of Fluconazole i.v. Fluconazole 200 mg b.i.d. p.o. for 2 months	2 months follow up without relapse
[82]	70/F	Prior day hospital for 1 week due to urinary tract infection with septic shock (Vancomycin 1 day, Piperacillin/ Tazobactam 3 days, followed by Ciprofloxacine p.o.), DM, CKD, CHF, survived SCD	13 months Single lead ICD	Nausea, vomiting, fatigue, fever	BC/UC: *C. glabrata* TOE: Multiple vegetations on ICD, AV vegetation, new tricuspid regurgitation	Hepatotoxicity	Caspofungin 70 mg/d for 2 days Caspofungin 100 mg/d and Flucytosine 37.5 mg b.i.b. Micafungin 150 mg/d instead of Caspofungin due to hepatotoxicity	Deceased on day 31
[83]	65/F	Hypertension, CKD, haemodialysis, DCM and ICM, SCD due to VF, 1 month before CIED-IE septic shock due to perforated diverticular disease	12 months ICD	Septic shock	BC: *C. albicans* TOE: 23 mm vegetation on ICD electrode	Septic shock, bilateral pulmonary septic embolism	Liposomal Amphotericin B (5 mg/kg/d) ICD explantation Caspofungin added (70 mg day 1, 50 mg/d) Reimplantation after 4 weeks (> 72 h no fever) 6 more weeks of liposomal Amphotericin B/Caspofungin	No follow up
[41]	25/F	NICM, NYHA IV, LV-EF 10%, obesity, hypertension, DM, DVT, pulmonary embolism, palliative inotrope therapy via Hickmann catheter: multiple bloodstream infections	32 months Single lead ICD	Not defined	BC: *C. albicans* TOE: 61,3 × 16,5 mm in the RA from SVC +21 × 16 mm RA part of RV electrode	Septic pulmonary embolisms	Micafungin AngioVac extraction s-ICD implantation 10 days later Long-term oral Fluconazole	8 months follow up without relapse
Bauer et al., 2019	64/M	Survived SCD due to VF, single lead ICD 14 months earlier, replacement due to loss of sensing 6 months earlier, CAD, paroxysmal AF, CKD	14 months Single lead ICD 6 months Lead revision	Asymptomatic	ICD and lead: *C. tropicalis* TTE/TOE: 40 × 17 mm on EV, 22 × 15 mm in RV	Pulmonary embolism	Percutaneous explantation Liposomal Amphotericin B 5 mg/kg/d for 28 days and 3 mg/kg/d due to nephrotoxicity for 28 days Flucytosine 25 mg/kg q.i.d. for 56 days LifeVest Bridging and s-ICD Implantation 1 month after antifungal therapy	14 months Follow up without relapse

AF – Atrial fibrillation; CAD – Coronary artery disease; CHF – congestive heart failure; CKD – Chronic kidney disease; CVA – cerebrovascular accident; DM – Diabetes mellitus; DVT – Deep vein thrombosis; EV – *Eustachian* valve; F – female; HP – histopathology; ICM – Ischemic cardiomyopathy; IVC/SVC: inferior/superior vena cava; LV-EF – Left ventricular ejection fraction; MRSA – methicillin-resistant *S. aureus*; NICM – Non-ischemic cardiomyopathy; IDA – intravenous drug abuse; M - male; PA – Pulmonary artery; PM – pacemaker; PV – Pulmonary valve; RA – Right atrium; RV – Right ventricle; SCD – Sudden cardiac death; TTE – transthoracic echocardiography; TOE – transoesophageal echocardiography; TV – Tricuspid valve; UC – Urine culture; VF – Ventricular fibrillation; VT – ventricular tachycardia.

treatment [2,29,32,33].

For CIED-IE, device removal is regarded as primary therapy [8,34,35]. There is evidence that percutaneous lead extraction is safe even in the case of lead vegetations larger than 2 cm [36–40]. With regard to the fungal aetiology, the large vegetations of the *Eustachian* valve and the apex of the right ventricle, early surgery which was refused by the patient would have been indicated [34]. Here, alternatively to an open surgery, minimal invasive extraction of large CIED-IE and large right-sided IE vegetations with an AngioVac system [41–49] or with a wire snare [50] might prove beneficial.

Regarding medical therapy, the combination therapy of liposomal Amphotericin B and Flucytosine ought to be performed for 6–8 weeks alone or in combination with surgery [34]. Caspofungin might be used instead of liposomal Amphotericin B [34]. Since our patient already received Caspofungin treatment for *C. tropicalis* sepsis 14 months earlier, we preferred liposomal Amphotericin B. *Candida* biofilms are more susceptible to liposomal Amphotericin B than deoxycholate Amphotericin B [51]. Nephrotoxicity and transfusion related reactions for liposomal Amphotericin B are also less pronounced [52].

After the survived sudden cardiac death 14 months earlier, our patient was qualified for a reimplantation of an internal cardiac defibrillator. Due to the limited data of fungal CIED-IE and fungal IE, we decided to postpone the reimplantation until 4 weeks after the end of the antifungal therapy. During this time, we equipped the patient with a wearable cardioverter defibrillator. Several authors showed that bridging with a wearable cardioverter defibrillator is effective in preventing sudden cardiac death [53–56]. To avoid further lead complications we implanted a totally subcutaneous ICD. According to current data, evidence for fungistatic Fluconazole prophylaxis was not strong enough for life long treatment [57]. Following antifungal therapy regimen with Amphotericin B and Flucytosine, the patient did not show signs of a relapse after 14 months.

With regard to the microbiological circumstances in the present case, we performed a *PubMed* based search for *Candida* CIED-IE and *Candida* Eustachian valve endocarditis. Case reports with uncompleted data and non-English case reports were excluded. The Eustachian valve, first described by the Italian anatomist Bartolomeo Eustachi [58], is rarely affected by an endocarditis [59]. It is located in the inferior right atrium and a remnant of the foetal heart, which has no particular function in adults. Our search revealed only two cases of *Candida* Eustachian valve endocarditis, which are presented in Table 1 [60,61]. In total, there are 26 cases of Candida CIED-IE and 5 cases of *C. tropicalis* CIED-IE, which are summarized in Table 2.

The present case adds important information to the current literature as it clearly demonstrates successful conservative therapy in a patient with extensive fungal vegetations.

Conflict of interest

There are none.

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