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Case Report

Candida pericarditis presenting with cardiac tamponade and multiple organ failure after combined damage control thoracotomy and laparotomy with splenectomy in a trauma patient: Case report and review of literature

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ABSTRACT

Candida pericarditis is a rare condition which has previously been described after cardiothoracic surgery and immunosuppressive states (Geisler et al., 1981; Eng et al., 1981; Kraus et al., 1988; Kaufman et al., 1988; Tang et al., 2009; Glower et al., 1990; Carrel et al., 1991; Rabinovici et al., 1997; Canver et al., 1998; Farjah et al., 2005; Gronemeyer et al., 1982 [1-11]). We describe the case of a 19-year-old male blunt trauma patient, who survived a damage control thoracotomy and laparotomy with splenectomy, who later developed a loculated *Candida* pericardial effusion, complicated with cardiac tamponade and multiple organ failure, and required antifungals and surgical reintervention with thoracotomy for drainage. A literature search of the reported cases demonstrates that Candida pericarditis is indeed a rare but fatal condition if not identified and treated appropriately. This article discusses the difficulties we encountered while recognizing the disorder in our patient and proposes a guideline to adequately treat the condition in an effective and timely manner. Candida pericarditis poses a special challenge for the physician since its correct diagnosis and management requires a multidisciplinary approach.

Introduction

Candida pericarditis is a rare condition that has been previously described in patients after cardiac or esophageal surgery and chronic immunosuppression [1–11]. Most recently, it has been reported to occur after cardiac transplantation [9,12,13]. The condition has never been described in the blunt trauma patient requiring resuscitative thoracotomy, mostly we assume, because this severely injured patient population has a very high mortality rate, therefore limiting the data regarding natural history and possible

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complications that the survivors are prone to develop. The most recent studies, including a nationwide analysis of outcomes after resuscitative thoracotomy, and retrospective experience at expert trauma level 1 centers, estimate the survival after blunt trauma resuscitative thoracotomy to be 6.8–7.6% [14,15]. Blunt trauma patients that survive these types of interventions undergo prolonged hospitalization [14] and require a variety of specialized services to recover to their pre-injury lives. In the United States, injury remains the leading cause of death among people between the ages of 1 and 44 years [16]. The survival for these critically ill patients has recently improved due to the creation of comprehensive trauma systems which optimize injury recognition, triage to an appropriate trauma center, deliver multidisciplinary inpatient care, and provide long term outpatient follow-up while at the same time prioritizing research and education [17].

Candida pericarditis is a high mortality condition if not recognized and treated on time [5,8,18–23]. Due to the tendency of pericarditis to occur later in the hospitalization timeline and resulting in devastating consequences on patients that already have used extensive amounts of medical resources, it is essential to effectively identify the condition and rapidly formulate an action plan. We present the case of a 19-year-old male that was admitted to the emergency department after a motor vehicle accident and was diagnosed with traumatic hemorrhagic shock. The patient survived a combined damage control thoracotomy and laparotomy, and later developed a nearly fatal *Candida* pericarditis infection with cardiac tamponade and multiple organ failure requiring antifungals and thoracotomy with pericardial drainage, after which he rapidly improved and fully recovered. To our knowledge, this is the first-time *Candida* pericarditis has been described in this setting. It is also the first time the association of *Candida* pericarditis and splenectomy has been documented in humans. To contextualize this clinical case, we reviewed the current literature on this condition, the pathophysiology, and the rationale behind the medical and surgical management of this individual.

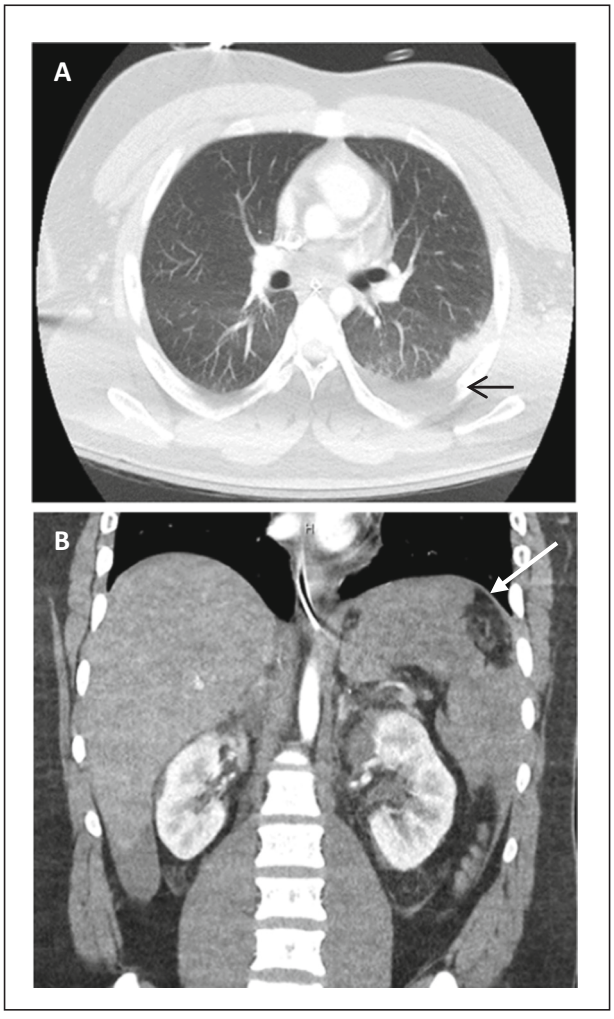

Fig. 1. Initial computed tomography of the chest/abdomen with IV contrast.
Note the pleural effusion consistent with hemothorax (black arrow). Note the splenic laceration (white arrow).

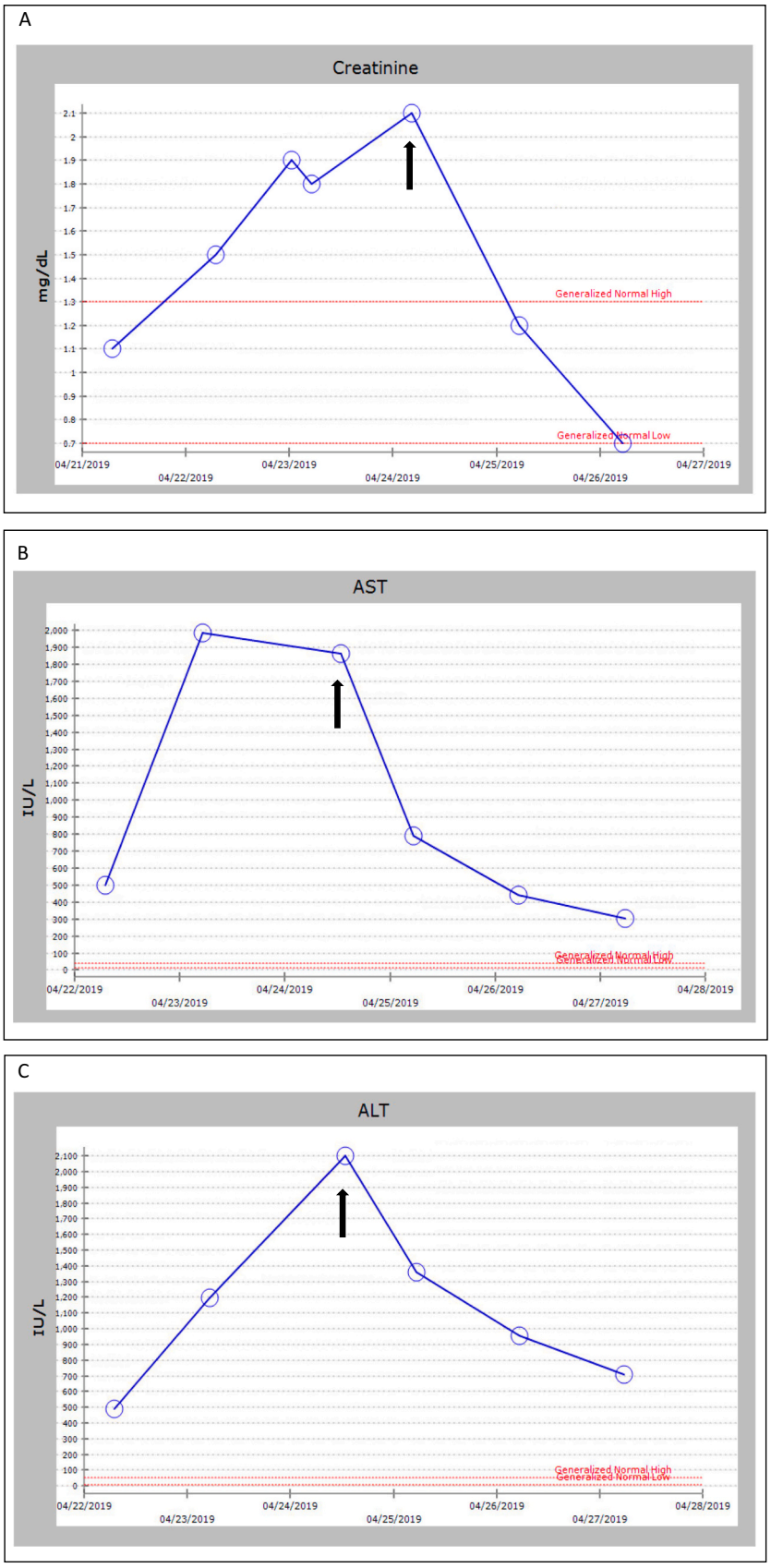

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Fig. 2. A. Laboratory abnormalities during pericardial tamponade.
Note the elevation in creatinine, that rapidly normalized after surgical pericardial drainage (black arrow). B. Laboratory abnormalities during pericardial tamponade.
Note the elevation in AST with a significant decrease after surgical pericardial drainage (black arrow). C. Laboratory abnormalities during pericardial tamponade.
Note the elevation in ALT with a significant decrease after surgical pericardial drainage (black arrow).

Case description

The patient is a 19-year-old male with no past medical or surgical history who had a motor vehicle crash where he was the restrained driver. His vehicle was t-boned at high speed by a truck. The patient was reportedly extricated by bystanders on the scene and was initially answering questions and communicating before becoming lethargic and unresponsive. Upon arrival to the trauma bay *via* emergency medical services the patient was noted to have a Glasgow Coma Scale (GCS) of 4 (E1V2M1) and therefore was intubated and placed in a hard collar. Focused assessment with sonography for trauma (FAST) examination revealed possible free fluid in the abdomen but because he was found to be hemodynamically stable it was decided to obtain a CT scan of the head, thorax and abdomen. After stabilization in the trauma bay followed by primary and secondary assessment, the patient was transported to the CT scanner. The CT readings revealed a left-sided hemothorax, a significant amount of blood in the pelvis, and a high-grade splenic injury (Fig. 1). He was also noted to have an occipital fracture and brain contusion. The patient was then noted to become hemodynamically unstable as evidenced by hypotension nonresponsive to fluid resuscitation. He was subsequently transported from the CT scanner directly to the operating room.

As the patient was being prepped for surgery, he suddenly lost pulses. The immediate decision was made to perform a left anterior lateral thoracotomy, and he was found to have a mild hemothorax with a left lower lung contusion. Since the myocardium could not be seen through the pericardial membrane, it was decided to perform pericardiotomy, but no cardiac injuries were found. After descending aortic clamping, the patient regained vital signs. Subsequently, the patient underwent a damage control laparotomy with four quadrant abdominal packing. At exploration he was found to have approximately 1 L of blood in the abdomen. This was the reason for the initial hemorrhagic shock with hemodynamic instability and rapid deterioration to cardiac arrest.

Additionally, the patient was found to have a grade five spleen laceration that required splenectomy after which the aortic clamp was released (27 min), he remained hemodynamically stable. He was also found to have a small bowel laceration that was staple excised and left in discontinuity. Additional injuries found were a non-expanding retroperitoneal hematoma in zone two, a cecal serosal laceration, and mild inflammation of the pancreatic tail. An open abdomen vacuum type dressing was applied, and he was transferred to the intensive care unit (ICU). On hospital day number 3, he was taken back to the operating room where he underwent a distal pancreatectomy, appendectomy, small bowel hand sewn anastomosis and repair of cecal serosal laceration. The pancreatic tail was found to have a severe contusion with devitalized tissue; therefore, we decided to remove it to prevent later complications such as a pancreatic leak [24,25]. The appendix was incidentally inflamed, although we are unsure if the appendicitis was a process that was there preoperatively, or a result of the mechanical trauma and contusion from the accident, we decided to remove it to prevent future diagnostic challenge in a potentially hostile abdomen [26,27]. Two Jackson-Pratt drains were left intraperitoneally adjacent to the pancreas staple line and in the pelvis, after which the abdominal fascia was successfully closed. He was then brought back to the ICU for further management. Nutrition was accomplished through an orogastric post-pyloric feeding tube. He was placed on broad spectrum antibiotics.

On hospital day number 9, he underwent successful repair of his left occipital condyle fracture that required instrumentation of the cervical spine by neurosurgery.

The patient neurologic status slowly improved, but he was not able to be weaned off mechanical ventilation. He also developed a left loculated pleural effusion that was managed with percutaneous catheter drainage. On hospital day number 16, he underwent tracheostomy placement. As the patient improved our intention was to extubate as soon as possible, however even though the patient was recovering he did not meet criteria for extubation at any point. His mental status continued to improve, and he regained consciousness, followed commands and by hospital day number 20, he was moving all extremities. At this point, the patient's white blood cell count, vital signs and physiologic functions had normalized.

On hospital day number 23, he was noted to develop recurrent fever, tachycardia, and a new increase in white blood cell count. Echocardiogram was obtained, and he was found to have a pericardial effusion with no evidence of tamponade. Decision was made to manage the effusion conservatively for the next three days, after which no improvement was noted. Blood cultures revealed *Candida parapsilosis*. Patient was started on antifungal fluconazole in addition to broad spectrum antibiotics. He then developed tamponade physiology and multiple organ failure secondary to decreased organ perfusion, as evidenced by a sudden increase of hepatic enzymes, elevation of his creatinine altered mental status and a low cardiac output (Fig. 2A, B, C).

Percutaneous aspiration was attempted but failed due to the difficult anatomical location and septation of the effusion. It was decided that the patient required additional surgical intervention. On hospital day #29, the patient underwent a left posterolateral thoracotomy with pericardial window and a left lung decortication with talc pleurodesis. Postoperatively, the patient did not improve and continued to have tamponade physiology. A repeat echocardiogram was obtained, it revealed a persistent pericardial effusion and thin effusion septations. (Fig. 3). The septa are thought to be characteristic of candida fibrinopurulent pericarditis and need to be completely broken down during surgical intervention to satisfactorily drain the effusion and prevent recurrence. Another option is complete pericardiectomy in case of deep infection of the pericardium causing constrictive pericarditis. Ultimately, the surgical team

made the decision to take the patient back to the operating room for anterolateral thoracotomy, decompression, and effusion drainage. During the surgical intervention, approximately 600 cc of fibrinopurulent fluid was drained. After the patient rapidly improved as evidenced by the normalization of hepatic enzymes and creatinine (Fig. 2B, C). Table 1 summarizes the order of surgical interventions done to the patient.

Summary of prior literature and discussion

We performed a search in PubMed with the term "candida pericarditis" including all articles published from 1950 to 2021. The search provided a total of 49 articles. Articles excluded were those that did not have *Candida* pericarditis as the etiology, or if the report did not specify a predisposing condition or procedure history. A total of 36 articles were included in the review. These articles yielded a total of 39 *Candida* pericarditis cases that were included. Table 2 summarizes the findings of the search based on the primary etiology subdivided by categories. A history of cardiac surgery was the most common association for the development of *Candida* pericarditis (25.6%), followed closely by esophageal surgery (20.5%), and spontaneous pericarditis (20.5%). Interestingly, the single condition with highest frequency found in our review was esophageal surgery for cancer (10.3%), followed closely by cardiac transplantation (7.7%), coronary artery bypass graft (7.7%) and leukemia (7.7%). Table 3 describes the data based on the patients' age, reported sex and the known *Candida* species present. Patients in the range of 41 to 60 years of age (41.0%) and males (61.5%) had a higher frequency of pericarditis. The most common candida species was *C. albicans* (66.7%), followed by *C. tropicalis* (10.3%) and *C. glabrata* (10.3%). The most common definitive therapeutic procedure was thoracotomy pericardiectomy (33.3%) followed by thoracotomy with pericardial drainage (20.5%) a total of 6 patients did not undergo a surgical intervention (15.4%). The most common antifungal used was amphotericin B (30.8%) and fluconazole (17.9%) (Table 4). The median time from insult to the development of candida pericarditis was 34 days, although it was noted to occur at any time from 2 days to 40 years according to the obtained literature (Table 4).

Regarding the initial surgical intervention, most current guidelines agree that pericardiotomy is indicated for any suspicion of cardiac injury especially when the myocardium cannot be seen through the pericardial membrane [14,28,29]. In this case, at the time of the initial thoracotomy and aortic clamping, we decided to perform the procedure to completely rule out cardiac injury since the chest tomography had shown evidence of chest injury, lung contusion and the possibility of hemorrhage. Looking back, we believe that the pericardiotomy could have been avoided, since we didn't have evidence of heart injury and this procedure might have been the initial seeding event for the Candida infection. Therefore, we support the notion that pericardiotomy should be performed selectively, only when there is strong suspicion by the surgeon or obvious signs of cardiac injury with pericardial fullness; furthermore, cardiac massage can be performed with an intact pericardium, and the pericardiotomy can be completed after aortic clamping if no obvious signs of cardiac injury [28–30].

Decision to start the broad-spectrum antibiotics was multifactorial; the patient was found to have multiple injuries including hollow

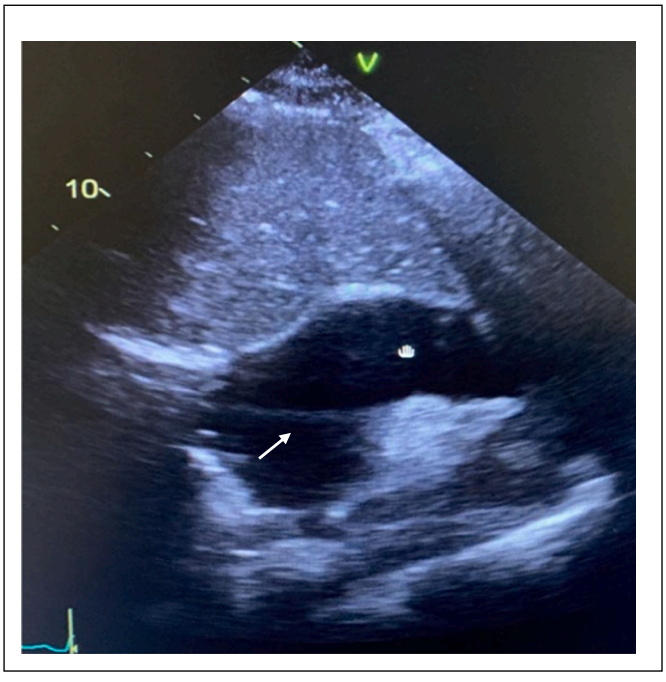

Fig. 3. Transthoracic echocardiogram subcostal view.
Note the large pericardial effusion (hand pointer) with a pericardial septum (white arrow).

viscus injury and pancreatic injury that required distal pancreatectomy with splenectomy which placed him at risk for infection [31–33] He was also found to have appendicitis [26,27], and he required multiple blood transfusions which are known to cause immunosuppression [34]. The drains were left in place mainly to detect a leak as the pancreatic tail had appeared unhealthy before resection.

Although our patient was a healthy young male with no previous history of immunosuppression, we believe that the combination of multiple surgical procedures including pericardiotomy (on initial admission), long-term broad-spectrum antibiotics, and splenectomy, placed the patient at risk for *C. parapsilosis* which grew in the blood cultures at the time that the pericardial effusion was developing. According to Kullberg et al., deep-seated candidiasis arises from either hematogenous dissemination or direct inoculation of candida species to a sterile site, such as the peritoneal cavity. Mortality among patients with invasive candidiasis is as high as 40%, even when patients receive antifungal therapy [35]. Schuster et al. performed a case control study of patients with *C. krusei* bloodstream infection at the University of Pennsylvania from 1982 to 2010. They enrolled 34 cases and 114 matched controls. They found that risk factors associated with *C. krusei* infection were splenectomy (OR 11.66; 95% CI 1.04, 130.64), and exposure to antimicrobials with anaerobic activity (OR 5.74; 95% CI 1.76, 18.67) among others [36].

There are several risk factors for *Candida* infection that have previously been identified such as diabetes mellitus, renal insufficiency, surgery, pancreatitis, the use of broad-spectrum antibiotics, parenteral nutrition, hemodialysis, mechanical ventilation, the presence of central vascular catheters, therapy with immunosuppressive agents and colonization of the skin or the mucus membranes of the gastrointestinal and urogenital tracts [37]. Recent basic research studies have demonstrated the essential role of the spleen's tyrosine kinase as a critical regulator of neutrophil responses to *Candida* species [38]. Interestingly, no cases in the literature exist associating splenectomy with *Candida* pericarditis before our report. The effect of splenectomy could be interpreted as an immunosuppressed state of the host. Our review revealed three cases for which *Candida* pericarditis has been associated with cardiac transplant managed with immunosuppressants. The cardiac transplant patients are remarkable examples of the pathophysiology of *Candida* pericarditis, associating a surgical procedure with chronic immunosuppression [9,12,13].

Candida mechanism of pericardial invasion can potentially occur both through local inoculation and hematogenous spread [35]. Possible local inoculation examples can be observed in the cardiac and esophageal surgery patients. It is well known that *Candida albicans* can colonize, and it is normally found in the gastroesophageal tract. Examples in our review can be found in cases that had thoracic esophageal surgery, anastomosis that leaked, colonic or gastric transpositions, or gastro-pericardial, esophago-pericardial fistulas [5,10,11,19,39–46]. It appears that this leak into the mediastinum is the mechanism of entry to the pericardium. On the other hand, cardiothoracic surgery appears to be another mechanism of local inoculation [3,6,7,9,12,13,47–50]. Cardiac surgery can by itself produce enough inflammation of the pericardium to produce an effusion [51]. Effusions then become an easy target for the fungal organism especially if accidentally inoculated during the surgical procedure; the growth of the fungal species is then accelerated if the patient is being managed with broad spectrum antibiotics or steroids [35], which are both used in patients with sepsis and septic shock. This infection can also occur by the hematogenous route, as demonstrated in the cases with no history of cardiothoracic procedures. These patients had either a leukemia, or were being managed with chemotherapy, and initially appeared to develop fungemia that then seeded the pericardium [1,4,52].

Candida pericarditis presents with a unique physio-pathologic challenge for the physician. *Candida* seeds the pericardium and subsequently produces a progressively enlarging effusion that can cause tamponade [4,18,40,53]. In addition, if the fungal infection is not treated, it can produce a deep tissue infection, causing pericardial inflammation and fibrosis with constriction [9,13,54–56].

The effusion eventually causes pericardial tamponade with collapse of the right atria and ventricle which in turn decreases the venous return and impairs the cardiac output [57]. This has the potential for organ hypoperfusion resulting in peripheral ischemia and the rapid development of multiple organ failure, in the already fragile and septic patient [58–61].

Conclusions

Initial resuscitative thoracotomy with pericardiotomy might be a mechanism for candida seeding and therefore we recommend a more selective pericardiotomy approach based on high suspicion by the surgeon [3,6,7,29,47,48].

Candida pericarditis is a rare condition that has been previously described in patients after cardiac or esophageal surgery, and chronic immunosuppression [7,9,12,13]. Our review reveals that most patients that survived a *Candida* pericarditis infection required

Table 1
Surgical interventions/procedures.

Procedure	Injury
1. Right anterolateral thoracotomy	Left hemothorax
2. Exploratory laparotomy with small bowel resection and splenectomy	Bucket handle mesenteric avulsion and Grade V splenic injury.
3. Distal Pancreatectomy, small bowel anastomosis, appendectomy, closure of abdominal fascia.	Pancreatic tail injury, small bowel discontinuity, appendicitis, serosal cecal tear.
4. Cervical instrumentation and fusion with hardware C1-C3	Left occipital condyle fracture (Andersson Type III)
5. Percutaneous tracheostomy	Respiratory failure
6. Pericardiocentesis	Pericardial effusion
7. Left posterolateral thoracotomy with lung decortication, mechanical and talc pleurodesis and pericardial window	Left chest empyema and cardiac tamponade
8. Left anterolateral thoracotomy	Pericardial tamponade

Table 2
Summary of literature search.

Possible etiologic condition	Num. of cases	Percentage
Cardiac surgery	10	25.6%
-Heart transplant	3	7.7%
-CABG	3	7.7%
-Cardiac ventricular	1	2.6%
-Pericardiotomy	1	2.6%
-Resuscitative thoracotomy	1	2.6%
-Unspecified	1	2.6%
Esophageal surgery	8	20.5%
-Esophageal cancer	4	10.3%
-Esophageal stricture	1	2.6%
-Esophageal atresia	1	2.6%
-Esophageal perforation	1	2.6%
-Fundoplication	1	2.6%
Spontaneous pericarditis	8	20.5%
-Systemic lupus erythematosus	1	2.6%
-Bone marrow transplant	1	2.6%
-IV drug abuse	1	2.6%
-Candida cystitis	1	2.6%
-History of tuberculosis. DM2	1	2.6%
-Unknown	1	2.6%
Chemotherapy/radiation	5	12.8%
-Leukemia	3	7.7%
-Gastric cancer	1	2.6%
-Hodgkin lymphoma	1	2.6%
Gastric surgery	2	5.1%
-Bariatric surgery	1	2.6%
-Unspecified	1	2.6%
Other causes	6	15.4%
Lung surgery - open lung biopsy	1	2.6%
Pericardiocentesis - candida skin infection	1	2.6%
Spontaneous esophago-pericardial Fistula due to alcohol abuse	1	2.6%
Spontaneous broncho-pleural fistula due to tuberculosis	1	2.6%
Pediatric endocarditis	1	2.6%
Pneumonia - ARSD	1	2.6%

Table 3
Summary of published cases based on the patients' age, gender, and *Candida* species.

	Count	Percentage
Age range		
0–20	6	15.4%
21–40	5	12.8%
41–60	**16**	**41.0%**
61–80	11	28.2%
Unknown age	1	2.6%
Sex		
M	**24**	**61.5%**
F	13	33.3%
Unknown	2	5.1%
Candida species		
albicans	**26**	**66.7%**
tropicalis	4	10.3%
glabrata	4	10.3%
parapsilosis	2	5.1%
kruzei	1	2.6%
guilliermondii	1	2.6%
Candida spp.	1	2.6%

Highest Count/Frequency/Percentage.

both antifungals and a type of surgical drainage (Table 3).

A sudden deterioration of a previously recovering patient with a history of resuscitative thoracotomy, splenectomy or any other immunocompromised states, prolonged hospitalization with use of broad-spectrum antibiotics and/or steroids, should alert the physician for the possibility of fungal infections [35,62]. *Candida* pericarditis should be in the differential diagnosis, and an echocardiogram should be considered to rule out pericardial effusion [63]; this is of utmost importance since the tamponade physiology might overlap or be misdiagnosed as sepsis [22,35,57,59]. Blood cultures should be immediately obtained and broad-spectrum

Table 4
Individual description of prior reported cases of pericarditis with *Candida* species.

Etiology	Age	Gender	Species	Surgical Management	Therapy	Time Frame	Ref.
Chemotherapy/radiation for gastric adenocarcinoma/ esophagojejunostomy	54	M	albicans	Pericardiocentesis	Caspofungin	5–2 months	18
Total esophagectomy with gastric pull-up for esophageal cancer	66	M	tropicalis	Pericardiectomy/ epicardiectomy	Not reported	6 years	42
Left ventricular dacron patch repair for ventricular rupture	61	M	albicans	Left thoracotomy with pericardial fenestration and Latissimus dorsi flap over patch	Fluconazole	149 days	47
Esophago-pericardial fistula in heavy alcoholic	43	M	albicans	Pericardiocentesis	Fluconazole	Unknown	41
Esophagectomy with colonic interposition (atresia)	42	F	albicans	Sternotomy drainage	Caspofungin	40 years	19
Tuberculous broncho-pericardial Fistula	17	M	parapsilosis	Pericardiectomy	Fluconazole	1 month	20
Neonatal endocarditis	14 days	F	albicans	None	Fluconazole/ amphotericin B	2 days	49
Pneumonia/ARDS history of IV drug abuse	57	M	glabrata	Pericardial drain placement	Voriconazole	Unknown	53
Spontaneous pericarditis	38	M	albicans	Pericardiectomy	Anidulafungin	months	55
Heart transplant	54	M	albicans	Pericardiectomy/ epicardiectomy	Liposomal amphotericin B	1 Month	13
Pericardiocentesis, candida skin infection.	76	F	albicans	Open surgical drainage	Not reported	48 h	48
Gastro-pericardial fistula-chemo/rads for gastric adenoCa	47	M	albicans	Percutaneous drainage	Fluconazole	2 months	5
Spontaneous pericarditis, IV drug abuse	46	F	glabrata	Pericardial window	Fluconazole	Unknown	23
Heart transplant	37	F	albicans	Pericardial window	Caspofungin/ fluconazole	33 days	12
Chemotherapy for leukemia	3	F	albicans	Pericardiocentesis	Voriconazole	5 weeks	43
Gastro-pericardial fistula (Nissen Funduplication)	58	F	kruzei	Pericardiectomy	Amphotericin B	1 year	10
Esophagectomy with gastric interposition for esophageal cancer	55	M	glabrata	Surgical drainage	Fluconazole	years	40
Gastric Sleeve, cholecystectomy, gastro-gastric fistula repair	40	F	glabrata	Pericardiectomy	Amphotericin B/ flucytosine	10 years	56
Spontaneous pericarditis, DM2. History of tuberculosis	70	M	albicans	Pericardiectomy	Fluconazole	Unknown	54
Heart transplant	52	M	albicans	Pericardiectomy	Amphotericin B	14 months	9
Spontaneous pericarditis	/	/	parapsilosis	Pericardiectomy	Unknown	Unknown	21
Pericardiotomy, open lung biopsy, Esophago-gastrostomy for esophageal cancer	51	F	albicans	Subxiphoid pericardial window	Amphotericin B	15 days	8
Bone marrow Ttransplant	19	F	guilliermondii	Unknown	Amphotericin B/ flucytosine	Unknown	52
Ivor-Lewis esophago-gastrectomy for benign esophageal stricture complicated with leak with thoracotomy and repair	69	M	albicans	Pericardiectomy	Amphotericin B	3 weeks	44
Pediatric cardiac surgery	12	M	*Candida* spp.	Unknown	Unknown	Unknown	50
Esophageal perforation (food bone) with thoracotomy and repair	62	M	albicans	Pericardiocentesis	Amphotericin B/ flucytosine	40 days	45
S/p CABG requiring resuscitative thoracotomy due to arrest	63	M	albicans	None	None	10 days	7
CABG	42	M	albicans	Left anterior thoracotomy and pericardial window	Amphotericin B	10 weeks	6
CABG	62	M	albicans	Left anterior thoracotomy and chest tube	Amphotericin B	25 days	6
Spontaneous pericarditis in SLE	20	F	albicans	Pericardiectomy	Amphotericin B	12 days	4
Large paraoesophageal hernia	53	/	albicans	Open surgical drainage	Amphotericin B/ flucytosine	Unknown	39
CABG with redo thoracotomy for bleeding	42	M	albicans	Pericardial window lateral thoracotomy	Amphotericin B	2 months	3
Chemotherapy (erythroleukemia)	74	F	tropicalis	None	Amphotericin B	1 month	3
Pneumonia open lung biopsy and thoracentesis	61	M	albicans	None	Amphotericin B	2 weeks	3
Chemotherapy/radiation Hodgkin lymphoma	77	F	tropicalis	None	None	6 days	11

(*continued on next page*)

Table 4 (*continued*)

Etiology	Age	Gender	Species	Surgical Management	Therapy	Time Frame	Ref.
Chemotherapy for leukemia	30	M	albicans	Thoracotomy with pericardial drainage	Amphotericin B/ flucytosine/ miconazole	6 weeks	1
Pneumonia and Candida cystitis	39	M	tropicalis	Pericardiectomy	Amphotericin B	1 month	2
Esophago-gastrectomy for esophageal cancer with esophago-pericardial fistula	57	M	albicans	None	None	6 months	46
Spontaneous pericarditis	34	M	albicans	Pericardiectomy	Unknown	1 week	22

antibiotics including antifungals contemplated.

We suggest that in case of a positive tamponade diagnosis, with identified pericardial septa, the best definitive therapy should include median sternotomy with direct mobilization of the heart and access to the posterior pericardial area, with manual rupture of the pericardial septa, and complete drainage of the effusion by a pericardial drain left in place. In the cases where the pericardium is thickened, it may be preferred to perform a complete pericardiectomy and epicardiectomy to ensure no recurrence of the infection.

Attempting drainage of the effusion through pericardiocentesis, epigastric pericardial window or through a left or right lateral thoracotomy might temporize the acute tamponade but compromise the access to the posterior pericardium and risk missing pericardial septa which would result in persistent infection and recurrent effusions with tamponade as observed in our case.

In our view, tamponade physiology with hypotension in the absence of pulmonary edema, acute respiratory distress syndrome or history of pulmonary hypertension, justifies a management with generous intravenous fluids and continuous hemodynamic monitorization, leg elevation and low PEEP ventilation to maximize venous return and right ventricular filling, coupled with immediate surgical drainage and antifungals [63–65]. This recommendation must be followed with care and as several studies have documented that excessive fluid resuscitation might contribute to tamponade physiology and accelerate cardiovascular collapse [57,63–65].

Our patient was discharged home after a 2-month hospitalization. Patient was decannulated in clinic one week after discharge. He was followed for 9 months. He had a full recovery with no sequela.

Declaration of competing interest

JJS, JLA and are employed by Renaissance Medical Foundation, the entity that provides medical services to the hospital.

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Authors' contributions

RAS: Roles/Writing - Original draft, Conceptualization, Methodology, Data curation; Formal analysis, Visualization, Investigation; Writing - review & editing.

JJS: Conceptualization, Methodology, Project administration, Supervision, Writing – review & editing.

JLA: Conceptualization, Validation.

JFV: Conceptualization, Validation.

AK: Conceptualization, Validation.

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