Case Report

AngioVac System for Infective Endocarditis: A New Treatment for an Old Disease

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ABSTRACT

Three different patients presented to our institution with right-sided infective endocarditis (IE). All three were found to have vegetation on the tricuspid valve. These patients were started on appropriate antimicrobial therapy according to their blood cultures sensitivities. Despite this management, the patients' clinical status did not improve solely on antimicrobials. Surgery was, therefore, indicated to remove the vegetations. Traditionally, the appropriate management would have been invasive surgery. However, these patients were subjected to a novel treatment in our institution for right-sided IE: percutaneous mechanical vegetation debulking with an AngioVac system. After this procedure, all three patients' clinical status improved drastically. This new less invasive approach seems to offer the same results as the traditional invasive surgery, with faster recovery time. More comparative studies are needed to confirm this idea.

Keywords: AngioVac, endocarditis, IV drug use

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INTRODUCTION

Right-sided infective endocarditis (IE) is usually less common than left-sided IE.[1] The former one was usually linked to devices such as pacemaker, defibrillators, or tunnel dialysis catheters. However, since the 1950s, there has been an increase in the incidence of right-sided IE and likely as a result of increased use of intravenous (IV) drugs.[2,3] Besides for prolonged antimicrobial therapy, treatment can be surgical to reduce the bacterial burden.[4] Traditionally, if the vegetation is seen on the tricuspid valve (TV), the surgical approach would be a TV repair/replacement.

The three patients with right-sided IE presented subsequently were treated appropriately with antibiotic therapy according to their cultures and sensitivities. Because their clinical outcome was not improving, and because these patients also presented with certain criteria, they had indications for surgery. However, an open invasive procedure was not free of complications and these three patients were already in a delicate medical state. Furthermore, knowing that they had a history of IV abuse made an open invasive procedure with a potential for a new valve an undesirable option of treatment. Because of these reasons, the alternative procedure implemented for these three patients was a percutaneous mechanical vegetation debulking approach, using the AngioVac system.

Case 1

A 37-year-old male patient, with frequent IV drug use, was presented to our institution with fever, chills,

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left-sided pleuritic chest pain and mild dyspnea. On clinical examination, he was using accessory breathing muscles and a 4/6 systolic murmur was noted in the left parasternal region that increased with inspiration. Basic laboratory studies along with blood cultures were obtained. Laboratory values were remarkable for leukocytosis of 37.000 cells/μl, with a left shift. A Computer topography (CT) of the chest exhibited multiple peripherally based nodules on both lungs, some with cavitation suggestive of septic emboli [Figure 1a]. He was started on empiric antibiotic therapy and a transesophageal echocardiography (TEE) was performed, revealing a 1 × 0.9 cm mobile vegetation in the TV [Figure 1b]. Blood cultures grew two out of two positives for methicillin-sensitive *Staphylococcus aureus* and the patients'antimicrobial regimen was converted to oxacillin.

Despite being on the appropriate antimicrobial therapy for more than 3 days, the patient had persistent fever and leukocytosis. Given that his clinical status was worsening, surgery was indicated to decrease the bacterial burden on the TV vegetation. Traditionally, the next step would have been a TV repair/replacement through a minimally invasive approach through the thoracic cavity. However, given that the patient's clinical status was not optimal for such an invasive procedure, we opted for a less invasive approach: percutaneous mechanical vegetation debulking with an AngioVac system. The patient tolerated the procedure well and he remained hemodynamically stable at all times. He completed a 4-week course of IV oxacillin after the vegetation was removed. Subsequent to the procedure, the patient no longer had episodes of fever and his leukocytosis trended down to normal levels. He was discharged in stable conditions.

Case 2

A 43-year-old male patient with history of IV drug abuse who in the past has had a complication from a spinal abscess presented with fever, cough, and left knee pain. On presentation, the patient had stable vital signs, except for a temperature of 100.8° F. Clinical examination revealed limited range of motion of his left knee and a systolic murmur in the left sternal border. His initial laboratory results indicated a leukocytosis of 14.000 cells/μl, elevated CRP, ESR, and toxicological screen was positive for opiates. Blood cultures were attained and an arthrocentesis was performed on his left knee. A CT of the chest was obtained that showed multifocal ground-glass and nodular opacities with internal cavitation in a peripherally predominant distribution concerning for septic emboli [Figure 2a]. The patient was started on empiric antimicrobial therapy.

The patient's blood and left knee synovial cultures were both positive for methicillin-sensitive *S. aureus* and the antibiotics were deescalated to cefazolin. An initial transthoracic echocardiography was unremarkable, but a follow up TEE revealed moderate-to-severe tricuspid regurgitation along with a 1.5 × 1.1 cm vegetation on the TV [Figure 2b]. Despite the antimicrobials controlling the patient's temperature, he had insistent leukocytosis. After surgical consultation, the patient was prepared for the Operating Room for a percutaneous mechanical vegetation debulking with an AngioVac system for his TV vegetation along with a left knee washout. It was after these procedures that the patient's clinical status improved drastically. IV cefazolin was continued for a total of 6 weeks and the patient was discharged in stable conditions.

Case 3

A 26-year-old female patient, with history of IV drug abuse and incarceration, was presented to the emergency department for episodes of fever, chills, and fatigue. On initial evaluation, she was found to be hemodynamically stable but with a temperature of 102.2° F. Initial laboratory work revealed a leukocytosis of 18,290 cells/μl with an elevated lactic acid of 3.2 mmol/l. Blood cultures were attained and empiric antimicrobial therapy was started with Vancomycin and Ceftriaxone. A CT of the chest was performed that exhibited multifocal nodular and consolidative opacities, some with central cavitation, and a complex loculated pleural effusion on the right

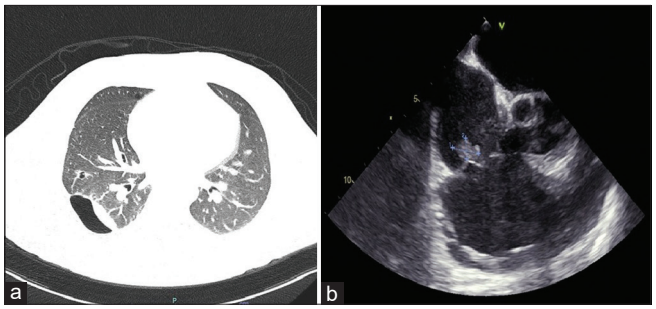

Figure 1: (a) Chest CT showing multiple peripherally based nodules (b) TEE showing a 1 × 0.9 cm vegetation in the TV

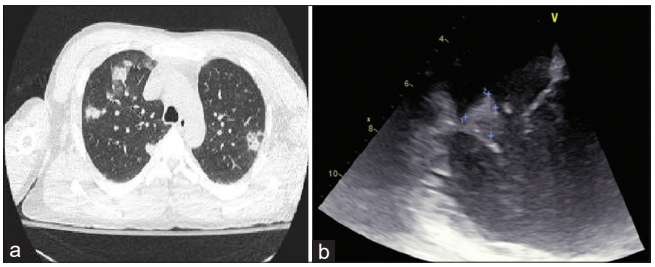

Figure 2: (a) Chest CT showing multifocal ground glass opacities with internal cavitation (b) TEE showing a 1.5 × 1.1 cm vegetation on the TV

pleura [Figure 3a]. A TEE was performed that showed a 1 × 1.5 cm vegetation on the TV with moderate tricuspid regurgitation [Figure 3b]. The patient's blood results returned positive for methicillin-resistant *S. aureus* for two out of two. Patient was continued on monotherapy with vancomycin, whereas ceftriaxone was discontinued. Because of her loculated pleural effusion on the right pleura, a right-sided thoracostomy tube for drainage of the pleural fluid was placed.

Despite the aforementioned treatments, the patient had fluctuations in her temperatures and along with marginally improved but persistent leukocytosis. Her antimicrobial regimen was transitioned from vancomycin to cephtaroline, as a consequence of her continued febrile states and subtherapeutic vancomycin levels, despite increased doses. At this point, a surgical consultation was arranged to perform a percutaneous mechanical vegetation debulking with an AngioVac system to achieve source control. The surgery was performed without complications. After the surgery, the patient no longer had fever and her leukocytosis resolved. She completed a 6-week course of antibiotic therapy with cephtaroline and was discharged in stable conditions.

Description of procedure

Each patient was sent to the Operating Room (OR) and general anesthesia was planned. Two large bore peripheral IV catheters (18G) were placed per patient. An arterial line was inserted in the left radial artery. The Standard American Society of Anesthesiologists monitors with five-lead electrocardiography were used throughout the procedures. After IV induction, the trachea was intubated and a TEE probe was inserted into the esophagus to assess cardiac integrity, specially the TVs, the right atrium, and to visualize the vegetation before and after the procedure. Fluoroscopy was also used during the procedure.

A modified Seldinger technique was used to access the right internal jugular vein as well as the right common femoral vein for each patient. A venous drainage cannula was inserted into the right internal jugular vein and a venous reinfusion cannula was inserted into the left common femoral vein for each patient. Both cannulas were connected to a Venous–Venous Extracorporeal Membrane Oxygenator (VV-ECMO) circuit. The AngioVac systems were de-aired and connected to the VV-ECMO circuit. Patients were heparinized to an Activated Clotting Time over 300 s. The Angiocath suction device was introduced into the venous drainage cannula, and it was placed in close proximity to the TV. Location was confirmed and verified with fluoroscopy as well as TEE. Suction was started and a vegetation was trapped inside the filter of the AngioVac system for each patient. After these procedures, the TEEs confirmed the absence of vegetations for each patient.

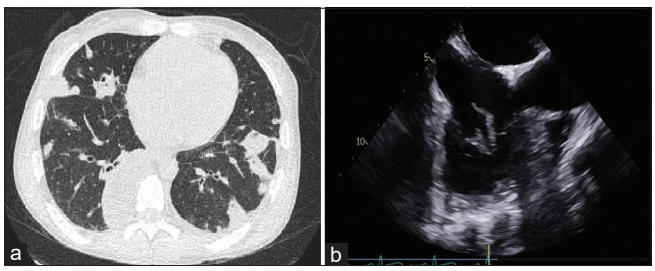

Figure 3: (a) Chest CT showing multifocal nodular opacities with a complex loculated pleural effusion (b) TEE showing a 1m × 1.5 cm vegetation on the TV

DISCUSSION

Since the second half of the last century, there has been a strong association between intravenous drug abuse (IVDA) and the incidence of right-sided IE.[3] Among IVDA patients presenting with fever, 13% will have echocardiographic evidence of IE and if bacteremia is present, 41% will have IE.[5] It is noted that this disease with this risk factor is seen mostly in young males of age between their 20s and 30s. In 70% of these cases, the infective organism is*S. aureus* and evidenced by our three patients' blood cultures.[6]

The mainstay of treatment for IE is prolonged IV antibiotics. However, in certain instances, IV antibiotics are inadequate and a surgical approach is warranted. According to the American Heart Association and the Infectious Disease Society of America, the indications for surgery in right-sided IE are the following: 1) right ventricle or atrium failure because of severe tricuspid regurgitation, 2) lack of response to appropriate antibiotic therapy, 3) vegetation more than 2 cm in size, and 4) recurrent or worsening septic emboli despite appropriate antibiotic therapy.[6] As noted in our cases, each patient met at least two of the above-mentioned criteria warranting surgical intervention.

Traditionally, the surgical approach would be an invasive approach of extracting the vegetation or an invasive approach to repair/replace the TV. These types of surgeries are costly, invasive, recovery may be lengthy, and may not be suitable for poor surgical candidates. It is also unadvisable to perform TV replacements in IV drug addicts, who would potentially re-infect their new valve in the future. Percutaneous mechanical vegetation debulking with an AngioVac system appears to offer an alternative to the invasive approach and for those with high risk of repeat IV drug use. The AngioVac suction has been approved by

the Food and Drug Association since 2014 for the removal of undesirable materials from the intravascular system such as thrombi in the iliocaval, pulmonary, or upper extremity vasculature.[7] Recently, this approach has been used also for the right-sided IE and the above three cases were the first in our institution, using this novel surgical approach for IE.

Although the AngioVac system seems to be a great surgical alternative, it is not free of side effects or complications. According to Worku *et al*.[8] where 56 patients who had AngioVac procedures were studied, the success rate of removing thrombus in the right side of the heart was no more than 82%. This same study reported 12% rate of complications that included hematoma and retroperitoneal bleed.[8] Another possible complication of an AngioVac procedure for vegetation removal on the TV is worsening of TV insufficiency given the suctioning properties of the device. According to Geroge *et al*.,[9] 3 out of 33 patients that had AngioVac procedures for TV vegetation removal had worsening of TV insufficiency that ultimately required TV replacement.

Despite these complications and side effects described, the AngioVac procedure does seem to offer certain benefits in comparison to an invasive TV procedure. According to another study from George *et al*.,[10] a retrospective comparison study of 100 patients with right-sided IE showed that the AngioVac approach compared to the traditional TV surgery offered a lower length of stay in the hospital (35 vs 45 days, $P = 0.028$), had less likely chances of requiring blood transfusions (56.8% vs 79.4%, $P = 0.016$), and days for therapy were much sooner (6 vs 15 days, $P < 0.001$). Although it is a novel approach that seems to be very beneficial, more comparative studies are required to emphasize the advantages of AngioVac system over TV surgery.

CONCLUSION

It is very important to know the indications for surgery in right-sided IE. More than that, it is also important to recognize that besides TV surgery (repair/replacement) or minimally invasive cardiac surgery, a new surgical approach has recently evolved, percutaneous mechanical vegetation debulking with an AngioVac system. This new approach seems to offer less time in the OR, faster time of recovery, more appropriate for poor surgical candidates, less invasive, and avoids the need to insert a prosthetic valve in an IV drug abuser.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient (s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflict of interest

There are no conflicts of interest.

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