Ghost Catheter Fibrin Sleeve: Case Report and Literature Review

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INTRODUCTION

Central venous catheter (CVC) is indicated in various inpatient and outpatient situations, such as hemodynamic monitoring, hemodialysis (HD) patients awaiting arteriovenous shunt, antibiotic and chemotherapy delivery. The use of CVC is on the rise in the United States, with several million catheters placed every year. Many patients require long-term CVC use, and this predisposes to complications, with catheter-related infection being the most common. Fibrin sheath formation is common on an indwelling catheter and has been reported to range from 42% to 100% within 7 days of catheter placement.[1] An unusual sequela or complication after the removal of a CVC is remnants of fibrin sheath or sleeve (ghost catheter fibrin sheath [GCFS]). These form on the surface of the CVC and are retained in the venous system after removal of the CVC (similar to a shed snakeskin that resembles the shape of the snake). GCFS is uncommon, with scattered case reports of this entity as discussed later. GCFS has been noted to be an incidental finding on subsequent computed tomography (CT) and echocardiography[2] but can be associated with complications such as infection, venous stenosis, venous collateral vessels, venous thrombosis, and pulmonary embolism. We report detection by transesophageal echocardiography (TEE) of GCFS following the removal of a CVC in two patients with end-stage renal disease on HD and briefly discuss the available evidence.

CASE PRESENTATIONS

Case 1

A 48-year-old man was brought to the emergency department via emergency medical services for acute-onset shortness of breath, cough, and fever for 48 hours. His medical history was significant for end-stage renal disease on HD through a tunneled catheter, liver transplantation on immunosuppression, hypertension, type 2 diabetes mellites, and chronic deep venous thrombosis previously on a 3-month course of anticoagulation, which was discontinued many months prior. His vital signs on arrival were as follows: blood pressure 121/68 mm Hg, heart rate 131 beats/min, respiratory rate 24 breaths/min, oxygen saturation 94% on room air, and temperature 103°F. On physical examination, the patient was febrile, with bilateral rales on lung examination, a left-side CVC (subclavian) was in place, and no erythema was present. Pertinent laboratory findings were a white blood cell count of $11.4\times10^3/\mu L$, potassium 6.8 mEq/L, blood urea nitrogen 53 mg/dL, creatinine 6.78 mg/dL and troponin I 100 ng/mL. Results of chest radiography were unremarkable. The patient was treated with intravenous fluids and antibiotics to cover community-acquired pneumonia and methicillin-resistant *Staphylococcus aureus*. Subsequent blood cultures showed *S aureus* susceptible to methicillin, so antibiotics were changed accordingly.

During hospitalization, the patient was found to have green purulent drainage from the tunneled catheter insertion site. He was given a short course of HD, followed by dialysis catheter removal. The catheter tip was sent for culture. Subsequently TEE was performed, as infective endocarditis was high in the differential diagnosis. This showed a large linear and tubular echo-dense mass within the superior vena cava protruding into the right atrium, 1.25 × 4 cm, representing GCFS likely related to the just removed CVC (Figure 1A) and also showed a separate rounded right atrial thrombus (Figure 1B). Figure 2 shows the great vessel view on TEE in x-plane mode of the GCFS in the superior vena cava in short axis.

Case 2

A 37-year-old patient with end-stage renal disease on HD presented with chills, fever, nausea, and vomiting 1 day after his HD session. He was found to be septic, with elevated lactate, and was started on broad-spectrum antibiotics. Blood cultures drawn from the dialysis catheter grew methicillin-sensitive *S aureus*, and the decision was made to remove the catheter after an additional session of HD. Upon removal, the catheter tip was cultured and also grew the same organism. TEE was done, showing a large tubular, linear mass in the superior vena cava–right atrial junction in the region of prior dialysis catheter, illustrating a second example of GCFS (Figures 3-5).

DISCUSSION

The formation of a fibrin sheath or an encasement around an indwelling catheter is a well-known phenomenon first reported by Motin *et al.*[3] in 1964. In a retrospective study, Alomari and Falk[4] found that 76% of their subjects developed fibrin sheath formation. Rudolf Virchow outlined injury to endothelial walls, disruption of normal flow, and stasis, well known as "Virchow's triad," likely serving as an inciting cascade that leads to thrombus formation.[5] The mechanism of fibrin sheath formation is a composite of interaction between the venous endothelium, catheter, and thrombus.[6] Inflammatory, endothelial, and smooth muscle cells are the biologically active cell types involved in the process. Three different types of fibrin sheath formation have been reported: a meshlike thrombus that bridges the vein wall and thrombus; the second type, found in the distal aspects of the indwelling catheter and called sleeve-related thrombus; and third type called mural thrombus, found on the vein wall adjacent to the distal intravascular aspect of the catheter. During catheter removal,

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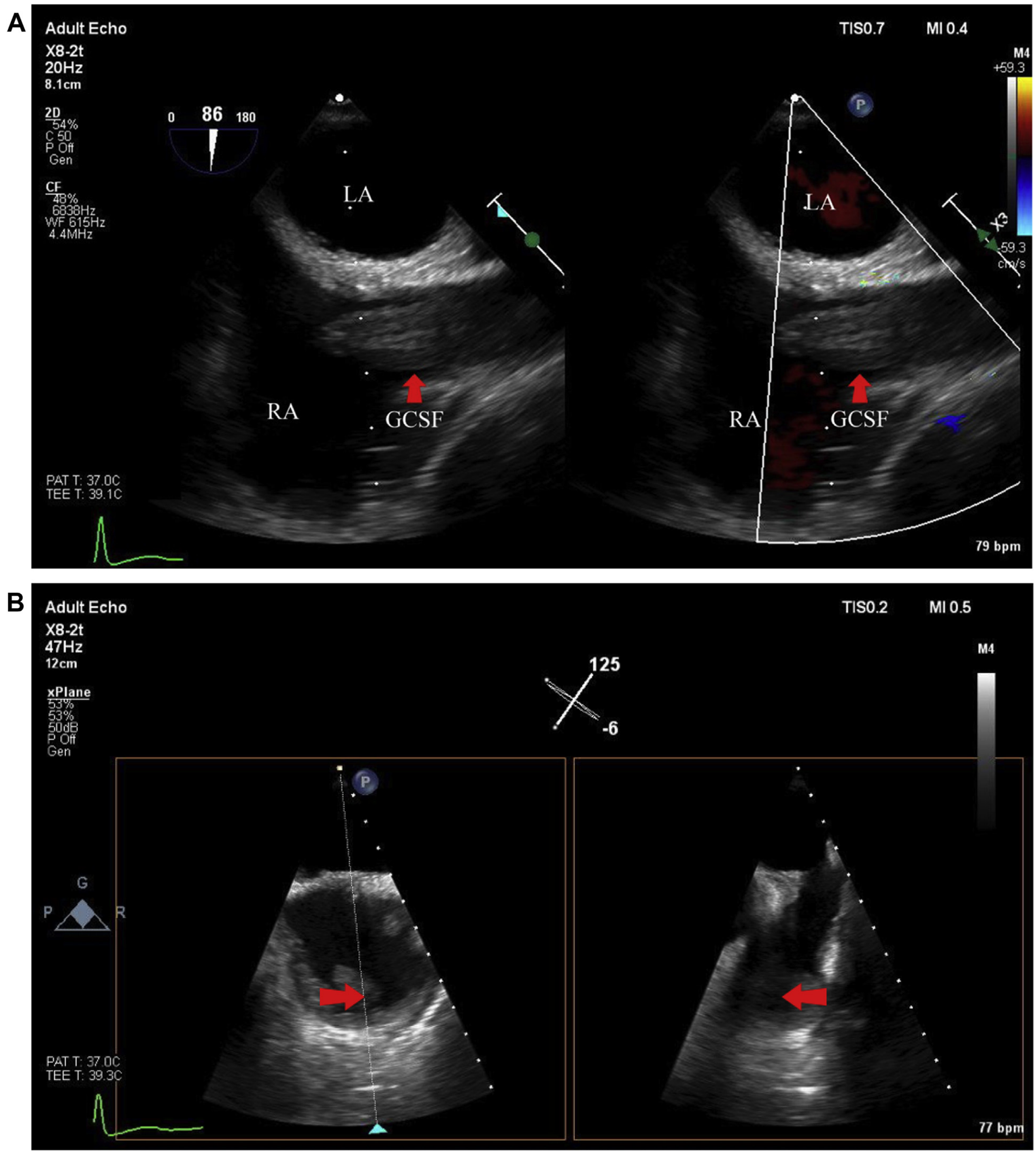

Figure 1 Bicaval color-compare mode of TEE showing large GCFS (*red arrows*) in superior vena cava (SVC; **A**). Bicaval view x-plane mode showing separate right atrial mass consistent with thrombus. The GCFS is seen near the SVC–right atrium (RA) junction separately **(B)**. *LA*, left atrium; *RA*, right atrium.

sometimes the fibrin sheath remnant stays within the vein forming GCFS.[5] The literature on GCFS is sparse. Krausz *et al.*[1] reported a prevalence of GCFS on chest CT of 13.6% (20 of 147 patients). Their study showed a higher prevalence of GCFS in women and an association with venous thrombus formation. The correlation between thrombus and sepsis has been well described. An observational prospective multicenter study performed by Timsit *et al.*[7] demonstrated the strong association of thrombosis and catheter-related sepsis. Similarly, Mehall *et al.*[8] found in an animal study that fibrin sheath significantly increases catheter-related infection and persistent

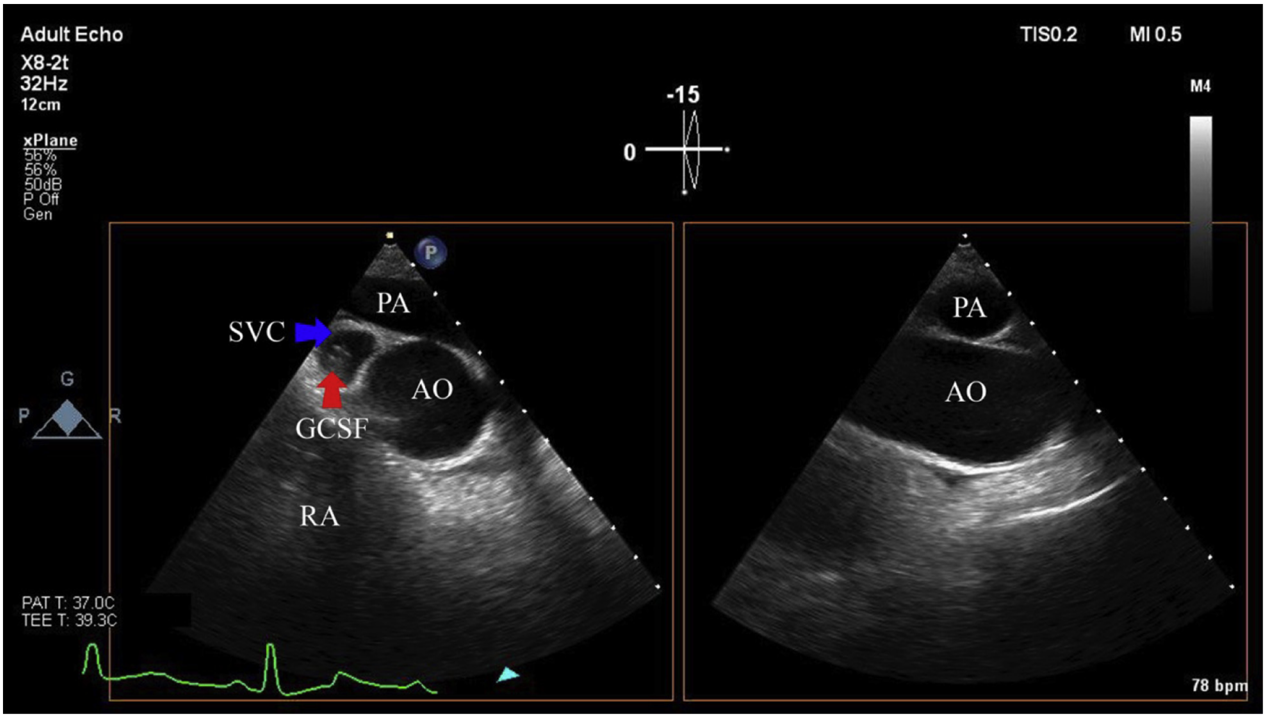

Figure 2 High short-axis view of TEE in x-plane mode showing aorta and GCFS (*red arrow*) in the superior vena cava (SVC, *blue arrow*). There was no valvular vegetation on any of the four intracardiac valves seen. The patient was treated for infective endocarditis with 6 weeks of antibiotics, as it could not be ruled out. *AO*, aorta; *LA*, left atrium; *PA*, pulmonary artery; *RA*, right atrium.

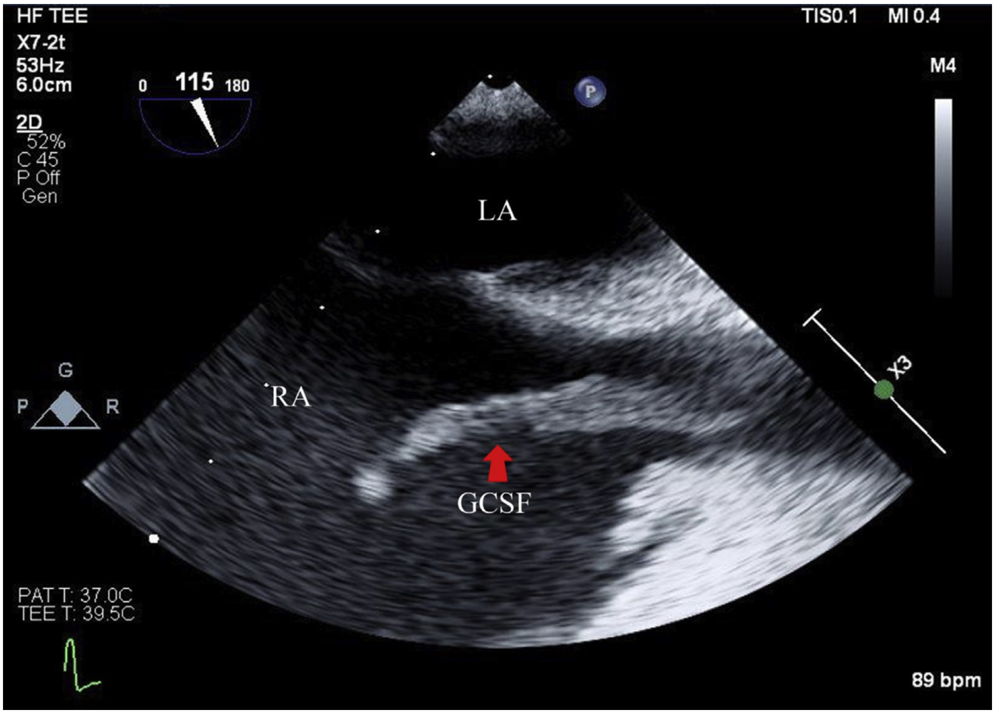

Figure 3 Bicaval view of TEE showing GCFS (*red arrow*) in the superior vena cava extending into the right atrium (RA) of a 37-year-old patient to illustrate the varying morphology of the GCFS. *LA*, left atrium; *RA*, right atrium.

bacteremia. Sinno and Alam[9] reported a case series of three patients in whom the catheter was removed after bacteremia, and GCFS was later found on TEE. All three patients were treated provisionally with antibiotics combined with anticoagulants. Peters *et al.*[2] detected on TEE a GCFS of 8 cm in length in a 54-year-old woman who had an indwelling catheter for HD.

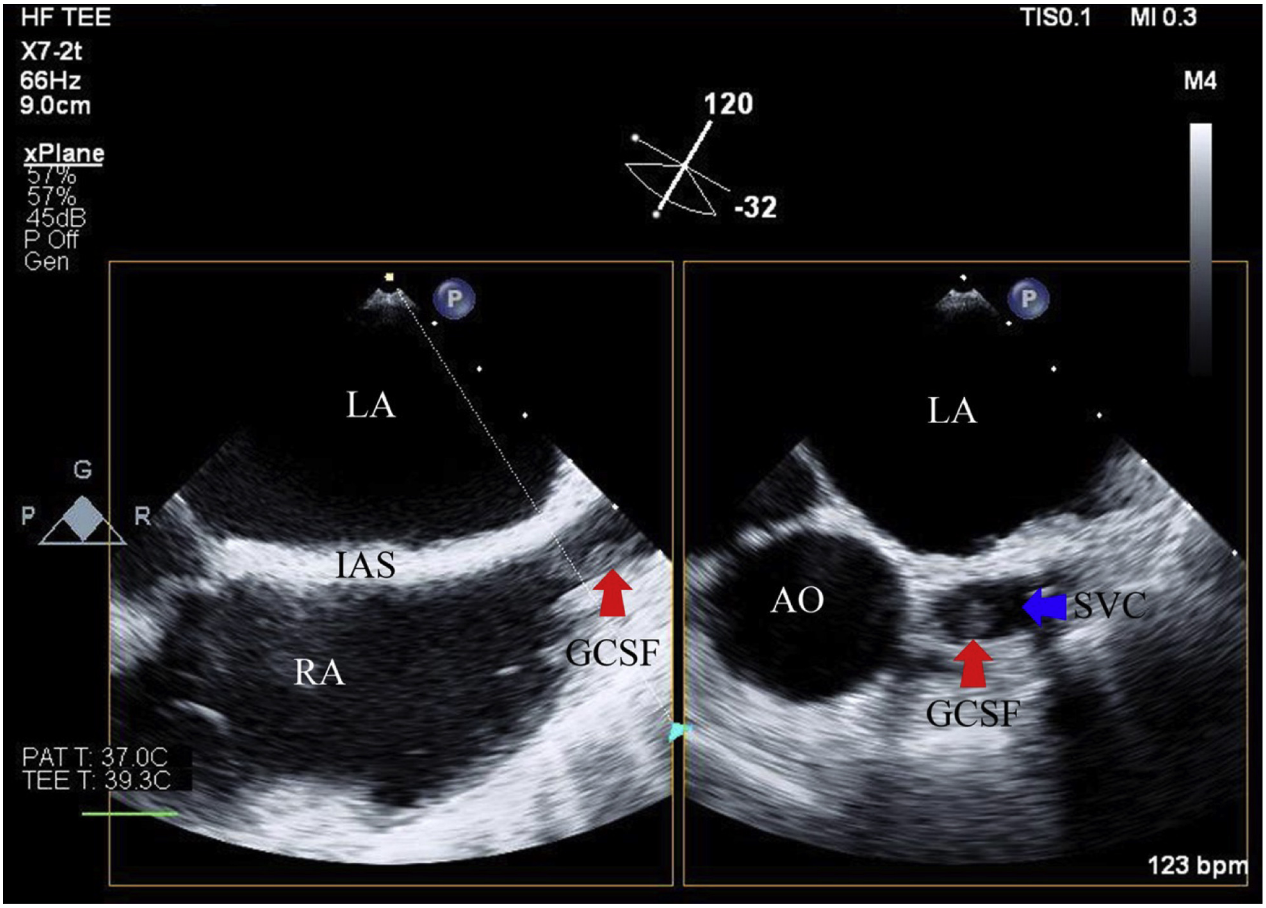

Figure 4 Bicaval view of TEE delineating the entire GCFS (*red arrow*) from superior vena cava (SVC, *blue arrow*) protruding to right atrium (RA). *AO*, aorta; *IAS*, interatrial septum; *LA*, left atrium.

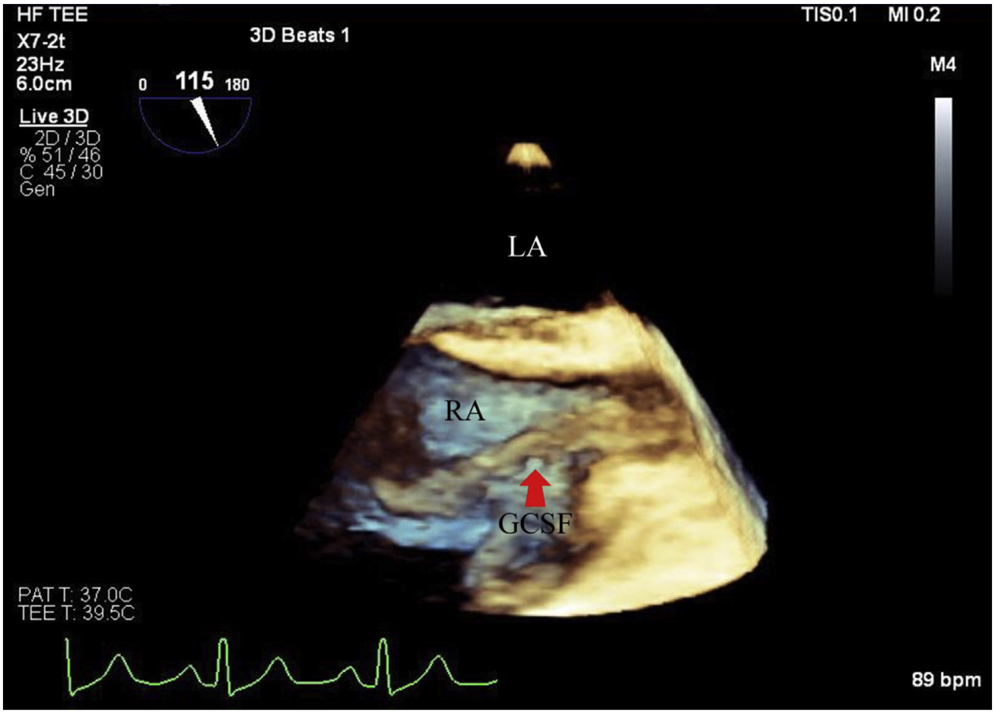

Figure 5 Three-dimensional image showing entirety of GCFS (*red arrow*) protruding from superior vena cava to right atrium. *LA*, left atrium; *RA*, right atrium.

TEE is widely regarded as an excellent modality to evaluate vegetations and intracardiac thrombus. The overall sensitivity to diagnose endocarditis ranges from 90% to 100%.[10] Although the diagnosis of a thrombus attached to a catheter tip is fairly common, there are no substantial data to formulate guidelines for echocardiographers to diagnose retained GCFS. It can often be misdiagnosed as catheter fragments and can lead to unnecessary surgical procedures. Unless there is histopathologic confirmation, distinguishing GCFS from thrombus can also be challenging. A few criteria can be used to assess the possible presence of GCFS. The location of the GCFS should be in the area of the removed catheter and have a temporal relationship to detection after catheter removal. The shape of the GCFS should resemble a tubular cast, which is how the fibrin sheath forms around the catheter. Although incidental GCFS can be identified at any point after catheter removal, it becomes challenging to differentiate it from new thrombus if the imaging is done weeks to months after catheter removal. Also, the risk for infection, thrombosis, and pulmonary embolism need to be assessed in the presence of GCFS.

Treatment options vary and depend on the clinical setting of detection of GCFS. In the setting of malfunction of the HD port because of a fibrin sheath, single-infusion low-dose lytic therapies have been used successfully.[11] Invasive attempts to remove the fibrin sheath have also been reported in the same setting using internal snare techniques.[12] In the setting of infection or embolus, which is usually detected with a combination of laboratory testing, TEE, and CT, removal of the catheter and completing a course of antibiotics along with anticoagulation have been used. There is no standard treatment for GCFS, and therapy must be tailored to the presenting clinical situation, as in many cases it may be incidentally detected on CT following the removal of an indwelling catheter.

CONCLUSION

We report two cases of GCFS in patients with long-term indwelling catheters that were removed. The exact treatment strategies for GCFS are not well defined, but completing an antibiotic course in the setting of bacteremia and judicious use of anticoagulation and reassessment using TEE or CT may be indicated on the basis of published literature. These cases illustrate that GCFS should be in the differential diagnosis for tubular masses seen during CT or TEE in patients with indwelling catheters that have been removed, as it poses issues not only in diagnosis but also in management strategies.

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