CASE REPORT

Fibrin sheath-associated endovascular infection of the heart: the Trojan horse of indwelling central venous catheters

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SUMMARY

Chronic indwelling central venous catheters can result in formation of fibrin sheaths increasing risk of occlusion, thrombosis and infection. Endovascular infection of right-sided heart structures induced by such sheaths is very rare. A 48-year-old woman with end-stage renal disease initially treated for diabetic ketoacidosis developed persistent *Staphylococcus epidermidis* bacteraemia without an identifiable source. Although transthoracic echocardiography was unremarkable, transoesophageal echocardiography revealed a fibrin sheath and vegetations in superior vena cava–right atrium junction, which was the site of the tip of a central catheter that had been removed 2 months prior, consistent with fibrin sheath-associated endovascular infection. The bacteraemia cleared and clinical improvement was seen with prolonged intravenous vancomycin. In patients with unexplained bacteraemia and history of a central catheter, rare causes of endovascular infections of right-sided heart structures like fibrin sheaths should be considered. These can persist months after catheter removal. Transoesophageal echocardiogram should be used for earlier detection.

BACKGROUND

Indwelling catheters, including permacaths for haemodialysis, are among several million catheters placed annually worldwide.¹ They carry a high risk for complications, including infections, thrombosis and thromboembolism. Development of fibrin sheaths, first described in 1964, increases the incidence of such complications.¹ Endovascular infection of right-sided heart structures induced by such fibrin sheaths is a rare occurrence with few reported cases in the literature. We present the case of a 48-year-old woman with unexplained persistent bacteraemia who was found to have a fibrin sheath with thrombus and vegetation formation on transoesophageal echocardiogram (TEE) which was the source of endovascular infection of the heart.

Case presentation

Our patient is a 48-year-old African-American woman with prior medical history of end-stage renal disease on haemodialysis via left arm arteriovenous graft (AVG), type 2 diabetes mellitus, coronary artery disease status-post bypass graft,

heart failure with reduced ejection fraction of 35%, peripheral artery disease with multiple angioplasties and a left below-knee amputation. She has a 30 pack-year smoking history with no history of illicit drug use. She presented with malaise, nausea and vomiting. Initial investigations showed blood pressure of 151/83 mmHg, heart rate of 61, respiratory rate of 18, temperature of 36.6°C, hyponatraemia (Na=127 mmol/L), hyperkalaemia (K=6.1 mmol/L), hypochloraemia (Cl=91 mmol/L), increased anion gap (25) metabolic acidosis (HCO₃=11 mmol/L), hyperglycaemia (glucose=534 mg/dL) and elevated beta-hydroxybutyrate (54.5 mg/dL). She was diagnosed with diabetic ketoacidosis, which was successfully treated. Blood cultures revealed *Staphylococcus epidermidis* bacteraemia. AVG site did not show any evidence of infection, chest X-ray did not show any signs of pneumonia or other respiratory infection and there were no symptoms or signs of urinary tract infection. Blood cultures remained positive for 3 days. Work-up to identify the source was started with an ultrasound of the AVG showing no collections or evidence of infection. Transthoracic echocardiogram revealed no vegetations and moderate tricuspid regurgitation. TEE was done for suspected intracardiac source revealing a non-mobile echodensity within the superior vena cava (SVC) proximal to the SVC–right atrial (RA) junction measuring 0.7×1.0 cm and a smaller mobile echodensity attached to the larger echodensity measuring 0.3×0.8 cm (figure 1). The patient had a permacath in the same position that was removed 2 months earlier, the tip of which was located at the SVC–RA junction as proven by review of prior X-rays. Given this history, a persistent fibrinous sheath with secondary infection was the most probable diagnosis. The patient was treated for fibrin sheath-associated endovascular infection with a 6-week course of intravenous vancomycin. The longer duration of therapy was decided as the infectious nidus was not removed and blood cultures were positive for >72 hours. Blood cultures from day 5 showed clearance of bacteraemia. Cultures from subsequent 2 days remained negative and clinical improvement was seen.

DISCUSSION

Endothelial injury at catheter insertion time leads to formation of a pericatheter thrombus within

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Figure 1 Transthoracic echocardiography showing echodensities in superior vena cava–right atrial junction.

48 hours that organises into fibroepithelial tissue over the course of several days. Further organisation creates an endothelial layer indistinguishable from the vein wall at 30 days.^{2–4} The sheath is mainly composed of platelet–fibrin thrombi, smooth muscle cell layers and collagen layers with overlying endothelial cells,^{4–6} making them histologically complex and thus limiting the efficacy of available treatment options such as fibrinolytics. The fibrinous material can persist after catheter removal and be a nidus for vegetations, infection, thrombosis and embolisation.⁷ These sheaths may be discovered incidentally on routine echocardiographic imaging and can result in catheter malfunction.

The rate of fibrin sheath formation in haemodialysis patients has been noted to be 47% in one study.¹ In spite of this fact, we could identify only four reported cases of fibrin sheath-induced endocarditis by Sinno and Alam⁷ and Cardozo *et al.*¹

Table 1 gives a comparative analysis of the cases described by Sinno and Alam, Cardozo *et al* and our case. In all the cases described by Sinno and Alam, the central catheter was present at the time of presentation. The patient in Cardozo *et al*'s case did have a femoral permacath that was in use at the time of presentation but the tip of the internal jugular (IJ) catheter, which developed the fibrin sheath, had been removed earlier; however, it is not reported as to how long ago it was removed.

In our case, the patient's right IJ central catheter was removed 2 months prior to symptom development and had been in use for a year before its removal. The presumption is that the fibrin

sheath developed from the prior permacath and subsequently caused thrombus formation and non-valvular vegetations seen as echodensities in SVC–RA junction. However, there were no pathological specimens to confirm the exact nature of these echodensities. In light of the absence of valvular vegetations on TEE as well as any device leads, and the presence of the echodensity with characteristics of a fibrin sheath in the region where the tip of that catheter was (based on review of prior chest radiographs), we safely concluded that fibrin sheath developed from the IJ permacath and served as a nidus for infection resulting in bacteraemia. Of note, fibrin sheaths have persisted up to 10 months after catheter removal in animal models.⁴

Early detection of the fibrin sheaths is of paramount significance. CT has a detection rate of 13%; however, it cannot identify thrombus or vegetation which are necessary to characterise endovascular infections of structures of the heart and endocarditis. Transthoracic echocardiography is also not able to detect fibrin sheaths. Therefore, imaging with TEE is important. In all the reported cases, TEE was used to identify the sheath and vegetations and confirmed the resolution after treatment. In four of the five cases, including this case, the location was SVC–RA junction; and RA in the remaining one.

When subsequent infection and endocarditis set in, prompt treatment with antibiotics is imperative. In all cases, antibiotic treatment resolved the bacteraemia and symptoms, and also resulted in dissolution of the vegetations (in cases where TEE was repeated after treatment). Nuclear medicine imaging (indium or positron emission tomography scan) was not available for the cases referenced as well as our case; however, it would be interesting to know the role of these modalities in detection of fibrin sheaths and is an area for further exploration. The exact antibiotic used and duration of treatment has not been reported in these cases. We consulted our infectious diseases colleagues for treatment recommendations. Since the patient had persistent bacteraemia (>72 hours), the infectious nidus was not removed and that the endovascular infection in this case was classified as a central-line-associated infection (due to permacath being the inciting factor and 6-week duration of antibiotic therapy was chosen based on guidelines of Infectious Diseases Society of America.⁹ It is also essential to determine the methods to reduce formation of fibrin sheaths. In animal studies, coating catheters with low molecular weight heparin has delayed formation of the sheaths.¹⁰ Also, significant reduction in catheter-related infections has been seen with systemic infusion of unfractionated heparin.^{11 12} These observations suggest that thrombus formation in fibrin sheath and

Table 1 Comparing five cases of fibrin sheath-induced endovascular infections of right-sided heart structures

Case	Age	Sex	Purpose of central catheter	Status of central catheter at time of presentation	Organism causing bacteraemia	Location of echodensities	Treatment
Sinno and Alam ⁷	24	M	Haemodialysis	In use, inserted 9 months prior	Methicillin-sensitive <i>Staphylococcus aureus</i>	SVC–RA junction	Antibiotics and anticoagulation
	50	M	Haemodialysis	In use, inserted 6 months prior	Methicillin-resistant <i>S. aureus</i>	SVC–RA junction	Antibiotics
	29	F	Venous access for hydration and opioid infusion for sickle cell pain crises	In use, inserted 24 months prior	Methicillin-resistant <i>S. aureus</i>	SVC–RA junction	NA
Cardozo <i>et al</i> ¹	86	M	Haemodialysis	Removed, unknown duration of use and time of removal	<i>Enterococcus faecalis</i>	SVC–RA junction	Antibiotics
Our case	40	F	Haemodialysis	Removed 2 months prior, used for 12 months	<i>Staphylococcus epidermidis</i>	SVC–RA junction	Antibiotics

NA, not applicable; SVC–RA, superior vena cava–right atrial junction.

vegetations are inter-related, and these areas should be targeted to prevent fibrin sheath formation and its subsequent vegetations and infection.

Learning points

- This case highlights the fact that fibrin sheaths persist months after catheter removal so the possibility of fibrin sheath-associated endovascular infections of right-sided heart structures should be entertained in cases of persistent unexplained bacteraemia and prior history of central catheter.
- Transoesophageal echocardiogram (TEE) can reliably detect fibrin sheaths and there should be low threshold for TEE for earlier detection.

Contributors MAS, MS and WI were involved in the case and writing of the manuscript. SC was the supervising senior physician on the case and responsible for revision of the manuscript.

Competing interests None declared.

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