Catheter-directed thrombolysis for thrombi in right atrium and upper extremity caused by peripherally inserted central catheters

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ABSTRACT

Introduction: Peripherally inserted central catheters (PICC) are widely applied in clinical practice. One of the foremost complications is the potential risk for thrombosis associated with their use. Especially the thrombi within the cardiac chambers are rarely observed in clinical practice, but they are potentially deadly to patients for pulmonary embolism. There are no evidence-based guidelines for their treatment, and the optimal treatment is controversial (conservative or positive). Case Report: We report the case of a 52-year-old female, who presented with both a right atrial thrombus and upper extremity deep vein thrombi on three days following PICC insertion. After an elaborate surgery with two catheters for thrombolysis and one filter for prevention of pulmonary embolism, the thrombi were dissolved effectively without occurrence of any complications. Conclusion: In summary, regarding the treatment choice of complex thrombi in both right atrium and upper extremity, with the development of vascular surgery and interventional equipment, interventional treatment might be a well-tolerated therapeutic option. The ingenious surgical design of two catheters for thrombolysis and one filter for prevention of pulmonary embolism highlights a safe and feasible treatment for this kind of thrombi with minimal trauma.

Keywords: Catheter-directed thrombolysis, Peripherally inserted central catheters, Right atrium, Thrombi

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INTRODUCTION

Peripherally inserted central catheters (PICC) are widely used in clinical practice. But some complications and risks exit with their use, such as deep vein thrombosis of the upper extremity, infection, and even pulmonary embolism [1–3]. The incidence of venous thrombosis is 6.67–13.91%, [3, 4] and the incidence of pulmonary embolism is up to 36–40% among those patients [5, 6] with a mortality rate of 17.4% [7].

In patients with thrombotic complication, catheter-related right atrial thrombi are rarely seen in clinical practice, but they are potentially deadly since the high possibility of pulmonary embolism. There are several treatment choices for those patients, including surgical thrombectomy, systemic anticoagulation, and systemic thrombolysis, etc., but the optimal treatment is controversial (conservative or positive) [8].

Only a few cases were reported to solve the problem by catheter-directed thrombolysis but with good results [8–11]. Here we report another even more complicated case with PICC-related thrombi in both right atrium and upper extremity. The thrombi were dissolved by two...
catheters for thrombolysis and a filter for prevention of pulmonary embolism. Written informed consent was obtained from the patient for publication of this case report and any accompanying images.

CASE REPORT

A 52-year-old female was diagnosed with breast cancer and underwent a mastectomy without complications. A PICC was placed in her right cephalic vein for chemotherapy. Three days later, the patient’s right arm was marked swelling. Her upper extremity and heart were examined by Doppler ultrasound, which showed thrombi in both the right atrium and around the PICC line. The size of the blood clot in the right atrium was 2.5×2.3 cm (Figure 1A). After consultation with a cardiac surgeon, the patient was not recommended for cardiac surgery because of the high risk and severe trauma. She was then referred to vascular surgery.

The patient did not suffer from any other systematic disease, and her only other pertinent history was a 30-year allergy to penicillin. She neither smoked nor drank. Physical examination revealed an edematous right arm. The PICC could be seen in her right elbow joint, and the skin around the catheter was erythematous. The temperature of the skin was normal, and the radial artery could be palpated. Cardiac and pulmonary auscultation and abdominal examination were normal. The patient did not have neck rigidity, and the neurologic examination was normal.

The patient was admitted for emergency surgery of a pulmonary artery catheter-directed thrombolysis (CDT) + superior vena cava filter implantation + right subclavian vein CDT. The intraoperative angiogram demonstrated a long thrombus in right axillary and subclavian vein around the PICC, and another thrombus in right atrium. The blood flow was fluent in superior vena cava, the left and right pulmonary artery branch. Regarding the surgery, firstly a catheter for thrombolysis was implanted in the trunk of the right pulmonary artery through the right femoral vein. The purpose was to dissolve the thrombus in right atrium and increase the local drug concentration in pulmonary artery in case of a pulmonary embolism. Secondly, after we confirmed that no thrombus was in the superior vena cava through the PICC catheter by angiography, a superior vena cava filter was inserted through the left femoral. The filter was used to capture the possible clots detaching from right axillary and subclavian vein thrombosis around the PICC during the process of thrombolysis, and prevent the pulmonary embolism. Thirdly, we replaced the PICC with a catheter for thrombolysis in the right subclavian vein, and the tip was placed in the superior vena cava (Figure 2). A dosage of 100,000 IU urokinase was injected through the two catheters respectively. After surgery, low-dose urokinase of 100,000 IU/24 h/catheter was continuously pumped through the catheters, which was heparinized from the catheter sheath. Hematological indexes, including hemoglobin, platelet, activated partial thromboplastin time (APTT) and fibrinogen, were tested every day to monitor and avoid the risk of bleeding.

On the third day after surgery, Doppler ultrasonography of the right upper extremity and the heart showed no obvious thrombosis around the catheter, and the thrombus in the right atrium had decreased to 2.3×1.3 cm (Figure 1B). On the sixth day after surgery, the thrombus in the right atrium had decreased to 1.3×0.9 cm (Figure 1C). Confirmed the normal blood flow in right axillary and subclavian vein by angiography, we removed the catheter of right upper extremity. Pulmonary artery CDT was continued with pumping of low-dose urokinase. On the tenth day after surgery, the thrombus in the right atrium dissolved, which was revealed by ultrasonic cardiogram (Figure 1D). The following day, angiography showed normal blood flow in superior vena cava and pulmonary artery, then the filter in superior vena cava and the catheter in pulmonary artery were all removed. We found that some thrombi were captured in the filter, and they were pathologically confirmed to be blood clots. On postoperative day 12, the patient was discharged from the hospital with a prescription for daily oral warfarin for continuous anticoagulation. International normalized ratio (INR) and D-dimmer was monitored to adjust the dosage of warfarin during the follow-up time.

DISCUSSION

Catheter-related right atrial thrombus (CRAT) is a rare complication in PICC. As a foreign body, PICC related local damage and hemodynamic abnormalities are the main reason for thrombus. On the one hand, the
catheter tip continuously moves with the heartbeat, and the repeated friction could damage the right atrium or the vascular intima and lead to activation of the clotting cascade, platelet aggregation, and thrombosis. On the other hand, the local hemodynamic abnormalities around the catheter tip could lead to eddy current and blood flow stasis, which tend to form thrombus. In previous case reports about CRAT, [12–14] the majority of the catheter tips were located in the right atrium. Therefore, the primary risk factor for atrial thrombosis lies in a PICC tip in the right atrium, and we should never place the tip of a PICC in the right atrium to avoid CRAT.

Regarding the treatment options for this patient, the following plans were considered:

1. Conservative treatment, including removal of the PICC, anticoagulants or peripheral intravenous thrombolysis. The risk was that the clots from either around the PICC or the right atrium could detach at any time, which would lead to a pulmonary embolism without the protection of a filter, especially when the PICC was removed.

2. Surgical treatment. After consultation with a cardiac surgeon who considered the patient’s overall condition, the patient was not recommended to undergo cardiac surgery. Although previous reports indicate that surgery could remove the blood clots, [12, 15] surgical trauma is massive and more difficult.

3. Catheter-directed thrombolysis (CDT). According to previous literature, only a few cases of right atrial thrombus have been treated by interventional surgery [8–11]. There were no clear guidelines for this kind of treatment. In accordance with the medical history of this patient, the duration of her upper extremity swelling was short, so we speculated that the blood clots might be fresh and that CDT might be a good choice. Therefore, after obtaining informed consent from the patient, we chose the proactive CDT option with the following treatment program:

   (1) Because of the thrombosis in her right atrium, there was a high risk for pulmonary embolism caused by deciduous blood clots; therefore, a catheter was inserted into the pulmonary artery through the heart. Taking advantage of the many side holes in the catheter, not only was the thrombus dissolved but also a pathway for the pulmonary artery was built so that once the thrombus detached, the pulmonary artery could still maintain blood flow.

   (2) A filter was placed in the superior vena cava to capture the clots detached from the thrombi in right axillary and subclavian vein around the PICC during the process of thrombolysis, and prevent the pulmonary embolism.

   (3) An infusion catheter was inserted through the PICC pathway to dissolve the thrombi in the upper extremity vein. Through the above surgical plan, we successfully dissolved the thrombi in the patient’s upper extremity vein and in the right atrium simultaneously and avoided the occurrence of pulmonary embolism. This kind of surgical plan and implementation has not yet been reported.

CONCLUSION

In summary, regarding the treatment choice of complex thrombi in both right atrium and upper extremity, with the development of vascular surgery and interventional equipment, interventional treatment might be a well-tolerated therapeutic option. The ingenious surgical design of two catheters for thrombolysis and one filter for prevention of pulmonary
embolism highlights a safe and feasible treatment for this kind of thrombi with minimal trauma.

REFERENCES


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Guarantor of Submission

The corresponding author is the guarantor of submission.

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Consent Statement

Written informed consent was obtained from the patient for publication of this case report.

Conflict of Interest

Authors declare no conflict of interest.

Data Availability

All relevant data are within the paper and its Supporting Information files.