Case Report

Percutaneous Catheter-Based Rheolytic Thrombectomy for Massive Pulmonary Embolism: A Case Report

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Abstract

Pulmonary thromboembolism is a life-threatening cardiovascular condition. The mortality rate is high in its current management. Besides supportive treatments, systemic thrombolysis and surgical thrombectomy play important roles in the comprehensive management of pulmonary embolism (PE). The percutaneous catheter-based rheolytic thrombectomy is a promising alternative for management of massive pulmonary emboli, particularly, when patients have contraindication with systemic thrombolysis or are not suitable for surgery.

We present the case of a 36-year-old Somalian man who came to our center for a total knee replacement (TKR). Three days after TKR, he developed sudden shortness of breath and decreased oxygen saturation. Computed tomography of pulmonary arteriogram showed extensive thrombi within the main pulmonary trunk, right and left pulmonary arteries, bilateral ascending and bilateral descending pulmonary arteries in keeping with massive PE. Because the patient was contraindicated for systemic thrombolysis, percutaneous, catheter-based rheolytic thrombectomy was chosen as the alternative treatment. His clinical symptoms improved immediately post-treatment. In conclusion, catheter-based rheolytic thrombectomy can serve as an alternative treatment for massive PE with a good clinical outcome.

Keywords: *thrombectomy, thrombolysis, pulmonary embolism*

Case report

Mr M, a 36 years old Somalian man had a history of bilateral knee pain since late childhood. Over the years, the pain became unbearable and the right knee joint had limited range of movement. His daily life activities were severely affected.

On 14th of May 2010, he visited the orthopaedic clinic in our center. The radiograph of the right knee showed erosion of the articular surfaces with reduction in joint space. In addition, minimal subchondral sclerosis was present. The left knee radiograph was less remarkable with a mild reduction of joint space, and no significant joint erosion demonstrated (Figure 1a). His C-reactive protein and uric acid levels were normal. His serum anti-nuclear antibody (ANA) test and rheumatoid factor test were negative. He was diagnosed with seronegative rheumatoid arthritis with severe arthritic changes of the right knee joint, and was indicated for right total knee replacement (TKR). His pre-operative biochemichal investigations were within normal ranges. Chest radiograph, electrocardiography (ECG), and cardiac ultrasound also showed no significant abnormality.

He underwent right TKR on 21st of May 2010 (Figure 1b). The operation was uneventful with an operative time of approximately three hours. Intraoperatively a limb tourniquet was used to reduce blood loss. Surgical biopsy was done and the histopathological study of the right knee showed fragments of fibrocollagenous tissue admixed with adipose tissue, and lined by synovial epithelium. Cellular areas composed of histiocytic cells and a few multinucleated giant cells, were noted which formed papillary projections. Collection of hemosiderin-laden macrophages was identified and foci of calcification were present. Findings were consistent with pigmented villonodular synovitis (PVNS).

Three days after the operation, he became progressively tachypnoeic. His blood pressure dropped to 80 mmHg systolic with sinus tachycardia of 130–140 beats per minute (bpm). Results of clinical examination of the lungs were negative as there were no crepitations, rhonchi, or bronchial breath sounds to suggest atelectasis or pneumonia. The arterial blood gas (ABG) result revealed a decrease in oxygen saturation (88%) with decrease in carbon dioxide and oxygen partial pressure (PCO_2 and PO_2). ECG showed sinus tarchycardia with dominant R wave on lead V1. A fibrin degradation test (D-Dimer) was not performed. The patient then was transferred to the general intensive care unit (GICU) for airway and hemodynamic supports. His blood pressure had gone up to 104/65 mmHg with fluid and inotrope infusion. The heart rate was stabilized to 95–100 bpm. Computed tomography of pulmonary arteriography (CTPA) was done immediately after stabilization, and showed extensive thrombi within the main trunk, right and left main pulmonary arteries in keeping with saddle emboli (Figure 2). In addition, there were thrombi present in ascending, descending, and tertiary branches of both pulmonary arteries. The largest thrombus was in the left main pulmonary artery which measured 4.0 cm × 0.7 cm. There were also areas of plate atelectasis in both lung bases. Hence, with presence of progressive hypotensive episodes and CTPA findings, the patient was diagnosed with massive PE.

A multidisciplinary discussion between the orthopaedic, cardiothoracic, and the interventional radiology teams took place to determine the best treatment option. Systemic thrombolytic or fibrinolytic treatment would compromise his new TKR as hematoma within the new joint will pre-dispose him to infection in the joint. With regards to the open thrombectomy, because the patient has extensive PE, which is associated with high morbidity and mortality rates, he was considered a high-risk candidate for open heart surgery. A catheter-based rheolytic thrombectomy performed by the interventional radiology unit was decided upon, as it was minimally invasive and had the potential to evacuate the clots, or at least improve the clinical outcome.

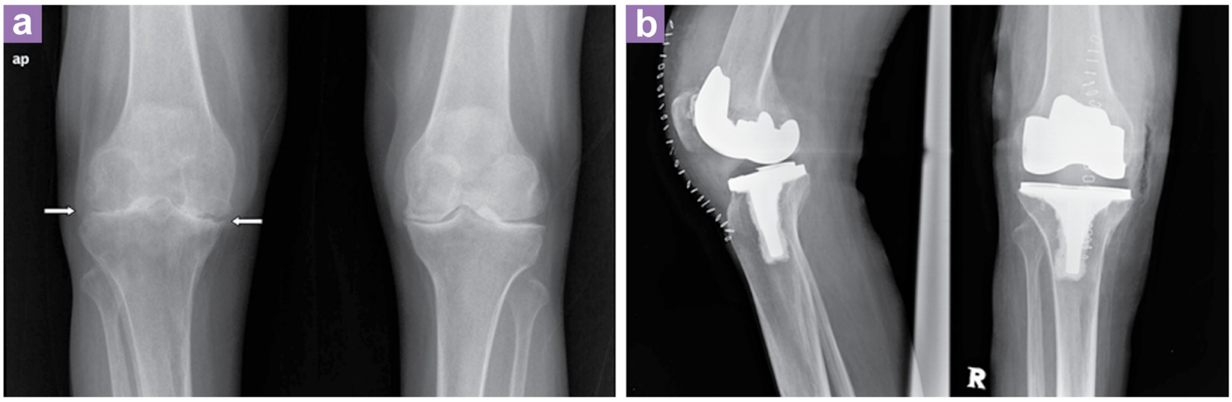

Figure 1: (1a) Pre-operative radiograph of both knees show erosion of articular surface of the right distal femur and proximal tibia with reduction in joint space (arrows). There was minimal subchondral sclerosis on the right, although no osteophyte was noted. The left knee had mild joint space reduction; however, there was no significant joint erosion. (1b) Radiographs of the right knee 3 days post-operation for total knee replacement showed in-place right knee prothesis.

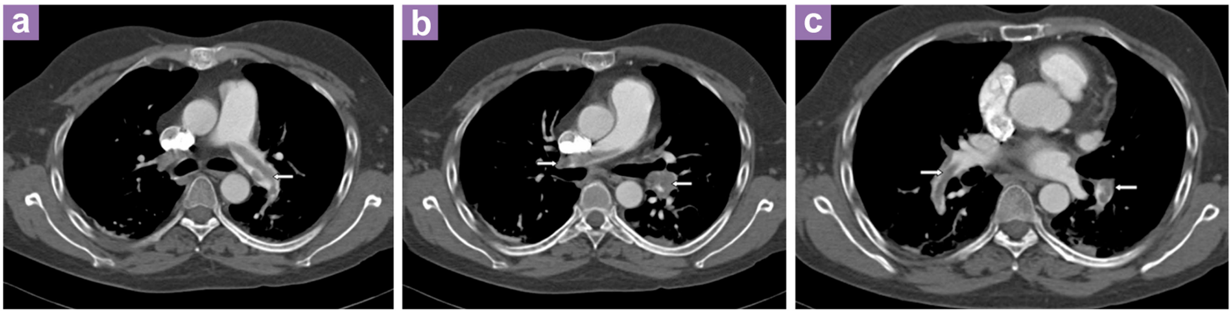

Figure 2: 2a, 2b, 2c; Computed tomography of pulmonary arteriography (CTPA) showed extensive filling defects within the main trunk, right and left main branches, secondary and tertiary branches of the pulmonary arteries representing pulmonary embolism (arrows).

Access to the pulmonary artery was through the right femoral vein using a 6 Fr vascular sheath, which was changed to 8 Fr sheath subsequently to advocate for the thrombectomy catheter. Initial diagnostic runs were performed using a 5 Fr pigtail catheter which revealed that the patient had a congenital ventricular septal defect (VSD) (Figure 3a). The massive saddle emboli was confirmed by the presence of multiple filling defects within the main trunk, right and left main pulmonary arteries as well as bilateral ascending and descending pulmonary arteries (Figure 3b and 3c).

An exchange guidewire and a guider were used to facilitate the 6 Fr rheolytic thrombectomy catheter to the main pulmonary artery. This cathether, Angiojet® Xpeedior® (AngioJet; Possis Medical, Minneapolis, MN), utilized complex fluid flow patterns to capture and remove thrombus. Intravenous thrombolysis can also be administered through this catheter with its power pulse delivery, although it was not administered during this treatment. Total thrombectomy time was maximum at 10 minutes. In all times, the patient's cardiovascular function was monitored by the anaesthetists. The intraluminal blood clots were sucked out at the main trunk, right and left main pulmonary branches, bilateral ascending and descending pulmonary arteries. Approximately, 60% of the blood clots were fragmented and sucked out as being evident by the reduction in filling defects compared with the baseline diagnostic runs. The saturated oxygen improved from 88% pre-treatment to 100% after treatment using high-flow oxygen. His blood pressure was stable ranging from 110/70 mmHg to 128/70 mmHg with the heart rate of 88–100 bpm. The thrombectomy was followed by inferior vena cava (IVC) filter insertion. There were clots remaining at the left descending pulmonary artery which could not be removed due to technical difficulty (Figure 3d and 3e).

Subsequently, the patient's oxygen saturation level remained stable with oxygen requirement of 3 L/min. Heparin infusion of 100 international units (IU) per hour was started 36 hours after thrombectomy. Three days after thrombectomy, the inotrope had been titrated off as he was hemodynamically stable and the patient was no longer showing symptoms of cardiopulmonary insufficiency thereafter. The patient's oxgen saturation, PCO_2 and PO_2 returned to normal ranges under room air. Concurrently, after thrombectomy he developed hematuria four hours after the treatment. This was likely in keeping with hemoglobinuria secondary to haemolysis, but it was resolved two days after the thrombectomy. The patient was supported with hydration therapy, renal profile monitoring and arterial blood gas analysis for any early sign of renal failure.

During his recovery period, he also developed right middle lobe pneumonia and was diagnosed with hospital acquired or ventilator acquired pneumonia. The pneumonia was resolved after seven days of antibiotics with administration of 3 g Cefepime daily. Ultrasound doppler in both lower limbs showed no evidence of deep vein thrombosis (DVT). However, we did not manage to do a baseline lower limb doppler ultrasound before the intravenous heparinasation. The patient was generally well, ambulated with a moving frame and was discharged three weeks later. After discharge, he was prescribed an oral anticoagulant (warfarin 5 mg daily) and was given a date for IVC filter removal in 12 weeks time.

Discussion

The case report illustrated an alternative to the conventional treatment, which includes systemic thrombolysis and surgical embolectomy for the management of PE.

Management of acute PE remains a challenge, particularly, in those with concomitant morbidity. Mortality rate remains exceedingly high (52%) in patients with massive PE, although they have been treated with systemic fibrinolysis. At present, clinical effectiveness of the fibrinolysis on mortality has not been clearly established beyond 90 days (1).

Systemic thrombolysis such as recombinant tissue plasminogen activator (r-TPA) has been suggested as the first-line treatment in patients with high risk PE presenting with cardiogenic shock with very few contraindications (2). On average, more than 90% of patients will respond to systemic thrombolysis within 36 hours (3). Good clinical outcome can be achieved if the thrombolysis is initiated within 48 hours of onset (4). Systemic heparinisation is recommended only after one week of onset as the benefits and risks were similar to systemic thrombolysis (5,6). However, systemic thrombolysis carries a significant risk of bleeding which is approximately 13% of major bleeding and 1.8% of intracranial or fatal haemorrhage, particularly, when pre-disposing conditions or co-morbidities existed (5,7).

Surgical pulmonary embolectomy has been performed for selected patients who have contraindication or inadequate response to thrombolysis, as well as those with patent foramen ovale and intracardiac thrombi (3). However, surgical treatment can only be offered in the limited specialized centers as with all open heart surgery, mortality and morbidity rates are higher, and careful selection of patients must be done. Surgical embolectomy is best done before development of cardiogenic shock.

The recent American Heart Association (AHA) guidelines for management of massive and submassive PE, iliofemoral deep vein thrombosis and chronic thromboembolic pulmonary hypertension 2011, has recognized catheter-based interventions or percutaneous catheter-based thrombectomy (PCBT), as an alternative when there is contraindication or no effectiveness with thrombolysis and when the surgery is impractical (2,8). Moreover, this indication can extend to the patients without contraindication of thrombolysis and those of late presentation (> 96 h after the onset) (1). Hybrid procedures which are mechanical thrombectomy as well as pharmacological administration of thrombolytics appear to be the best option in managing massive PE. AHA categorised catheter-based interventions as level C, class IIA, recommendations since there is no randomized trial of medical management versus catheter-based interventions that exist. Catheter-based interventions should be made an option in the presence of local expertise and availability of devices and facilities (8).

PCBT has presented clear advantages compared with other treatments. Firstly, the thrombus is removed by an anatomically localized therapy. Intra pulmonary thrombolysis can be

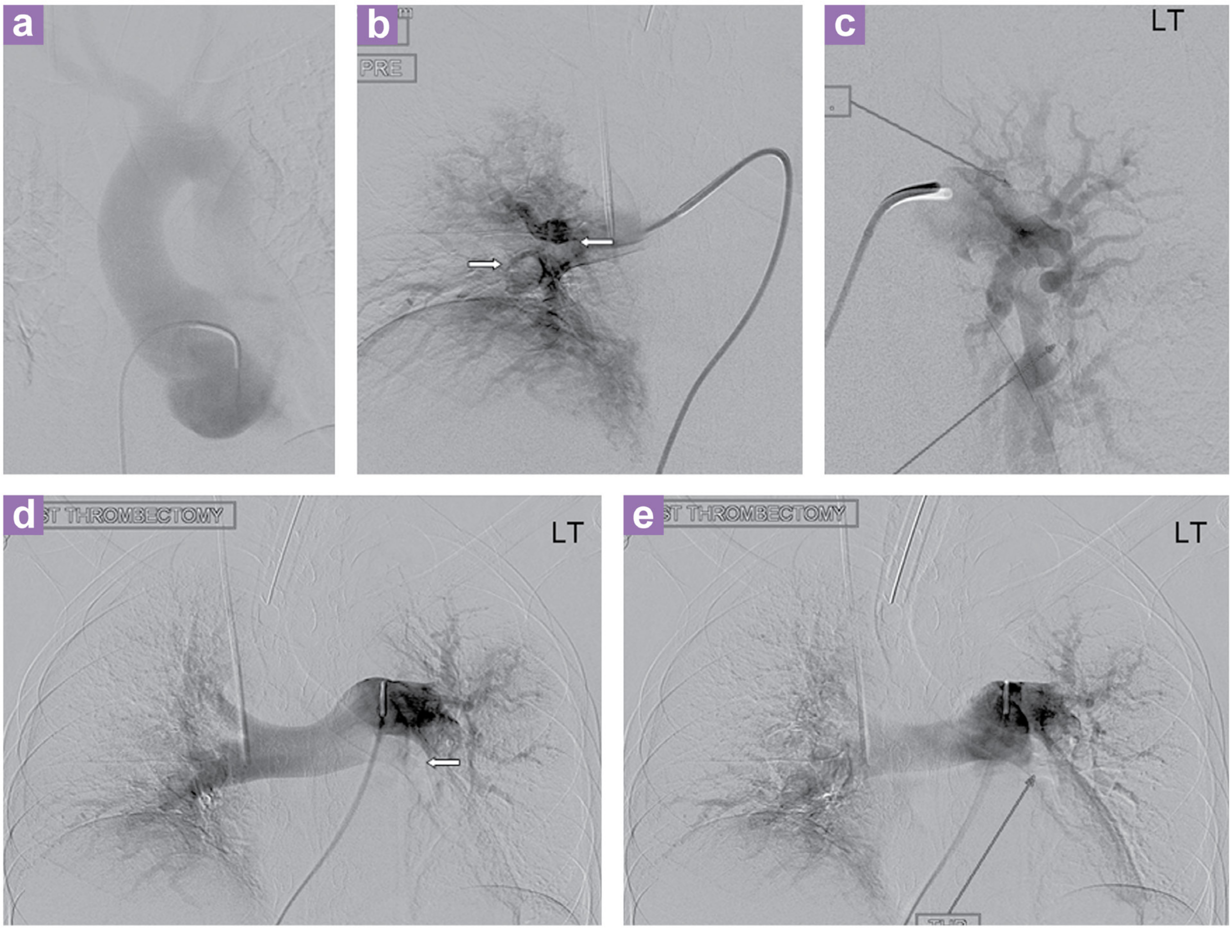

Figure 3: (a) The catheter's tip was identified within the left ventricle and contrast flows directly into the ascending aorta. (b,c) These were consistent with ventricular septal defect. Pulmonary arteriogram showed multiple filling defects within the pulmonary arteries (white short and black long arrows). (d,e) Post-thrombectomy pulmonary arteriogram showed residual filling defects within the left descending pulmonary artery (white short and black long arrows). The rest of the pulmonary arteries were patent.

added if considered necessary and assumed that it does not induce systematic fibrinolytic state. Secondly, the guiding catheter can be steered into the affected territories with selective aspiration. Recovery of the flow can be ascertained during the procedure, and the pulmonary pressure is continuously monitored. Thirdly, PCBT can be performed immediately after the diagnostic pulmonary angiogram meanwhile it takes time for thrombolysis to be effective (1).

The mechanism of the AngioJet® Xpeedior® Catheter involves using positive pressure for the saline spray, and negative pressure to suck the clots using the Bernoulli principle. The specialized catheter with multiple holes has functions for saline and drug spraying and also for sucking. The high pressure saline streams spray to break the thrombus, after which the clot fragments will be sucked away. The sprays will make the catheter stay apart from the vessel wall, decreasing the incidence of arterial denudation. Fragmented thrombus will be collected in a bag attached to the suction device (9).

Complications in PCBT include arrhythmia, particularly, bradycardia, tricuspid regurgitation, mechanical hemolysis, fluid overload, and bleeding due to anticoagulation. Moreover, injury to the structures including ventricular perforation and denudation of the intimate layer was more likely to occur if catheter sizes are big (10 French (F) or more). Reducing the procedure time and using short, intermittent pulsation in addition to using smaller catheters can reduce this risk (1,2,10). In our case, the patient had a transient hemoglobinuria due to clot fragmentation.

Our patient had massive PE with thrombus within the main trunk, right and left main branches, ascending and descending as well as the tertiary branches of pulmonary arteries. He was classified as grade 4 PE since more than 50% of pulmonary arteries were thrombosed (11). ECG showed prominent R wave at lead V1, representing pulmonary hypertension due to PE with contribution from VSD. At the time of diagnosis, the patient had hypotension with shock index > 1. However, the signs of cardiogenic shock did not progress further partially since the diagnosis was made early, and the treatment was initiated instantly before outbreak of the more severe symptoms. He showed immediate clinical improvement after thrombectomy with good response to the treatment.

There were many small studies, which showed success with PCBT with or without localized thrombolytics with minimal complication and good efficacy (1,12,13). One common thing that these studies shared was that PCBT was a treatment option only when systemic thrombolysis was contraindicated. With more studies coming up, PCBT should be considered as the first-line treatment for massive PE as it can provide both mechanical and pharmacological treatment. It is a focused therapy that is minimally invasive with minimal complication.

Conclusion

As illustrated in this case, thrombectomy can become an alternative treatment for massive PE with relatively good clinical outcome when there is contraindication for systemic fibrinolytics. Interventional radiologists or endovascular specialists who are experts in operating thrombectomy devices should be the ones who perform catheter-based interventions in PE with the help of cardiopulmonary anaesthetists.

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Conflict of interest

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Authors' Contribution

Conception and design, analysis and interpretation of the data, drafting of the article, and collection and assembly of data: DVN
Critical revision of the article for important intellectual content: YY, SM, ZM

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