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Case Report

Percutaneous Mechanical Thrombectomy of Submassive Pulmonary Embolism and Extensive Deep Venous Thrombosis for Early Thrombus Removal

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Traditional treatment with anticoagulation in nonfatal submassive pulmonary embolism can result in serious sequelae of chronic thromboembolic pulmonary hypertension or poor exercise tolerance, and functional impairment. To prevent long-term complications in previously healthy young patients, other treatment options to actively resolve existing thrombi should be considered. Despite recommendations for use in only severe clinical presentations, endovascular interventional techniques could serve as suitable treatment options for such patients. Here we report the case of a previously healthy 23-year-old female with submassive pulmonary embolism and extensive deep vein thrombosis in the inferior vena cava down to the right popliteal vein. The patient was initially treated with catheter-directed thrombolysis. However, she continued to show extensive venous thrombosis and pulmonary embolism. Percutaneous thrombectomy and aspiration using an AngioJet successfully removed the main pulmonary artery embolism and venous thrombus. The patient's recovery was uneventful, and 3-month follow-up showed no signs of recurrence or discomfort.

Key Words: Pulmonary embolism, Deep vein thrombosis, Mechanical thrombolysis, Thrombolytic therapy

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INTRODUCTION

Recent studies have shown that up to 41% of previously healthy patients who developed acute submassive pulmonary embolism (PE) displayed poor exercise tolerance and self-reported functional impairment [1-7]. Furthermore, unresolved PE leads to chronic thromboembolic pulmonary hypertension (CTEPH) in approximately 3% of patients, who are at higher risk of recurrent venous thromboembolism (VTE), which is often fatal with severe cardiopulmonary impairment [3-8]. These long-term complications of acute PE, also called "post-PE syndrome," are becoming increasingly recognized. Persistent perfusion defects due to unresolved thrombi are among its main determinants. Despite anticoagulant therapy, long-term resolution is achieved in an estimated 70% to 85% of all patients [6]. The availability of various new catheter-based approaches for the treatment of acute PE has opened a vast field of research to improve both short- and long-term outcomes in such patients [9]. The percutaneous rheolytic thrombectomy device (AngioJet system; Boston Scientific, Marlborough, MA, USA) combines the advantages and benefits of the clot fragmentation technique and catheter-directed thrombolysis (CDT), allowing for the rapid dissolution and removal of

large emboli [10,11]. The case report was approved by the Institutional Review Board of the Seoul National University Hospital (IRB no. 2102-107-1197).

CASE

A previously healthy 23-year-old female presented with right lower limb swelling for one day. One month prior, she was mildly injured with contusions to the face and both lower limbs as a passenger in a traffic accident. Physical examination showed a markedly increased diameter of the right versus left lower limb. Initial vital signs revealed an increased heart rate of 113 beats/min and fever up to 38.6°C but normotension. Laboratory tests showed elevated D-dimer level and slightly increased levels of cardiac biomarkers. Bedside echocardiography revealed no cardiac abnormalities. Details of the patient's initial clinical characteristics are summarized in Table 1.

Computed tomography angiography (CTA) of the lower limb and chest showed extensive DVT in the inferior vena cava (IVC) and right iliofemoral to popliteal veins as well as a submassive PE involving the right main and left lower segmental pulmonary arteries (Fig. 1).

Anticoagulation treatment was initiated consisting of subcutaneous enoxaparin 1 mg/kg twice daily. Considering the patient's young age and acute presentation, a strategy of early thrombus removal was preferred. After the insertion of an infrarenal IVC filter (Celect; Cook Medical, Bloomington, IA, USA), CDT with recombinant tissue plasminogen activator (Actilyse; Boehringer Ingelheim, Ingelheim, Germany) was performed via the right popliteal vein at an infusion dose of 0.8 mg/h for 21 hours. Follow-up 24-hour venography showed a remnant thrombus, and pharmacomechanical thrombectomy (PMT) using an AngioJet was performed from the IVC down to the femoral vein. Balloon angioplasty was performed with a Mustang (Boston Scientific) 10 mm×60 mm to the right common iliac vein (Fig. 2). Anticoagulation was changed to rivaroxaban 15 mg twice daily for 3 weeks.

Follow-up CTA performed 5 days after PMT showed a reduced burden of DVT but no change in PE extent. After discussion with experienced radiologists and sufficient informed consent was provided by the patient, aspiration and PMT of the PE using an AngioJet was performed and

Table 1. Initial clinical characteristics and test results

Characteristic	Patient	Reference value
Patient characteristic		
Weight (kg)	55.2	
Height (cm)	158	
Body mass index (kg/m^2)	22.1	
Vital sign		
Blood pressure systolic/diastolic (mmHg)	140/88	
Pulse rate (beat/min)	113	
Respiratory rate (breath/min)	16	
Body temperature (°C)	38.6	
Oxygen saturation SpO2 (%)	99	
Bedside echocardiography		
Left ventricular ejection fraction (%)	65-70	
Right ventricle dilatation	None	
Blood test		
White blood cell (μL)	15,630	4,000-10,000
Hemoglobin (g/dL)	12.8	12-16
Platelet count (μL)	197,000	130,000-400,000
C-reactive protein (mg/dL)	14.73	0-0.5
D-dimer (μg/mL)	35.47	0.04-0.49
Cardiac biomarker		
Creatinine kinase (IU/L)	31	20-270
Creatinine kinase-MB (ng/mL)	1.1	0-6.6
Troponin-I (ng/mL)	0.03	0-0.028
Brain natriuretic peptide (pg/mL)	123	0-100

resulted in successful recanalization of the main pulmonary arteries (Fig. 3). The patient's vital signs were continuously monitored during the procedure and in the intensive care unit for 24 hours. No adverse events such as bradycardia, arrhythmia, hypotension, renal impairment, hemoptysis, or signs of hemorrhage occurred. The swelling improved dramatically, and the patient was discharged on hospitalization day 7 on rivaroxaban with class II compression stockings. Follow-up after 3 months on rivaroxaban showed no signs of recurrence or discomfort.

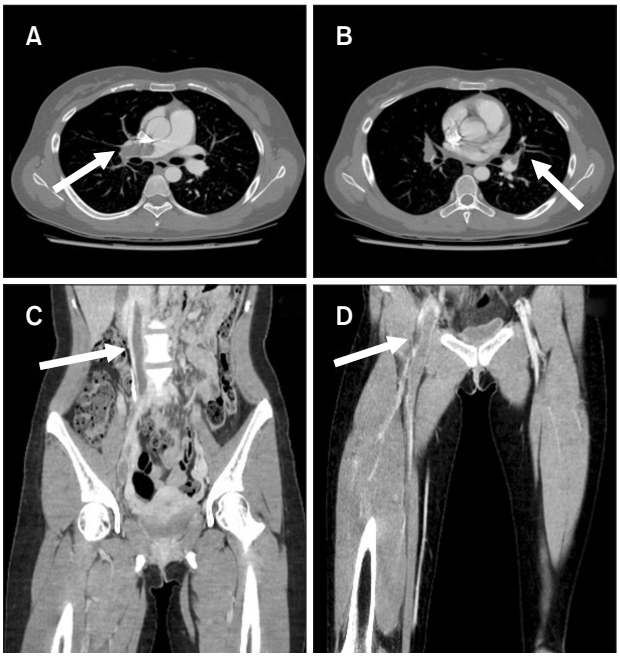

Fig. 1. Initial computed tomography angiography showed right main pulmonary artery thromboembolism (A), left lower lobe segmental artery pulmonary thromboembolism (B), inferior vena cava thrombus (C), and extensive deep vein thrombosis in right common iliac to popliteal vein (D).

DISCUSSION

Thrombus resolution in cases of PE with traditional treatment consisting of systemic heparinization followed by oral anticoagulation is initially trifling, and long-term resolution remains under debate [5,6]. Resolution was as low as 10% after 24 hours of treatment versus 50% at 2 to 4 weeks post-treatment. At 6 to 12 months after the initial diagnosis, 25% to 30% of patients showed only partial resolution [3,5,6,8]. After 3 months of treatment, the thrombus resolution reached a plateau phase and only very small improvements were seen thereafter, suggesting the occurrence of remodeling in the remaining clots to form permanent fibrous scars [3,5]. The resulting long-term complications consist of chronic functional limitations and a decreased quality of life [6].

CTEPH is the most severe form of post-PE syndrome, and its prognosis is poor in untreated patients [1,6]. Due to its nonspecific initial symptoms of dyspnea on exertion and fatigue, its diagnosis is often delayed. On delayed final diagnosis, most patients show severe functional impairment matching a New York Heart Association (NYHA) heart failure classification of III or IV [1,6-8]. The incidence of CTEPH after acute PE in patients without other major comorbidities is approximately 3% [8]. However, the rate of less severe manifestations of post-PE syndrome is much higher. The results of the prospective Evaluation of Long-term Outcomes after Pulmonary Embolism (ELOPE) study demonstrated that almost half of acute PE patients have exercise limitations, a limited walking distance, and dyspnea at 1 year that adversely influence their quality of life [2]. In one prospective study of previously healthy patients with acute PE, 48% had a NYHA classification of II or higher that lasted over a 3-year follow-up period [6,7]. Therefore, the goal of treatment in acute PE should also include reducing and preventing long-term sequelae.

Therefore, PMT is an attractive treatment option since

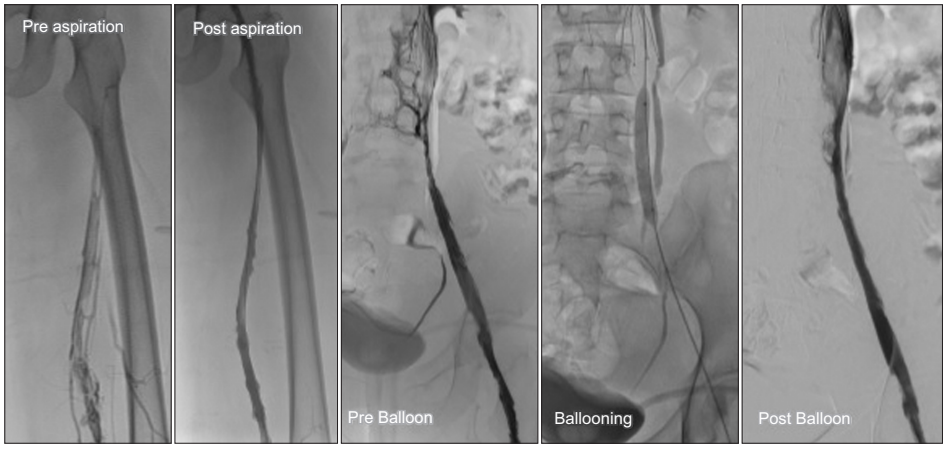

Fig. 2. In prone position, pharmacomechanical thrombectomy with AngioJet was performed via popliteal vein puncture, followed by balloon angioplasty with Mustang 10 mm×60 mm to right common iliac vein stenosis.

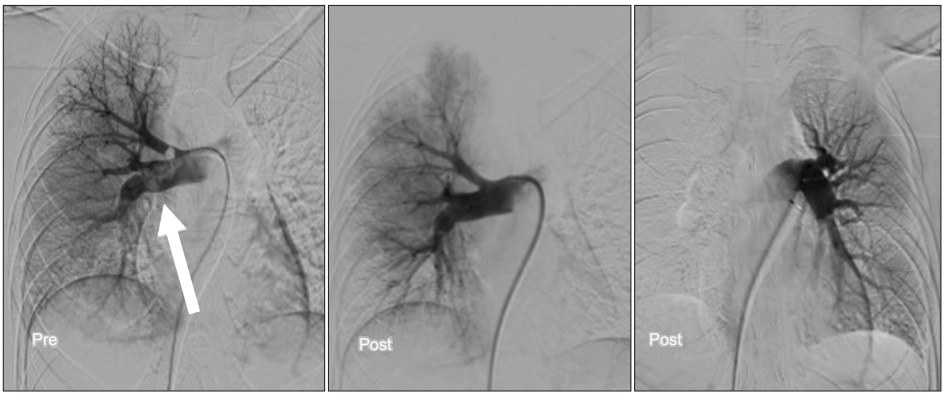

Fig. 3. Arteriography was initially undertaken through a 7-Fr sheath and a pigtail catheter was placed up to the main pulmonary vein. A large thrombus at the right main pulmonary artery (RPA) was checked and an 8Fr shuttle for aspiration thrombectomy was attempted followed by AngioJet Zealante for mechanical thrombectomy. Repeated aspiration and mechanical thrombectomy were undertaken and completion pulmonary arteriography showed that the RPA thrombus disappeared without distal embolism.

it limits the impact of thrombolytics and can extract central and peripheral emboli quickly and easily [10,12-14]. Although thrombus removal as a primary treatment for DVT was dropped from the American College of Chest Physicians guideline due to a lack of evidence of reducing post-thrombotic syndrome, the long-term results of PMT including those of the Catheter-directed Venous Thrombolysis (CaVenT) study now support PMT for patients with a high proximal DVT and low risk of bleeding, such as in this case [15]. In particular, in healthy young patients, rapid recovery and a return to daily activities is critical in improving the quality of life. In addition to prompt symptom relief, further aesthetic satisfaction may result in swelling improvements. However, caution should be exercised when preventing distal embolization in PMT, as PMT fragmentation can result in detrimental large emboli, particularly in cases of an extensive thrombus burden. In such cases, preventive IVC filter placement and CDT followed by adjunctive PMT can minimize complications and maximize treatment efficiency [14].

The AngioJet is a PMT system that removes large emboli by dissolution and fragmentation. In the management of PE, the reported AngioJet clinical success rate was 86.5% with a major complication rate of 2.4% and minor complication rate of 7.9% [12]. Conversely, a review by Kuo et al. [16] reported that specific catheter-related complications such as hemoptysis, pulmonary artery perforation, bradycardia, and hemoglobinuria were especially high with the AngioJet system [17]. Special care and technical considerations should be taken to prevent complications due to distal embolization. First, the "freshness" or duration of the thrombus occurrence is important. Thrombus organization and vessel wall remodeling occur as soon as 7 days and with time the thrombus becomes increasingly adherent to the vessel wall. Such a chronic thrombus requires a longer duration of treatment in the power pulse mode using larger amounts of thrombolytic agents. This is a known cause of bradycardia, hemoglobinuria, and hemoptysis with the AngioJet system [18]. Prior thrombolytic treatment, whether systemic or catheter-directed, can help alleviate the thrombus burden and enable easier dissolution. Second, as previously mentioned, filters or distal balloon placements can be used before the maceration process to mitigate the embolization. Compared to other PMT products, the AngioJet rheolytic system creates a Bernoulli effect that results in less distal embolization [19].

Furthermore, there is not yet sufficient data to prove the benefits of catheter-based approaches for the treatment of acute PE; thus, they are recommended for use in only high-risk or "massive" PE cases [10,20]. The present case, based on the American Heart Association classification, was a "submassive" PE due to the mildly elevated brain natriuretic peptide and troponin I levels and would not normally be recommended for such treatment. However, we decided to perform PMT because the patient was previously healthy, the right main pulmonary artery was occluded with a high risk of chronic functional impairment, and the risk of periprocedural complications was relatively low according to experienced interventionalists.

However, it must be noted that the prognostic stratification of PE in all major guideline committees is based on short-term mortality of patients with hypotension and right ventricular disease [9,20]. Chronic functional limitations and quality of life impairments were not considered. The lack of randomized trials, differences in clinical endpoints, and long-term follow-up data on the safety and efficacy of the routine use of PMT should not preclude its identification as an unsuitable treatment option. Clinical, radiological, and laboratory risks should also be used to drive the therapeutic

decision-making process [9]. With careful patient selection and technical attention to preventing distal embolization and iatrogenic injury, PMT with an AngioJet could result in better and early recovery of symptoms, especially in healthy young patients with extensive VTE. Therefore, we recommend that this procedure be performed in high-volume centers by experienced interventionalists and multidisciplinary teams to manage possible complications.

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CONFLICTS OF INTEREST

The authors have nothing to disclose.

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AUTHOR CONTRIBUTIONS

Concept and design: SKM. Analysis and interpretation: EAJ, KWC. Data collection: EAJ. Writing the article: EAJ, SKM. Critical revision of the article: AH, SA, SM. Final approval of the article: all authors. Statistical analysis: none. Obtained funding: none. Overall responsibility: SKM.

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