Use of Rheolytic Thrombectomy in Treatment of Acute Massive Pulmonary Embolism

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PURPOSE: The 6-F Xpeedior (AngioJet; Possis Medical, Minneapolis, MN) rheolytic thrombectomy catheter (RTC) uses high velocity saline jets for thrombus aspiration, maceration, and evacuation, through the Bernoulli principle. The purpose of this study was to evaluate the efficacy of thrombus removal using the RTC in patients with acute massive pulmonary embolism (PE).

MATERIALS AND METHODS: Seventeen patients (mean age, 51.7 + 16.6 years; range, 30–86 years; 9 men, 8 women) with massive PE initially diagnosed by computed tomography (CT) or VQ scan and confirmed by pulmonary angiography were treated with the RTC. All patients had acute onset of PE symptoms and all presented with hemodynamic compromise and dyspnea. Ten of 17 patients had enough residual thrombus to warrant adjuvant catheter directed thrombolytic infusion with reteplase. Six patients had contraindications to thrombolytic therapy. One patient presented with renal cell carcinoma and tumor embolus as suspected cause of PE. Angiographic and clinical outcomes during the hospital stay were evaluated.

RESULTS: The RTC was successfully delivered and operated via a 0.035-inch guide wire in all attempted cases. Treatment resulted in immediate angiographic improvement and initial relief of PE symptoms (improvement in dyspnea and oxygen saturation) in 16 of 17 patients. One patient developed heart block during the procedure, and further treatment with the RTC was discontinued. Bradycardia occurred in one patient (managed with lidocaine). After thrombectomy, 10 patients received adjunctive reteplase thrombolysis for treatment of residual thrombus, and 12 received inferior vena cava (IVC) filters. In the patient with renal cell carcinoma, histopathologic analysis of the evacuated material confirmed tumor origin of the embolism. There were two deaths, both within 24 hours of treatment and secondary to PE. One death occurred in a patient who had only minimal thrombus removal after treatment with the RTC and no thrombolysis. The remaining 15 patients showed continued improvement in PE symptoms and were eventually discharged from the hospital with mean length of stay 10.3 + 6.5 days (range, 5–30 days).

CONCLUSIONS: Rheolytic thrombectomy can be performed effectively in patients with massive PE. However, a large portion of the patients in this study underwent adjuvant overnight thrombolytic infusion. Further evaluation in a larger cohort of patients is warranted to assess whether this treatment may offer an alternative or complement to thrombolysis or surgical thrombectomy.

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Abbreviations: IVC = inferior vena cava, PE = pulmonary embolism, PMT = percutaneous mechanical thrombectomy, RTC = rheolytic thrombectomy catheter

PULMONARY embolism (PE) is a common disease process estimated to result in 150,000 deaths per year in the United States (1). Patients' symptoms range from completely asymptomatic to cardiogenic shock and sudden death (2). PE is difficult to diagnose with a 10% immediate mortality rate and a 30% mortality rate for those who survive initially (3).

Because of the high mortality rate, patients suspected of having PE should undergo further diagnostic testing. Patients with small pulmonary emboli usually receive systemic anticoagulation with unfractionated heparin or low-molecular-weight heparin. Patients with large or massive pulmonary embolism have traditionally been treated with intravenous thrombolytics, catheter-directed thrombolytic infusion, or surgical pulmonary embolectomy dependent on symptomatology (3).

Percutaneous mechanical thrombectomy (PMT) in the pulmonary arteries has been reported by various authors with a number of devices (3–7). The purpose of this study was to evaluate the efficacy of thrombus removal with use of the rheolytic thromb-
bectomy catheter (RTC) (Possis Medical, Minneapolis, MN) in patients with acute massive PE.

MATERIALS AND METHODS

Patient Population

Seventeen patients (mean age, 51.7 ± 16.6 years; range, 30–86 years; 9 men, 8 women) with massive PE were treated with the RTC.

Technique

Data were gathered in a retrospective manner on patients who underwent mechanical thrombectomy in the pulmonary arteries with the RTC. PE was diagnosed by computed tomography (CT) or ventilation/perfusion scintigraphy initially and confirmed by pulmonary angiography. Informed consent was obtained from all patients. Before the procedure, all patients underwent 12 lead electrocardiography sessions. Six patients had contraindications to thrombolytic therapy. Of the six patients with contraindications to thrombolytic therapy, four had recent surgery (<14 days), one had recent intracranial hemorrhage, and one had significant preprocedure hemoptysis. One patient was transferred from the operating suite with suspected renal cell carcinoma and tumor embolus as the suspected cause of PE. Angiographic and clinical outcomes during the hospital stay were evaluated. Follow-up phone calls were made.

The technique for pulmonary angiography was placement of a 6-F sheath in the right common femoral vein with use of sonographic guidance. In one patient the procedure was performed through the right internal jugular vein because of body habitus. A 5-F pigtail catheter was used to select each main pulmonary artery and nonionic contrast material (iodixanol, 320 mgI/mL; Nycomed, Princeton, NJ) was injected. Pulmonary arterial pressures were measured before contrast material injection and at the termination of the procedure. Preprocedure and postprocedure pressure data were not included because the data were incomplete.

The pigtail catheter was removed and an 8-F, 65- or 80-cm sheath (Super Arrow Flex; Arrow International, Read-
to resolve resting dyspnea. This patient did not receive thrombolytic infusion because of contraindications, but an IVC filter was placed. The patient was discharged to home 11 days later.

Bradycardia occurred in one patient but improved with administration of a 100 mg bolus of lidocaine.

There were two deaths, both within 24 hours of treatment and secondary to PE. One death occurred in a patient that had only minimal thrombus removal after treatment with the RTC. The patient had a 30-second episode of apnea during PMT and the procedure was stopped. An IVC filter was placed. No thrombolytics were administered because of contraindications. The patient was systemically anticoagulated with heparin. The patient died 24 hours later of hypotension and cardiac arrest.

The second death occurred during PMT. During rheolytic thrombectomy the patient developed hemoptysis. The patient then developed apnea and
bradycardia. Attempts were made for resuscitation (full advanced cardiac life support protocols), which were unsuccessful.

Follow-up

The mean follow-up time is 18.7 ± 6.85 months (range, 5–29 months) from RTC treatment. Of the 15 patients surviving the first 24 hours, all are alive, except two who were lost to follow-up. Nine patients remain on Coumadin. Eight out of 13 patients are asymptomatic regarding dyspnea. Four patients complain of dyspnea on exertion and one patient requires home oxygen therapy. All patients who remain symptomatic had comorbidities including chronic obstructive pulmonary disease, congestive heart failure, morbid obesity, and asthma. The patient requiring home oxygen therapy had been diagnosed with chronic obstructive pulmonary disease, chronic aortic dissection, and congestive heart failure with pleural effusions before presenting with PE.

DISCUSSION

This study evaluated the results of PMT with the rheolytic thrombectomy catheter in the pulmonary arteries. The Angiojet Xpeedior catheter (Possis Medical) is well suited to perform PMT in this anatomical location. This catheter allows passage via a 0.035-inch guidewire. The guidewire facilitates directing the catheter into branches but having the guidewire in place can decrease its effectiveness because of reduction in the size of the return lumen.

Overall, 15 of 17 patients (88%) recovered from massive PE and were discharged with a mean length of stay of 10.3 days. This compares well to a 10% initial mortality and a 30% mortality rate of those who survive PE initially (3). Because of the high mortality rate, patients suspected of PE should be screened as rapidly as possible by either ventilation/perfusion scintigraphy or CT. Patients with large pulmonary emboli should undergo confirmation and evaluation with pulmonary arteriography (the gold standard). If arteriography establishes that PE is present, the number of occluded segments should be determined.

Massive PE is equivalent to obstruction of two or more lobar arteries as defined by the Urokinase Pulmonary Embolism Trial (9). Patients with occlusion or obstruction of two or more lobar segments should be treated aggressively. Patients with contraindications to thrombolysis can benefit from PMT. Patients with no contraindications to thrombolysis should undergo thrombolytic infusion. However, patients with significant symptoms may benefit from initial PMT followed by thrombolytic infusion. Initial treatment with PMT not only eases patient’s symptoms more rapidly by aspiration of some thrombus, and fragmentation and clearing of central thrombus, but also increases surface area making thrombolytic infusion more successful (3). Because the surface area of the pulmonary capillary bed is many times greater than the central surface area, fragmentation of the central thrombus is quite effective. Although the AngioJet device is more effective in complete removal of thrombus in peripheral vessels, it does remove and fragment very effectively in the central pulmonary arteries.

Disadvantages of the AngioJet include the cost of the pump-drive set, the risk of fluid overload, complications from hemolysis, and reported bradyarrhythmias (8). Although fluid overload is a risk the AngioJet system, this device results in less net fluid infusion than other PMT systems that are driven by fluid infusion. Although the patients in this study did have hemoglobinuria after PMT with the AngioJet catheter, no significant complications developed as a result.

In one patient with renal cell carcinoma with IVF invasion, tumor embolus was removed from the pulmonary artery. The patient was undergoing nephrectomy when hypoxemia developed. After PMT with the RTC, cyto logic analysis of the aspirated material clearly demonstrated tumor cells. The patient was alive and asymptomatic at 24 months follow-up.

Two patients developed significant bradyarrhythmias during the procedure. These arrhythmias have been described by a number of authors (10–13). Interestingly, these arrhythmias occur not only during central cardio pulmonary interventions but also in peripheral arterial use including PMT in a transjugular intrahepatic portosystemic shunt (13). Initially the cause of these arrhythmias was thought to be related to hemolysis and liberation of adenosine (13). However, other PMT devices result in hemolysis and these bradyarrhythmias have not been reported in the use of those devices. In the authors’ experience it is common for patients to develop mild decrease in heart rates during PMT with the AngioJet (Possis Medical). These arrhythmias may be related to vibrations created by the drive unit because the patients’ heart rates appear to return to baseline while the drive unit is off. No studies have been performed evaluating the AngioJet device (Possis Medical) and its link to arrhythmias.

In the two patients in this study, the first patient developed third degree block and the procedure was discontinued. The patient’s PE symptoms were relieved by PMT and the patient remains asymptomatic. The second patient developed sinus bradycardia during the procedure that seemed to improve after the administration of a 100 mg bolus of lidocaine (Abbott Laboratories, Abbott Park, IL) intravenously.

This study reported two deaths related to PE. One death occurred in a patient that had only minimal thrombus removal after treatment with the RTC. The patient had a history of recent intracranial hemorrhage and presented with dyspnea and hypoxemia. CT demonstrated a large right lower lobe infiltrate (pulmonary infarction?) and a large right PE. The patient had a 30-second episode of apnea during PMT and spontaneously recovered. The procedure was terminated and the patient was systemically anticoagulated. This patient most likely died from and inability to tolerate adequate treatment for her massive PE.

The second patient had massive bilateral pulmonary emboli diagnosed by CT. During PMT the patient developed hemoptysis and subsequent apnea and bradycardia. Hemoptysis is not an uncommon occurrence after PE especially massive PE (4). It is unclear whether this patient’s death was caused by disease or the procedure itself. It is possible for the RTC to rupture a pulmonary artery branch; however, no extravasation was noted during the procedure.

This study was limited by a small retrospective case series. This study suggests that percutaneous mecha-
cal thrombectomy in the pulmonary arteries with the AngioJet Xpeedior system (Possis Medical) may be of benefit in patients with massive PE. This system is effective in both patients with contraindications to thrombolysis and as an adjuvant therapy in patients receiving thrombolytic infusion. However, a large portion of the patients in this study underwent adjuvant overnight thrombolytic infusion. Further evaluation in a larger cohort of patients is warranted to assess whether this treatment may offer an alternative or complement to thrombolysis or surgical thrombectomy.

References