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SHORT COMMUNICATION

Initial experience of pulmonary embolism response team with percutaneous embolectomy in intermediate–high- and high-risk acute pulmonary embolism

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INTRODUCTION

Shock or persistent hypotension affects 5% of patients with pulmonary embolism (PE) and identifies a high-risk group with PE-related mortality exceeding 15% [1, 2]. Primary reperfusion, particularly systemic thrombolysis, is the treatment of choice. Due to high bleeding risk, active malignancies, or multiple medical comorbidities, only a minority of unstable patients undergo thrombolysis [2, 3]. Up till now, when this treatment was contraindicated or unsuccessful, a surgical embolectomy has been recommended. Unfortunately, due to its limited immediate availability, surgical embolectomy can only be performed in selected high-risk patients. Significant progress in interventional cardiology has made percutaneous catheter-directed thrombectomy (CDT) an alternative to surgical embolectomy [4–15]. CDT of PE may encompass mechanical or ultrasound-assisted clot fragmentation, aspiration, and local low-dose fibrinolytic injection [1, 7–10, 13]. CDT was proposed as an integrated part of the treatment offered by a pulmonary embolism response team (PERT) [1, 11, 12]. According to our data, due to high prevalence of absolute contraindications, only approximately 40% of haemodynamically unstable patients received thrombolysis therapy [3]. In May 2015, we established a local PERT with CDT capabilities for urgent invasive therapy of intermediate–high- or high-risk PE in patients with high bleeding risk or those after unsuccessful thrombolysis. We report our initial experience of a single-centre PERT in the treatment of intermediate–high- or high-risk PE with rheolytic percutaneous embolectomy.

METHODS

Our PERT consists of an interventional cardiologist, intensivist, radiologist, and a clinical cardiologist with experience in echocardiography and vascular ultrasound. The PERT is called to high-risk PE patients with absolute contraindications to thrombolysis or those after an unsuccessful primary/rescue thrombolysis, as well as to intermediate–high-risk PE patients who fail to respond to parenteral anticoagulation. CDT is performed in a cardiac catheterisation laboratory under unfractionated heparin administration (a bolus of 70 IU/kg followed by intravenous infusion adjusted to the activated partial thromboplastin time (aPTT) [1]. After exclusion of proximal lower limb venous thrombosis with bedside ultrasound, selective pulmonary angiography is performed with a 5 F or 6 F angled pigtail catheter via a femoral or jugular vein approach. An 8 F 55- or 90-cm guiding catheter is inserted into the pulmonary artery and an AngioJet percutaneous thrombectomy system (Medrad Inc., Warrendale, PA, USA) is advanced into the proximal pulmonary artery beyond the thrombus. Individual catheter activation times are limited to 20 s, and the system is stopped if clinical bradycardia or dyspnoea occurs. The total AngioJet activation time is limited to 3 min for treatment of unilateral PE and 4 min for bilateral PE. Rheolytic thrombectomy is stopped either when haemodynamic stabilisation occurs or when the maximal activation time is reached. Following CDT all patients are transferred to the coronary care unit with continuous unfractionated heparin infusion adjusted to the aPTT [1].

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Table 1. Clinical characteristics, procedural and follow-up data of catheter-directed thrombectomy (CDT) patients

Patient number, sex, age [years]	Clinical characteristics	Risk of PE	Initial IV treatment	Indications for CDT treatment	AngioJet		Follow-up
1. M, 45	Haematuria, recurrence of urinary bladder cancer, cardiogenic shock	High-risk PE	Vasopressors, UFH, rtPA 30 mg (IV) — as initial treatment	Unsuccessful thrombolysis	Rescue CDT: Unilateral	CDT: 120 s, 500 mL, rtPA 10 mg Mild dyspnoea and transient bradycardia during CDT Potassium level (K^+) — before CDT/after CDT: 4.5–6.5–3.8 Creatinine level (mg/dL) — before CDT/after CDT: 1.0–2.5–0.7	Discharged 30 days after CDT
2. M, 66	Cardiac arrest, intubation, prolonged CPR (2 h), severe acidosis (pH 6.8)	High-risk PE	rtPA 100 mg (IV) — as initial treatment UFH, vasopressors	Unsuccessful thrombolysis	Rescue CDT: Bilateral during CPR	CDT: 91 s, 380 mL Potassium level (K^+): max: 4.8 Creatinine level (mg/dL): 1.47 (on admission)	Transient haemodynamic stabilisation PEA, death 10 h later
3. F, 73	Cardiogenic shock on second day after elective hip replacement	High-risk PE	UFH, vasopressors	Absolute contraindications to thrombolysis	Primary CDT: Bilateral	CDT: 219 s, 170 mL Potassium level (K^+): 4.7–5.3 Creatinine level (mg/dL): 1.47–2.42–4.34–2.70–1.4	AKI requiring transient renal replacement therapy Discharged 47 days after CDT
4. F, 66	Syncope with cardiogenic shock second day after elective knee surgery	High-risk PE	UFH, vasopressors	Absolute contraindications to thrombolysis	Primary CDT: Bilateral + 20 mg rtPA	CDT: 112 s, 200 mL Mild dyspnoea during CDT requiring 0.5 mg of midazolam Potassium level (K^+): 4.0–4.3–4.6 Creatinine level (mg/dL): 1.26–0.64	Discharged seven days after CDT
5. F, 59	Diagnosed with urogenital cancer, cardiogenic shock, massive bilateral PE, and pericardial effusion on CT (tamponade on admission to our department), severe acidosis (pH 6.8)	High-risk PE	UFH, vasopressors IV, pericardiocentesis immediately followed by CDT	Absolute contraindications to thrombolysis	Primary CDT: Bilateral + balloon angioplasty with peripheral catheter 6.0 × 40 mm	CDT: 100 s, 250 mL Potassium level (K^+): 6.0 (on admission — before CDT) Creatinine level (mg/dL): 1.4 before CDT , no data after CDT	Transient haemodynamic stabilisation PEA, death 1 h after CDT

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Table 1. (cont.). Clinical characteristics, procedural and follow-up data of catheter-directed thrombectomy (CDT) patients

Patient number, sex, age [years]	Clinical characteristics	Risk of PE	Initial IV treatment	Indications for CDT treatment	AngioJet		Follow-up
6. F, 71	Initially intermediate–high-risk PE, unsuccessful thrombolysis due to progressive deterioration	Intermediate–high-risk PE	LMWH, vasopressors, and 50 mg rtPA followed by CDT	Unsuccessful thrombolysis	Rescue CDT: unilateral + balloon angioplasty with coronary and peripheral catheter 5.0 × 20 mm/7.0 × 30 mm	CDT: 60 s, 250 mL Dyspnoea and dizziness during CDT Potassium level (K^+): max: 4.7–5.7–4.3 Creatinine level (mg/dL): 1.08–0.67	Stabilisation Discharged 23 days after CDT
7. M, 43	Initially intermediate–high-risk PE with progressive deterioration	Intermediate–high-risk PE	LMWH, vasopressors followed by CDT	Absolute contraindications to thrombolysis	Primary CDT: Unilateral + balloon angioplasty with peripheral catheter 6.0 × 20 mm	CDT: 141 s, 200 mL Dyspnoea during CDT Potassium level (K^+): 4.5–4.0–4.1 Creatinine level (mg/dL): 0.93–0.79	Stabilisation Discharged to tertiary hospital eight days after CDT

AKI — acute kidney injury; CDT — catheter-directed thrombectomy; CPR — cardiopulmonary resuscitation; CT — computed tomography; F — female; IV — intravenous; LMWH — low-molecular-weight heparin; M — male; PE — pulmonary embolism; PEA — pulseless electrical activity; rtPA — recombinant tissue plasminogen activator; UFH — unfractionated heparin

RESULTS AND DISCUSSION

Between May 2015 and March 2018, 291 patients with PE were admitted to our department, of whom 193 were diagnosed with intermediate-risk PE (120 patients classified as intermediate–high-risk and 73 as intermediate–low-risk) and 15 with high-risk PE. Thrombolysis was performed in 16 patients and CDT in seven patients (Table 1). Haemodynamic data before and after CTD are presented in **Supplemental Table 2 (see journal website)**. An example of a CDT intervention is presented in **Supplemental Figure 1 (see journal website)**. Despite ongoing significant improvement in the management of PE, morality rate in the high-risk group still remains unacceptably high. Haemodynamic instability affects 5% to 10% of all PE cases and is a strong indication for urgent revascularisation [1–3]. Systemic thrombolysis is preferred, while surgical embolectomy is recommended when thrombolysis is contraindicated or has failed. Percutaneous embolectomy has become a treatment option for patients with high-risk PE [1]. There are several catheter intervention techniques, including thrombus fragmentation, suction thrombectomy, rheolytic thrombectomy, conventional CTD, and ultrasound-assisted catheter-directed low-dose thrombolysis. There is no single, generally accepted technique for CTD in high-risk patients.

We report seven haemodynamically unstable patients treated with the AngioJet system, which generates a high-pressure saline jet with a pressure gradient calculated by Bernoulli's principle, enabling the removal of thrombus fragments. The AngioJet system has received the United States Food and Drug Administration (FDA) approval and the Conformité Européenne (CE) mark for treatment of proximal deep vein thrombosis, as well as the CE mark for PE treatment. Transient release of bradykinin, adenosine, or potassium secondary to haemolysis may lead to dyspnoea, bradycardia, or even heart block. In some cases, haemoglobinuria with acute kidney injury was reported, which resulted in a FDA black-box warning for the use of AngioJet in PE [14, 15]. Importantly, technical improvements of the AngioJet system and shortening of its activation time prevented these complications [15]. Four of our subjects had contraindications to thrombolysis: recent major surgery, multiorgan injury, or cardiac tamponade, while in the remaining three patients systemic thrombolysis failed. Five of seven urgently treated patients with high-risk PE survived and were discharged in good general condition. Two patients died despite transient haemodynamic improvement. We think that irreversible cardiogenic shock and multisystem organ failure due to prolonged cardiopulmonary resuscitation and long-lasting systemic hypoperfusion caused multiorgan failure with severe life-threatening acidosis (pH < 6.9), which led to a fatal outcome despite haemodynamic improvement. Importantly, we observed only one major complication in survivors. An elderly woman, due to contrast media nephropathy and probably haemolysis during CDT, experienced acute kidney injury requiring transient renal replacement

therapy. However, several months earlier she had developed contrast-induced nephropathy (with an estimated glomerular filtration rate nadir of 20 mL/min) after an elective invasive vascular procedure. No significant hyperkalaemia was detected after CDT.

This is a case-based, observational study with a relatively small number of patients and interventions. Due to the lack of a department of cardiac surgery in our institution and a very limited immediate availability of surgical embolectomy, our local PERT with CDT capabilities does not include a cardiac surgeon.

In conclusion, we are convinced that CDT is potentially lifesaving in patients with high-risk PE and contraindications to fibrinolysis as well as those after failed fibrinolysis. There is undoubtedly a need for further studies assessing the efficacy and safety of this technique in patients with PE.

Conflict of interest: *none declared*

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