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Case Report

Catheter-directed Thrombolysis for Severe Pulmonary Embolism in Pediatric Patients

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Background: Catheter-directed thrombolytic (CDT) therapies for severe pulmonary embolism (PE) have been shown to be effective and safe when compared with systemic thrombolysis in adults. Pediatric studies assessing efficacy and safety of CDT for PE are lacking. Hence, our aim was to review CDT as a therapy for pediatric PE.

Methods: We retrospectively reviewed charts of patients aged <18 years, who underwent CDT for main or major branch pulmonary artery occlusion associated with hypotension or right ventricular dysfunction secondary to PE during a 3-year period, in our tertiary care academic Pediatric Intensive Care Unit.

Results: Six CDT interventions were performed on 5 patients with PE (median age: 16.5 years). All patients presented with chest pain and dyspnea. The predisposing factors for thrombogenesis differed in all patients, and all had multiple risk factors. Five of six procedures (83%) were accompanied by ultrasound agitation with EKOS endowave infusion system (ultrasound-accelerated CDT [UCDT]), whereas 1 had CDT without ultrasound agitation. Complete resolution of PE occurred in 4 instances (67%) at 24 hr, whereas in 2 cases (33%), there was partial resolution. One patient with complete resolution underwent another successful UCDT after 4 months for recurrence. Clinical parameters (heart rate, respiratory rate, blood pressure, and oxygen saturations) and echocardiographic findings improved after treatment in all the patients. Median duration of hospital stay was 9 days with no mortality and treatment-related complications. All patients were discharged with long-term anticoagulation.

Conclusions: Our case series is the first that describes CDT/UCDT as an effective and safe therapy for pediatric patients with severe PE. CDT is known to accelerate fibrinolysis via focused delivery of thrombolytic agent to the thrombus site. For carefully selected patients, CDT/UCDT provides a useful treatment option for severe PE irrespective of the etiology, predisposing conditions, and associated comorbidities.

Pulmonary embolism (PE) in children is a potentially lethal condition and yet is a vastly understudied arena. Autopsy studies show a higher prevalence (0.7−4%) of PE compared with medical database registries (0.9 per 100,000 admissions) suggesting that this condition is often clinically underrecognized.[1,2] A more recent study from a tertiary emergency department in the United States

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estimates the incidence of new PE at 2.1 per 100,000 emergency room visits.[3] As a manifestation of venous thromboembolic disease, the incidence of pediatric PE continues to rise as successful management of previously untreatable malignancies, complex congenital cardiac conditions, and usage of central venous catheters increases.[4,5] Mortality of pediatric PE remains high at 10%, thus emphasizing the urgent need to appropriately diagnose and treat this condition.[6]

Validated clinical prediction scores[7,8] and risk stratification guidelines[9,10] exist for adult PE. The presence of hypotension or shock signifies massive PE, whereas occurrence of right ventricular strain or hypokinesis without hemodynamic instability is classified as submassive PE. Rapid diagnosis and severity categorization facilitate prompt initiation of optimal treatment strategy[11] that may include cardiorespiratory support, systemic anticoagulation, catheter-directed thrombolysis (CDT), systemic thrombolysis, and/or surgical embolectomy.[8,12]

Systemic thrombolysis and embolectomy are effective at thrombus resolution but are associated with significant hemorrhagic complications.[13] CDT therapies have been shown to be effective and safe when compared with systemic thrombolysis in adults.[14,15] Novel techniques such as ultrasound-accelerated CDT (UCDT) have been shown to achieve faster and more complete clot resolution with lesser complications than CDT alone in adults.[16] However, pediatric studies assessing efficacy and safety of CDT or UCDT for PE are lacking, and hence, exploring the potential of these modalities in pediatrics was the focus of our study.

We describe here a case series of critically ill pediatric patients treated with CDT or UCDT for PE at our institution.

MATERIALS AND METHODS

Setting

We conducted a retrospective study during a 3-year period (December 2009—December 2012) after approval from the Institutional Review Board of Baylor College of Medicine. In pediatric patients aged <18 years, treated at Texas Children's Hospital, Houston, TX with CDT or UCDT for submassive or massive PE, etiologic factors for PE and clinical parameters were reviewed.

Intervention

The indication for CDT was massive or submassive PE as defined by the presence of either hypotension or severe right ventricular (RV) dysfunction in the setting of complete occlusion of the main or major branch pulmonary arteries (PAs). RV function and strain were determined by preintervention echocardiography and electrocardiography. CDT was chosen as the treatment of choice after clinically evaluating risks and benefits in individual patients, comparing them with other therapies such as systemic thrombolysis and after discussing the same with the parents and patients. Each CDT intervention was performed with ultrasound-guided access of femoral vein through which a catheter (5F—7F) was placed in the affected PA. For bilateral PE, catheters were parked in the right and left main PAs, and for unilateral PE, the catheter was parked in the occluded main branch PA. Recombinant tissue plasminogen activator (tPA) was delivered at the thrombus site. UCDT involved ultrasonic pulses delivered by EKOS endowave system[17] along with targeted delivery of tPA. All patients received thrombolytic infusion of tPA (0.75—2 mg/hr per catheter port) with the catheters left in situ for 24 hr. One patient with recurrent PE received a tPA bolus of 10 mg before the start of the infusion. All cases received systemic anticoagulation via heparin infusion. Heparin bolus was administered before the infusion in 4 of the 6 cases. Heparin infusion was administered at 500 U/hr or 10 U/kg/hr during the period of thrombolysis with tPA. After tPA was discontinued, the heparin infusion was titrated to achieve anti-Xa level between 0.3 and 0.7 U/mL and activated partial thromboplastin time between 60 and 90 sec. Coagulation parameters and echocardiographic findings were assessed pre- and post-intervention in all patients. Evolution of PE was evaluated by angiography at 24 hr after intervention.

Definitions and Data Analysis

Complete resolution of PE was defined as no residual thrombus detected by angiography. Partial resolution was defined as resolution of main or major branch PA thrombi but presence of residual clots in peripheral PAs. Treatment-related complications encompassed local or systemic bleeding events and/or need for escalation of cardiorespiratory support. We compared pre- and post-treatment clinical and laboratory parameters for all cases. Clinical parameters were collected as median of values available pre- and post-treatment as median of values over a 24-hr period. The parameters were analyzed with descriptive statistics, paired *t* test, and Fisher's exact test as appropriate using STATA software (College Station, TX.).