

## Endovascular Treatment of Acute Pulmonary Embolism and Pulmonary Hypertension in Patients with Chronic Pulmonary Embolism

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### Abstract

**Purpose:** Purpose of the study is to show the effectiveness of the endovascular treatment of acute pulmonary embolism and pulmonary hypertension in patients with chronic pulmonary embolism.

**Material and Methods:** Our experience with supraselective fibrinolysis and thrombus fragmentation in patients with massive and submassive PE. We present the data for 41 patients, treated for the period 10.2013-06.2015: 24 men (59%) and 17 women (41%) with massive PE and submassive PE, with an average age-61 years (24-82).

**Results:** During the procedure in 18 patients (43%) pulmonary pressure decreased over 10%. After the procedure 32 patients (78%) showed clinical improvement (reduced shortness of breath, hemodynamic stability), echocardiography data showed - lower pulmonary pressure and improved RV, LV ratio.

**Conclusions:** The endovascular techniques for treating both acute and chronic PE are an effective and feasible option for treatment. They are becoming first line of treatment for acute PE in the centers with experienced endovascular teams. The advantages are the usage of very low doses of adjunctive thrombolytic therapy, low risk of bleeding and rapid hemodynamic improvement in patients with an acute thrombotic event, lifesaving procedure.

**Keywords:** Pulmonary embolism; Endovascular treatment; Pulmonary hypertension

**Definition:** Pulmonary embolism (PE) is an obstruction of the pulmonary artery or its branches by a blood clot, with full or partial blockage of blood flow.

### Introduction

Endovascular techniques (ET) for recanalization of complete and partial occlusions of the pulmonary trunk or major pulmonary arteries. ET are the method of choice or in fact a life-saving procedure by a certain group of patients with massive or submassive pulmonary embolism. They may be used as an alternative to thrombolysis when there are contraindications or in hospitals, where emergency surgical thrombectomy is unavailable or contraindicated. ET can be performed when systemic thrombolysis has failed to improve hemodynamics in the acute phase of PE. The hybrid technique that involves catheter based defragmentation and local thrombolysis is a new advanced strategy for effective treatment of patients with PE, assessed as high and intermediate risk. This technique is more widely used in endovascular centers with extensive experience in treatment of various vascular pathology.

### The objectives of catheter-based therapy include:

- Rapid reduction of pulmonary artery pressure,
- Reduction in pulmonary vascular resistance (PVR);
- Increasing systemic perfusion;

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- Facilitate recovery of RV.
- Reduction of the amount of the fibrinolytic agent (based upon supra selective catheter fibrinolysis applies 1/3 to 1/2 of the total systemic dose of fibrinolytic)

### History and development of endovascular treatment of PE and pulmonary hypertension due to PE

1969 was approved the first catheter for pulmonary thrombectomy (Greenfield -Boston Scientific/ MediTech; Watertown, MA).

The first case of endovascular treatment in patients with pulmonary hypertension due to chronic pulmonary thromboembolism and chronic obstruction of the pulmonary artery branches was described in 1988. from VOORBURG., *et al* [1].

In the meta-analysis for the endovascular treatment of acute PE of William T. Kuo., *et al.* [2] data for all the patients, that underwent this treatment from 1990. to 2008 was summarized. The first series of cases was described by Brady and Crake, 1991 [3].

### Basic techniques and devices for endovascular treatment of acute PE:

Trans catheter selective fibrinolysis with defragmentation:

After puncturing the cubital or femoral vein a catheter is placed through 5 Fr introducer in the pulmonary artery and defragmentation of the thrombus with selective fibrinolysis can be performed.

The advantages of this method are:

1. Can be performed in any Cath lab with a trained team;
2. Fast effect of treatment – patient’s condition rapidly improves;
3. Low doses of fibrinolytic agent, reducing the risk of bleeding;
4. The puncture is performed with a small size introducer (5 Fr), which further reduces the risk for complications of the puncture site.

As a disadvantage of the method is the risk of distal embolization especially when there is large non-obstructive thrombus in the main vessels. This complication can lead to clinical worsening of the patient during the procedure.



**Figure 1:** Catheter PigTail with side holes serving for the fragmentation of thrombus, Supraselective infusion fibrinolytic in cases of PE.

**II. Trans catheter aspiration thrombectomy:** Many devices are described in the literature designed for removing the fresh thrombus and thus restoring the blood flow in the vessel.

### **Devices**

**1. Greenfield catheter:** This device is the first catheter (1969), which is specifically invented for the treatment of massive PE. Removes centrally located fresh thrombus by manual suction with a large syringe. The device and thrombus as a whole were extracted, which required dissection of a vein.

**2. Amplatz thrombectomy device** is a 7 F catheter with a distal metal head and rotating shaft. It uses an impeller spinning at 150000 rpm to suck in the thrombus, fragment the clot into smaller pieces, and expel the pieces through the side-holes without aspirating them. The device cannot be advanced over a wire and the clinical experience is quite limited with case series reporting primarily angiographic improvements.

**3. Aspirex catheter:** Aspirex is 11F catheter thrombectomy device, which is specifically designed and developed for percutaneous interventional treatment of PE pulmonary artery with diameters from 6 to 14 mm.

**Rheolytic thrombectomy:** This device relies on the Bernoulli principle to generate a vacuum in the low-pressure zone behind a series of high-pressure saline jets positioned at the tip of the catheter. The saline jets disrupt the thrombus, which is then aspirated in the vacuum zone. A unique feature of this catheter allows forceful spraying of a thrombolytic agent and saline without simultaneous aspiration.

### **Complications**

Complications during endovascular treatment techniques in PE are rare, but serious. They include: death of deterioration of RV failure, distal embolization, perforation of the pulmonary artery, pulmonary haemorrhage, systemic bleeding complications, pericardial tamponade, bradycardia, contrast-induced nephropathy and complications in puncture area.

Balloon angioplasty with chronic pulmonary hypertension caused by obstruction of the branches of the pulmonary artery after recurrent pulmonary embolism.

Balloon angioplasty by chronic stenosis of the pulmonary artery causing pulmonary hypertension is a method of choice for patients who are contraindicated for thrombendarterectomy and in patients who are at high risk for surgery.

To summarize our experience with supra selective fibrinolysis and thrombus fragmentation in patients with massive and submassive PE, we present the data for 41 patients, treated in our clinic.

### **Clinical experience of Hospital, "CITY CLINIC"**

Between 10.2013 - 06.2015 - 41 patients with massive PE and submassive PE were successfully endovascular treated: 24 men (59%) and 17 women (41%).

The age of the patients varies: from - 24 years, to -82 years, average - 61 years.

### **Risk factors**

3 patients (7%) - with previous orthopedic intervention, 2 patients (11%) - taking oral contraceptives, 12 patients (29%) - smokers, 11 patients (26%) - with established diabetes mellitus, 5 patients (12%) - with history of stroke, 26 patients (63%) - with DVT, 7 patients (17%) - with a cancer disease, 3 patients (7%) - with known coronary pathology [4].

Massive PE, dyspnea, hypotension, tachycardia, echocardiography data RV dilatation and/or pulmonary hypertension, RV/LV size > 1, subtotal or total filling defects left or right main pulmonary artery detected by CT or conventional angiography-were found in 19 patients (46%).

Submassive PE shortness of breath, stable hemodynamic parameters, echocardiography data DK burden and or pulmonary hypertension and multiple filling defects of the pulmonary artery branches established by CT or conventional angiography- in 22 patients (54%). Elevated values of D-dimer in all patients, Pro- BNP in 27 patients, Troponin T in 15 patients.

Echocardiography evidence of increased pulmonary pressure within 40-60 mmHg- was revealed in 34 patients (66%), more than 70mmHg - in 8 patients (20%), the highest measured value -115mmHg in 1 patient (2%) [5].

In 60% of cases acute PE was diagnosed with CT angiography and confirmed by conventional pulmonary angiography.

All patients with proven PE - underwent percutaneous - catheter directed treatment with super selective thrombin fragmentation and fibrinolysis [6].

The purpose of the catheter intervention thrombin fragmentation is the destruction of the obstructive thrombus from the main pulmonary artery and to improve the early recovery of RV function, to stabilize the hemodynamic parameters and improve survival rates. This fragmented thrombus has considerably larger contact area, which increases the effect of fibrinolytic agents, leading to the restoration of blood flow in the pulmonary artery. The success of the therapy depends on the time factor, as the best results are achieved during the first days. After 14-21 days' thrombus is in the phase of organization, making it difficult to make a mechanical impact on it.

2 of the patients (5%) had access vena basilica dextra, 11patients (27%) - vena femoralis dextra and 28 patients (68%) - vena cubiti dextra. In all patients is used 5Fr introducer and 5 Fr pigtail catheter. A pulmonary angiography was performed with an average contrast dose - 20ml, using subtraction. Bilateral obstructions of the branches of the pulmonary artery was found in 35 patients (85%); 21 patients (51%) were with a subtotal filling defect of the two main branches of the pulmonary artery, in 10 patients (24%) were found multiple occlusive defects in the filling of segmental branches [7].

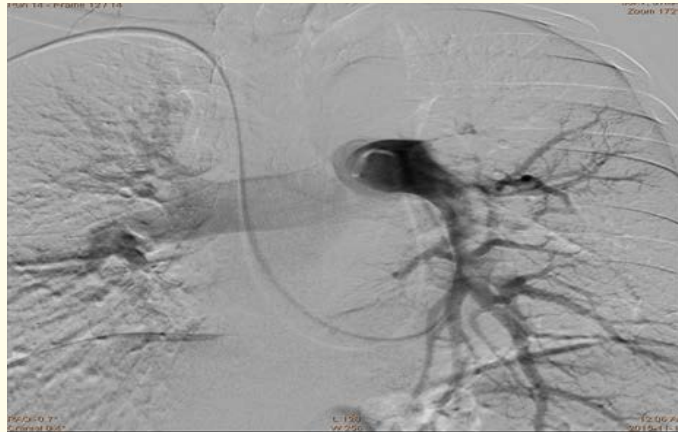
By rotational movement of the pigtail catheter thrombus fragmentation was done and locally was applied Actilyse 30 mg, followed by a two-hour infusion of 20 mg Actilyse. During the procedure in 18 patients (43%) was registered a decrease of pulmonary pressure by over 10%. After the procedure 32 patients (78%) showed clinical improvement (reduced shortness of breath, hemodynamic stability), echocardiography data showed - lower pulmonary pressure and improved RV / LV ratio.

In 9 patients (22%) with some comorbidity, age, presence of cancer, coronary and cerebral vascular disease, there was a longer recovery period and persistence of respiratory failure within hospitalization. No complications or bleeding were observed in these 41 patients.

All patients underwent parenteral and oral anticoagulation.



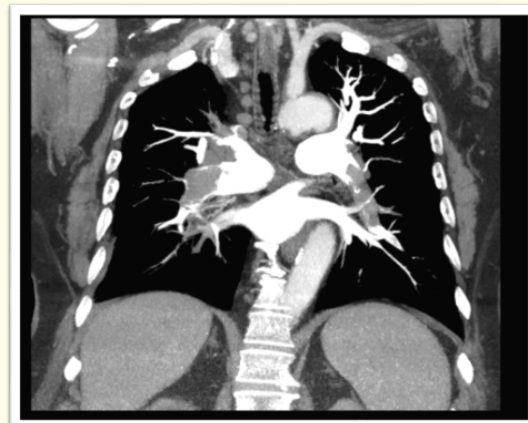
**Figure 2:** A high-thrombotic lesion in the right pulmonary artery.



**Figure 3:** Massive thrombus in the left pulmonary artery.



**Figure 4:** PTA of a.pulmonalis dextra, followed by supraselective application of Actilyse 10 mg. Registering very good immediate results.

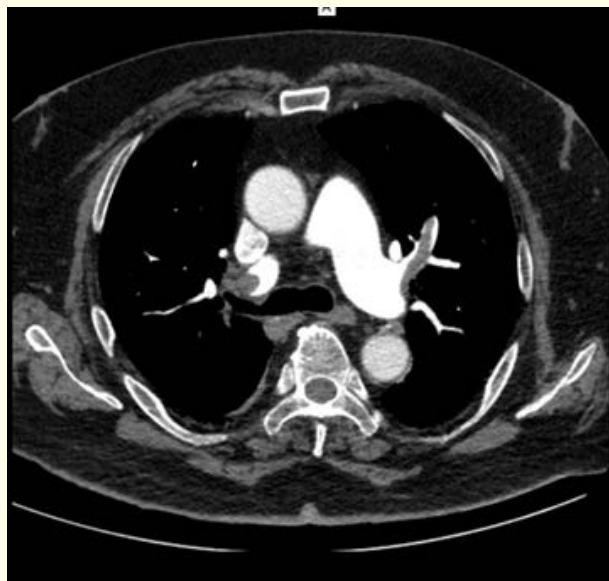


The endovascular techniques for treating both acute and chronic PE are a cheap and very effective option for treatment. They are becoming the first line of treatment for acute PE in the centers with experienced endovascular teams. The advantages are very low doses of adjunctive thrombolytic therapy low risk of bleeding, and the expectation of rapid hemodynamic improvement in patients with an acute thrombotic event/ lifesaving procedure [8].

CT coronary reconstruction shows overriding clot on the right pulmonary artery bifurcation and in the lumen of the right lung lower lob artery. Another thrombus is present in the left lung lower lob artery.



On the axial section is visible a mural thrombosis on the bifurcation and a thrombus with a free component in the lumen of the right pulmonary artery. There is also a mural thrombosis in the left upper lob artery [9].



Right pulmonary artery with mural thrombosis in the middle lob part. On the left side- clot in the lumen of the artery in a third segment.

### **Bibliography**

1. Voorburg JA, *et al.* "Balloon angioplasty in the treatment of pulmonary hypertension caused by pulmonary embolism". *Chest* 94.6 (1988): 1249-1253.
2. William T Kuo., *et al.* "Catheter-directed Therapy for the Treatment of Massive Pulmonary Embolism: Systematic Review and Meta-analysis of Modern Techniques". *Journal of Vascular and Interventional Radiology* 20.11 (2009): 1431-1440.
3. Brady AJB and Crake T. "Percutaneous catheter fragmentation and distal dispersion of proximal pulmonary embolus". *Lancet* 338.8776 (1991): 1186-1189.
4. Michael R Jaff., *et al.* "Management of Massive and Submassive Pulmonary Embolism, Iliofemoral Deep Vein Thrombosis, and Chronic Thromboembolic Pulmonary Hypertension". *Circulation* 123.16 (2011): 1788-1830.
5. Skaf E., *et al.* "Catheter-tip embolectomy in the management of acute massive pulmonary embolism". *American Journal of Cardiology* 99.3 (2007): 415-420.
6. Chechi T, *et al.* "Rheolytic thrombectomy in patients with massive and submassive acute pulmonary embolism". *Catheter Cardiovascular Intervention* 73.4 (2009): 506-513.
7. Kucher N and Goldhaber SZ. "Management of massive pulmonary embolism". *Circulation* 112 (2005): e28-e32.
8. Kucher N., *et al.* "Randomized controlled trial of ultrasound-assisted catheter-directed thrombolysis for acute intermediate-risk pulmonary embolism". *Circulation* 129.4 (2014): 479-486.
9. Kataoka M., *et al.* "Percutaneous transluminal pulmonary angioplasty for the treatment of chronic thromboembolic pulmonary hypertension". *Circular and Cardiovascular Intervention* 5.6 (2012): 756-762.

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