Catheter-Based Embolectomy for Acute Pulmonary Embolism

Devices, Technical Considerations, Risks, and Benefits

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KEYWORDS

• Pulmonary embolism • Pulmonary embolectomy • Catheter therapy • Catheter-directed therapy • Percutaneous intervention

KEY POINTS

- Percutaneous pulmonary embolectomy can be useful in high-risk patients with contraindication to thrombolytics, although data are limited.
- Understanding the anatomy and defining the location of pulmonary thrombi are key to a successful procedure.
- Given that all techniques are challenging and achieve at best a partial thrombus removal, more comparative outcomes and technological research are needed.

INTRODUCTION

The cornerstone for treatment of pulmonary embolism (PE) is anticoagulation. Other treatment modalities, like surgery, catheter therapy, or thrombolysis, remain controversial, especially in the absence of cardiogenic shock. With the recent rise in the use of catheter-based treatments for PE patients, interventionalists should become familiar with all available options and techniques.

This text reviews the general indications and principles of nonlytic catheter treatment of PE, reviews the available data, describes the general techniques of catheter placement in the pulmonary artery (PA) branches, and then describes specific catheters used in PE treatment.

INDICATIONS

Patients who are hemodynamically compromised (high-risk or massive PE) have a high mortality rate with anticoagulation alone and may benefit from a more advanced treatment modality. Although systemic thrombolysis is usually indicated for these patients, at least a third have some contraindication to systemic thrombolytics.[1] Moreover, up to 10% of patients who receive systemic thrombolysis remain in shock.[2] For these patients, surgical embolectomy should be considered. Surgical expertise is often limited, however, to selected centers and there can be high morbidity and mortality, especially in patients who have failed thrombolytics. As such, percutaneous pulmonary embolectomy is

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recommended for many high-risk PE patients with contraindications to thrombolysis and/or failure of thrombolysis if the expertise is available at the treatment facility (class IIa, level of evidence [LOE] C).[3,4]

A more controversial indication for catheter-based embolectomy is the presence of right heart strain without shock (intermediate-risk or submassive PE). A majority of these patients should continue to be treated with anticoagulation alone, and more advanced therapy (thrombolysis, catheter-based therapy, or surgery) should be reserved for those at the upper end of the risk spectrum and at low risk for complications from such therapies (class IIb, LOE C).[3,4] Patients with significant symptoms and persistent desaturation despite anticoagulation for a few days may also potentially benefit from invasive therapy that targets occlusive thrombi in main PA branches, although the proof for such benefit is currently anecdotal.[5]

In the appropriate clinical scenario, anatomic criteria must also be met when considering catheter therapy. Totally or subtotally occluded central, lobar, or interlobar branches should be the targets of therapy, rather than segmental branches.

For patients without a contraindication to thrombolysis, systemic or catheter-directed thrombolysis should be considered before catheter embolectomy given the higher LOE for the former compared with the latter.[6] In the presence of hemodynamic compromise or if a patient is at risk for worsening clinical status and in the presence of contraindication to thrombolysis, catheter-based embolectomy can be an attractive option, especially as an alternative to surgical embolectomy.

Given the lack of data and the absence of a standard approach to catheter embolectomy, selection of patients for such treatment is best undertaken after multidisciplinary discussions among specialists with expertise in PE treatment and in centers familiar with its techniques.[7]

CHALLENGES

All percutaneous PE treatment modalities face the following common challenges:

- Attempting to remove large, frequently organized thrombi with devices limited in size
- Difficult manipulation through large spaces that are often tortuous
- Thrombi frequently involving many branches that are difficult to visualize and navigate
- Risk of vascular complication both at the access site and the pulmonary bed in an anticoagulated patient
- Unclear endpoints to determine the completion of the procedure (PA pressure, right ventricular size, thrombus reduction, PA blood flow, clinical status, and so forth)
- Lack of scientific evidence: data behind percutaneous PE thrombectomy are limited to case reports or retrospective case series. As illustrated in a metanalysis by Kuo and colleagues[8] of available catheter-based PE treatment studies, clinical success was achieved in 86%, but there was significant heterogeneity in the definition of success, and most of the thrombectomy cases also included some form of catheter-directed thrombolytic therapy.
- No currently available device is able to remove the majority of the PE. The goal of treatment is usually to remove or macerate as much thrombi as possible to allow better pulmonary perfusion and hence hemodynamic stabilization or symptomatic improvement.
- None of the devices currently on the market is approved or cleared by the US Food and Drug Administration (FDA) for PE treatment.

TECHNICAL CONSIDERATIONS

Venous Access

Managing access is a prerequisite for a successful thrombectomy. Most complications of catheter treatment of PE are related to access site (injury or hematoma), especially when there is concomitant thrombolytic use, which is commonly performed in conjunction with catheter thrombectomy.[8] Access should be obtained under direct ultrasonographic guidance, which is also helpful in ruling out venous thrombi at the access site. Either jugular or femoral veins may be accessed for pulmonary thrombectomy, with differing advantages and disadvantages depending on the individual device used.

In femoral venous access, venous angiography is performed to ensure adequate venous size and absence of thrombi. In cases of the iliac vein appearing focally small/compressed (as in May-Thurner syndrome), it can still be frequently crossed by a large sheath safely, but care should be exerted not to push against resistance, and sheath advancement should be directly