Impact of reperfusion therapies on clot resolution and long-term outcomes in patients with pulmonary embolism: a retrospective observational study

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Research Article

Keywords: pulmonary embolism, pulmonary vascular obstruction, venous thromboembolism, chronic thromboembolic pulmonary hypertension, RV dysfunction; dyspnea

Posted Date: April 4th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-2734365/v1

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Abstract

**Background:** Major progress in reperfusion strategies has substantially improved the short-term outcomes of patients with pulmonary embolism (PE), however, up to 50% of patients report persistent dyspnea after acute PE. This study aims to evaluate the impact of reperfusion therapies on clot resolution and compare the long-term outcomes following acute PE in patients treated with reperfusion therapies to anticoagulation alone.

**Methods:** A retrospective study of the pulmonary embolism response team (PERT) registry at our institution between January 2017 and June 2021 and included patients with repeat imaging at 3 to 12 months. The primary outcome was to determine the incidence of residual pulmonary vascular obstruction (RPVO) following acute PE and clot burden was assessed for each patient. Secondary outcomes included the development of PE recurrence, right ventricular (RV) dysfunction, chronic thromboembolic pulmonary hypertension (CTEPH), readmission, and mortality at 12 months.

**Results:** A total of 382 patients were included and 107 patients received reperfusion therapies followed by anticoagulation. Patients who received reperfusion therapies including systemic thrombolysis, catheter-directed thrombolysis and mechanical thrombectomy presented with a higher vascular obstructive index (VOI, 47% vs 28%, p<0.001), more frequent concomitant deep vein thrombosis (DVT, 69% vs 40%, p<0.001), and right heart strain on both computed tomographic pulmonary arteriography (CTPA, 82% vs 37%, p=0.001) and echocardiogram (81% vs 43%, p<0.001) at the time of diagnosis. A higher absolute reduction in VOI (45% vs 26%, p<0.001, 95% CI 14.0-25.6), greater improvement in RV function (82% vs 65%, p=0.021), lower 12-month mortality rate (2% vs 7%, p=0.038) and readmission rate (33% vs 46%, p=0.031) were observed in the reperfusion group. No statistically significant differences were found between groups in the development of CTEPH (8% vs 5%, p=0.488) and PE recurrence (8% vs 6%, p=0.646).

**Conclusion:** We observed a more favorable survival, greater improvement in clot resolution and RV function in patients treated with reperfusion therapies. Future randomized control trials are needed to confirm our findings.

**Background**

Acute pulmonary embolism (PE) remains a leading cause of morbidity and mortality with around 100,000 deaths annually in the United States. ¹ Although major advances in PE management including diagnostic and therapeutic strategies have substantially improved the short-term outcomes of PE,² few studies have assessed its long-term effects.³⁻⁵ Even with adequate anticoagulation, more than half of the patients have persistent dyspnea and functional limitations following acute PE, with proposed attributable causes ranging from clinical post-PE syndrome to persistent pulmonary vascular abnormalities.⁶⁻⁸ Residual pulmonary vascular obstruction (RPVO) is a frequent sequela following acute PE that has been associated with serious clinical impacts. While these chronic or slowly resolving thrombi may be
asymptomatic, the persistent obstruction of the pulmonary vascular bed could lead to elevation of pulmonary resistance and ultimately right ventricular (RV) dysfunction. The rarest and most severe long-term outcome is the development of chronic thromboembolic pulmonary hypertension (CTEPH). In addition, several studies found that RPVO is an independent predictor of recurrent venous thromboembolism (VTE).

Reperfusion therapies have been shown to improve short-term outcomes by rapidly and effectively reversing the hemodynamic burden that PE imposes on the pulmonary circulation and the right heart. Theoretically, the rapid and effective clot resolution exerted by reperfusion therapies could possibly minimize the development of long-term consequences of PE, including RV dysfunction and CTEPH. However, whether and to what extent reperfusion therapies could prevent the development of long-term sequelae has not been clearly delineated, either due to limited data or variable parameters used as outcome measures. The purpose of the present study is to investigate the role of reperfusion therapies in the reduction of RPVO and its impact on late outcomes.

**Study Design And Methods**

**Study Population**

We conducted a retrospective review of all hospitalized patients between January 2017 and June 2021 at our institution who underwent evaluation by the pulmonary embolism response team (PERT). Patients were included if meeting the following criteria: (i) diagnosis of acute PE confirmed by computed tomography pulmonary angiography (CTPA) or lung perfusion/ventilation (V/Q) scan; (ii) completed treatment of therapeutic anticoagulation for at least 3 months; (iii) and underwent repeat imaging from 3 to 12 months follow-up after an index PE due to persistent dyspnea. Patients were excluded on account of the following: (i) diagnosis of PE not confirmed by CTPA or V/Q scan; (ii) did not receive treatment either due to contraindications to anticoagulation, limited life expectancy or hospice care; (iii) unavailability of follow-up; (iv) PE-related or non-related in-hospital death; (v) death during follow-up without imaging; (vi) and duplicated cases. This study was approved by the Institutional Review Board at Temple University Hospital (Protocol #26021) and conducted in accordance with the Declaration of Helsinki. Informed consent was waived due to the retrospective nature of the study.

**Outcomes Measures**

Demographics, comorbid conditions, and risk factors for VTE were collected and summarized. The main outcome was to determine and compare the incidence of RPVO in patients who received reperfusion therapies plus anticoagulation to those who received anticoagulation alone in 3 to 12 months following acute PE. RPVO was assessed using CTPA or lung V/Q scan, or both if available, and was defined by the presence of persistent filling defects noted on CTPA or residual perfusion defects on V/Q scan. Clot burden was quantified and calculated by using Qanadli score system. In brief, the arterial tree of each lung was regarded as having 10 segmental arteries (three to the upper lobes, two to the middle lobe/
lingula, and five to the lower lobes). The presence of embolus in a segmental artery was scored 1 point and the embolus at the most proximal arterial level was scored according to the number of segmental arteries arising distally. Each score was assigned to a weighing factor from a scale of 0–2 (0 = no defect; 1 = partial occlusion; 2 = complete occlusion). The maximal CT obstructive score is 40 and the vascular obstructive index (VOI) was calculated using the formula: \[ \frac{\sum (n \times d)}{40 \times 100} \], where n is the value of proximal thrombus in the pulmonary arterial tree equal to the number of segmental branches arising distally, and d is the degree of obstruction.\(^{13}\)

The secondary outcomes were to determine the late sequelae of PE in patients who received reperfusion therapies, which included PE recurrence, RV dysfunction, CTEPH, readmission, and mortality at 12 months. PE recurrence was defined by the presence of a new thrombus in a different segmental area than that of the initial PE or a new perfusion defect on the V/Q scan. An echocardiographic assessment of RV function was performed at the time of PE diagnosis and between 3 and 12 months to determine changes in RV function, which was classified as follows: (i) persistent RV dysfunction; (ii) new RV dysfunction; (iii) and improvement of RV function. CTEPH was defined by the following two criteria: (i) the presence of pulmonary hypertension (mean pulmonary arterial pressure > 20mmHg) with a pulmonary capillary wedge pressure < 15mmHg confirmed via right heart catheterization; (ii) and the presence of thromboembolic occlusion of the pulmonary vasculature, either by V/Q lung scan or CTPA.

### Statistical analysis

All continuous variables were tested for normality and presented as mean with a standard deviation (SD), or median with an interquartile range (IQR) if the distribution were skewed. Categorical variables were presented as absolute numbers (percentage). Comparison between the anticoagulation and the reperfusion group was performed using the Student t-test or Mann-Whitney U test for continuous variables, or Fischer’s exact or \(X^2\) test for categorical variables, as appropriate. Survival distributions at 12 months were estimated by the Kaplan-Meier method and compared using the Log-Rank test. The software SPSS Statistics for Mac, version 29.0 (IBM Corp., Armonk, NY, USA) was used for statistical analysis. P-values of < 0.05 (two-sided) were considered statistically significant.

### Results

**Study Population and patient characteristics**

Out of 594 cases between January 2017 and June 2021 identified in the PERT registry, 212 cases were excluded due to the following reasons: duplicated cases (n = 2), diagnosis of PE not confirmed by CTPA or V/Q scan (n = 3), unavailability of repeat imaging (n = 126), PE-related or non-related in-hospital death (n = 62), death during follow-up without repeat imaging (n = 9), and contraindications to anticoagulation, limited life expectancy or hospice care (n = 10). Figure 1 demonstrates patient selection. A total of 382 patients were included and the severity of PE was as follows: 106 cases (28%) of low-risk PE, 122 cases (32%) of intermediate-low risk, 132 cases (34%) of intermediate-high risk, and 22 cases (6%) of high-risk
PE. A total of 107 patients (28%) received reperfusion therapies, which included full-dose thrombolysis (n = 9, 8%), half-dose thrombolysis (n = 14, 13%), catheter-directed thrombolysis (CDT, n = 69, 65%), and mechanical thrombectomy (n = 15, 14%). All patients who received reperfusion therapies had intermediate-risk and high-risk PE.

Baseline patient characteristics of the study cohort are reported in Table 1. Among intermediate-risk and high-risk PE group, patients who received reperfusion therapies had a significantly lower prevalence of cardiac diseases (23% vs 50%, p < 0.001), chronic obstructive pulmonary disease (COPD, 7% vs 16%, p = 0.020), and malignancy (11% vs 24%, p < 0.010). In addition, higher rates of concurrent deep vein thrombosis (DVT, 69% vs 45%, p < 0.001), signs of RV strains on CTPA (85% vs 49%, p < 0.001) and echocardiogram (81% vs 56%, p < 0.001) were observed in reperfusion group.
Table 1
Baseline patient characteristics.

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Intermediate and high-risk PE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AC (n = 275)</td>
</tr>
<tr>
<td>Gender (female)</td>
<td>119 (43)</td>
</tr>
<tr>
<td>Age, mean (± SD)</td>
<td>57 ± 17.1</td>
</tr>
<tr>
<td>Race, n (%)</td>
<td>140 (51)</td>
</tr>
<tr>
<td>Black</td>
<td>50 (18)</td>
</tr>
<tr>
<td>White</td>
<td>84 (31)</td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>BMI, mean (± SD)</td>
<td>32 ± 9.2</td>
</tr>
<tr>
<td>Comorbidities, n (%)</td>
<td>112 (41)</td>
</tr>
<tr>
<td>Cardiac diseases</td>
<td>43 (16)</td>
</tr>
<tr>
<td>COPD/asthma</td>
<td>26 (9)</td>
</tr>
<tr>
<td>CKD</td>
<td>5 (2)</td>
</tr>
<tr>
<td>ESRD on hemodialysis</td>
<td>71 (26)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>14 (5)</td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td>54 (20)</td>
</tr>
<tr>
<td>Malignancy</td>
<td>37 (13)</td>
</tr>
<tr>
<td>Recent surgery</td>
<td></td>
</tr>
<tr>
<td>sPESI score &gt; 1</td>
<td>175/236 (74)</td>
</tr>
<tr>
<td>Elevated BNP</td>
<td>99/253 (39)</td>
</tr>
<tr>
<td>Elevated troponin</td>
<td>77 (28)</td>
</tr>
</tbody>
</table>

AC = anticoagulation; BMI = body mass index; BNP = B-type natriuretic peptide; CKD = chronic kidney disease; COPD = chronic obstructive pulmonary disease; CT = computed tomography; DVT = deep vein thrombosis; ECHO = echocardiogram; ESRD = end-stage renal disease; LV = left ventricular; PA = pulmonary artery; PE = pulmonary embolism; RV = right ventricular; SD = standard deviation; sPESI = simplified pulmonary embolism severity index;
Assessment of pulmonary vascular obstruction

The mean (SD) follow-up time of imaging was 6 (3.5) months. RPVO was observed in 21% of patients (n = 23) treated with reperfusion therapies, compared to 9% of patients (n = 25) treated with anticoagulation alone (21% vs 9%, p = 0.001). A higher mean VOI (47% vs 28%, p < 0.001, 95% CI 13.8–24.7) was observed in patients treated with reperfusion therapies, compared to anticoagulation alone. The VOI was reduced from 47–0.5% in the reperfusion group, and from 28–1.5% in the anticoagulation group. Thus, a significantly greater absolute reduction in VOI (45% vs 26%, p < 0.001, 95% CI 14.0-25.6) was observed in the reperfusion group. Table 2 summarizes differences in changes of VOI between anticoagulation and reperfusion groups. Figure 2 demonstrates VOI at the time of diagnosis and follow-up.
Table 2
Changes in vascular obstructive index (VOI) at time of diagnosis and at follow up.

<table>
<thead>
<tr>
<th></th>
<th>Anticoagulation group (n = 275)</th>
<th>Reperfusion group (n = 107)</th>
<th>P value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOI at time of diagnosis, mean (SD)</td>
<td>27.6 (17.3)</td>
<td>46.9 (21.2)</td>
<td>&lt;0.001</td>
<td>13.8–24.7</td>
</tr>
<tr>
<td>VOI at follow up, mean (SD)</td>
<td>1.5 (5.9)</td>
<td>0.5 (2.4)</td>
<td>0.197</td>
<td>13.5–25.0</td>
</tr>
<tr>
<td>Absolute reduction in VOI, mean (SD)</td>
<td>25.6 (17.6)</td>
<td>45.4 (21.7)</td>
<td>&lt;0.001</td>
<td>14.0–25.6</td>
</tr>
<tr>
<td>Clot resolution, number (%)</td>
<td>270 (91%)</td>
<td>84 (79%)</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Complete resolution</td>
<td>25 (9%)</td>
<td>23 (21%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RPVO = residual pulmonary vascular obstruction; VOI = vascular obstructive index

Long-term outcomes following acute PE

Table 3 summarizes all outcome measures at the 12-month follow-up. Of 199 patients who had echocardiographic signs of RV dysfunction at the time of diagnosis, 145 patients (73%) had repeat echocardiography at follow-up (e-figure 1). Improvement in RV function was more frequently seen in patients treated with reperfusion therapies (82% vs 65%, p = 0.021). There was no statistical difference in the development of new RV dysfunction (21% vs 18%, p = 0.749) compared to patients treated with anticoagulation alone. No statistically significant differences were found between groups in the development of CTEPH (8% vs 5%, p = 0.488) and PE recurrence (8% vs 6%, p = 0.646).
Table 3
Outcome measures at 12-month follow-up.

<table>
<thead>
<tr>
<th>Cohort</th>
<th>Intermediate and high-risk PE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AC (n = 275)</td>
</tr>
<tr>
<td>VOI at PE diagnosis</td>
<td>28%</td>
</tr>
<tr>
<td>RPVO</td>
<td>25 (9)</td>
</tr>
<tr>
<td>Changes in RV function</td>
<td>28/79 (35)</td>
</tr>
<tr>
<td>Persistent RV dysfunction</td>
<td>51/79 (65)</td>
</tr>
<tr>
<td>Improvement in RV function</td>
<td></td>
</tr>
<tr>
<td>New RV dysfunction</td>
<td>13/73 (18)</td>
</tr>
<tr>
<td>PE recurrence</td>
<td>17 (6)</td>
</tr>
<tr>
<td>CTEPH</td>
<td>13 (5)</td>
</tr>
<tr>
<td>Readmissions</td>
<td>127 (46)</td>
</tr>
<tr>
<td>PE-related</td>
<td>34 (12)</td>
</tr>
<tr>
<td>PE non-related</td>
<td>93 (34)</td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>41/325 (13)</td>
</tr>
<tr>
<td>Mortality (discharge to one-year)</td>
<td>21/284 (7)</td>
</tr>
<tr>
<td>Cancer</td>
<td>11/21 (52)</td>
</tr>
<tr>
<td>Respiratory failure</td>
<td>2/21 (10)</td>
</tr>
<tr>
<td>COVID</td>
<td>2/21 (10)</td>
</tr>
<tr>
<td>Septic shock</td>
<td>1/21 (4)</td>
</tr>
<tr>
<td>Stroke</td>
<td>2/21 (10)</td>
</tr>
<tr>
<td>Unknown</td>
<td>3/21 (14)</td>
</tr>
</tbody>
</table>

CTEPH = chronic thromboembolic pulmonary hypertension; PE = pulmonary embolism; RPVO = residual pulmonary vascular obstruction; RV = right ventricular; VOI = vascular obstructive index
<table>
<thead>
<tr>
<th>Cohort</th>
<th>Intermediate and high-risk PE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total mortality</td>
<td>62/325 (19)</td>
</tr>
<tr>
<td></td>
<td>0.786</td>
</tr>
<tr>
<td></td>
<td>45/208 (22)</td>
</tr>
</tbody>
</table>

CTEPH = chronic thromboembolic pulmonary hypertension; PE = pulmonary embolism; RPVO = residual pulmonary vascular obstruction; RV = right ventricular; VOI = vascular obstructive index

Readmissions and mortality at 12 months

Patients treated with reperfusion therapies had a lower readmission rate of 33% within a 12-month follow-up period (33% vs 46%, p = 0.031). For patients who survived acute PE, a higher mortality rate at 12 months was observed in patients who received anticoagulation alone (7% vs 2%, p = 0.038), with the causes of death being: cancer (n = 11), respiratory failure (n = 3), COVID (n = 2), septic shock (n = 2), stroke (n = 2), and unknown causes (n = 3). There were no statistically significant differences in in-hospital death (16% vs 13%, p = 0.291) and overall mortality (23 vs 19%, p = 0.786). Figure 3 demonstrates the cumulative risk of death at 12-month.

Patients with intermediate and high-risk PE

A stratified analysis of patients with intermediate and high-risk PE revealed similar findings, notably higher mean VOI at diagnosis (47% vs 31%, p < 0.001, 95% CI 9.8–22.1), greater absolute reduction in VOI (45 vs 29%, p < 0.001, 95% CI 9.9–22.9), improvement in RV function (82% vs 66%, p = 0.043), decreased mortality in patients who survived acute PE (2% vs 8%, p = 0.024) and readmission rate (33% vs 47%, p = 0.043) in reperfusion group (supplemental file, Table S1).

Discussion

In this study, RPVO was observed in 21% of patients with acute PE treated with reperfusion therapies up to one-year follow-up. Patients treated with reperfusion therapies had a higher clot burden as evidenced by a higher VOI and more frequent concomitant DVT at time of diagnosis. Reperfusion therapies resulted in a greater clot reduction, improved RV function, lower readmission rate and 12-month mortality rate in patients who survived acute PE. There was no statistically significant difference in the development of late outcomes, including PE recurrence and CTEPH.

The incidence of RPVO following an index PE is in keeping with previously reported rates ranging from 19–51.8%.\textsuperscript{10,11,14} There is a paucity of data regarding the long-term effects of reperfusion therapies on PE, and the few studies that investigated its impact came to different conclusions. Two small, prospective randomized trials reported that thrombolysis, compared with anticoagulation, might improve functional capacity and the persistence of pulmonary hypertension at long-term follow-up.\textsuperscript{15,16} A retrospective multicenter cohort study by Semaan et al. found a survival benefit in patients treated with CDT over anticoagulation without any significant procedure-related complications.\textsuperscript{17} On the contrary, Konstantinides et. al reported that thrombolysis did not appear to reduce long-term mortality rates,
residual dyspnea, or RV dysfunction. Nevertheless, data regarding clot burden and the extent of clot resolution exerted by reperfusion therapies were not available in existing studies, which could have underestimated the long-term benefits of reperfusion therapies.

In this study, it is unsurprising that a higher proportion of patients treated with reperfusion therapies had RPVO on follow-up imaging, as these patients had a higher clot burden at the time of diagnosis and were more likely to present with signs of right heart strain. In fact, our data suggest that despite the presence of RVPO, reperfusion therapies resulted in a greater extent of clot reduction and a lower VOI at follow-up. In addition, these patients had a significantly greater improvement in RV function compared to anticoagulation alone. These findings highlight the benefits of rapid clot resolution achieved by reperfusion therapies and their potential role in the prevention of long-term sequelae following PE that could contribute to chronic dyspnea.

Our findings may have important implications for daily clinical practice and future clinical research studies. First, current guidelines recommend reservation of reperfusion therapies only to patients with high-risk PE or intermediate-high-risk PE with imminent signs of hemodynamic decompensation, given the concerns of a higher risk of bleeding. This study provides insights into the potential long-term benefits of reperfusion therapies, suggesting the feasibility of expanding the role of reperfusion therapies in patients with high clot burden, with or without signs of RV strain at the time of diagnosis. Early involvement of multidisciplinary PERTs can facilitate the careful selection of patients who may be candidates for reperfusion therapies.

Second, the optimal duration of anticoagulation treatment after PE remains controversial. Patients with associated risk factors for VTE recurrence, including unprovoked PE, cancer, or high clot burden at the time of diagnosis often receive prolonged or indefinite anticoagulation. The result from our study that reperfusion therapies lead to a greater extent of clot resolution suggests the possibility of shortening the duration of anticoagulation treatment in those treated with reperfusion therapies, provided that serial imaging to observe clot resolution is available. Dedicated PE care follow-up allows timely identification of patients who are at risk of developing late outcomes of PE such as CTEPH.

In accordance with existing literature, we did not observe a reduction in the development of CTEPH. A potential explanation is that CTEPH remains rare, and the sample size may be too small to determine the impact of reperfusion therapies on CTEPH. The pathophysiology of CTEPH remains unknown, further studies are needed to investigate the potential role of reperfusion therapies in the prevention of maladaptive cardiopulmonary remodeling and to elucidate the underlying mechanism that leads to CTEPH.

Study Limitations

There are several limitations to our study. First, we did not include parameters that represent exercise tolerances and functional capacity. Thus, a correlation between the radiographic findings of RPVO with the severity of symptoms or the degree of functional impairment could not be delineated. Second,
patients with incomplete follow-up were excluded from the study, which might have led to selection bias. Third, patients who had severe symptoms were most likely to seek medical attention, and thus the prevalence of RV dysfunction, PE recurrence, and CTEPH could have been overestimated. Finally, the mean follow-up time is relatively short compared to other existing studies. Other limitations included the retrospective, single-center nature of the data, which may be prone to selection bias.

**Conclusion**

In this study, we observed a greater extent of clot resolution and improvement in RV function in patients treated with reperfusion therapies compared with anticoagulation alone. A survival benefit at one-year follow-up was also observed in the reperfusion group. Such findings suggest the possibility of expanding reperfusion therapies beyond current recommendations. Future randomized control trials are needed to confirm our findings.

**Abbreviations**

CDT= catheter-directed thrombolysis; CTEPH= chronic thromboembolic pulmonary hypertension; CTPA= computed tomography pulmonary angiography; DVT= deep vein thrombosis; PE= Pulmonary embolism; PERT= pulmonary embolism response team; RPVO= residual pulmonary vascular obstruction; RV= right ventricular; VTE= venous thromboembolism; perfusion/ventilation= V/Q; VOI= vascular obstructive index;

**Declarations**

**Ethics approval and consent to participate**

This study was approved by the Institutional Review Board at Temple University Hospital (Protocol #26021). The informed consent requirement was waived by the Institutional Review Board at Temple University Hospital due to retrospective nature of the study. All methods were conducted in accordance with the Declaration of Helsinki.

**Consent for publication**

Not applicable.

**Availability of data and materials**

All data generated or analyzed during this study are included in this published article and supplementary file.

**Competing interests**

No conflicts exist for all authors.
Funding disclosure

None declared.

Author’s contribution

KUL and PR designed the research study and drafted the manuscript. KUL collected and analyzed the data, and is the guarantor of the article, taking responsibility for the integrity of the work as a whole from inception to the published article. SL and RB helped revised the manuscript. RB, VL, and JP reviewed the imaging studies and treated the patients who underwent catheter-directed thrombolysis.

Acknowledgements

Not applicable.

References


**Figures**
594 cases in the PERT registry

- Duplicated cases = 2
- PE confirmed by other diagnostic methods = 3

589 cases confirmed by CTPA or V/Q scan

- Unavailability of repeat imaging = 126
- No treatment = 10
- PE-related or non-related in-hospital death = 62
- Death during follow-up = 9

382 cases with follow up

- Anticoagulation group = 275

Reperfusion group = 107
- Full-dose TPA = 9
- Half-dose TPA = 14
- CDT = 69
- Mechanical thrombectomy = 15

Figure 1

Patient selection flow diagram.
Figure 2

Changes in vascular obstructive index at the time of PE diagnosis and at follow-up.

Changes in pulmonary vascular obstructive index (VOI) between reperfusion group and anticoagulation group in: A) whole patient cohort; B) patients with intermediate-risk and high-risk PE.

Figure 3
Cumulative risk of death at 12-month: A) patients who survived PE hospitalization; B) total mortality including in-hospital death.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- supplemental.docx