

## Surgical embolectomy in treating acute massive pulmonary embolism

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### Abstract

**Objective:** To evaluate the outcome of patients with massive pulmonary thrombo-embolism.

**Methods:** The retrospective study comprised data of pulmonary embolectomy done on patients with anatomically extensive pulmonary embolism with severe right ventricular dysfunction, symptomatic hypotension or those unresponsive to thrombolytic therapy. Medical records of 16 cases with massive pulmonary embolism that had undergone embolectomy at the Madani Heart Center in Tabriz, Iran, between January 2003 and July 2011 were included. SPSS 16 was used for statistical analysis.

**Results:** Of the 16 patients, 10(62.5%) were women, and 6(37.5%) were men. The mean age of the patients was 53±17.75 years. There were 2(12.55%) deaths, while 14(87.5%) were discharged from hospital and followed up for at least 2 years. Immediate pre-discharge echocardiographic evaluation revealed dramatic decrease in the right ventricular systolic pressure with a mean of 93.61±15.48 mm/Hg and 50.25±19.85 mm/Hg of pre-and post-embolectomy respectively ( $p<0.001$ ). However, it never dropped so much as to be considered normal.

**Conclusion:** The high proportion of survival suggests embolectomy shall be used in cases of massive pulmonary thrombo embolism.

**Keywords:** Embolism, Thrombolytic embolectomy, Right ventricular dysfunction, Hypotension. (JPMA 63: 955; 2013)

### Introduction

Pulmonary embolism (PE) is a common and potentially lethal condition. Most patients who succumb to it do so within the first few hours of the event. Despite diagnostic advances, delays in PE diagnosis are common and represent an important issue.<sup>1</sup> As a cause of sudden death, massive PE is second only to sudden cardiac death.<sup>2</sup> It still has a high mortality rate despite the advances in the diagnosis and therapy.<sup>3</sup> Patients with pulmonary thrombo-embolism (PTE) need rapid diagnosis, risk stratification and an appropriate short or long term management for reducing the mortality rate.<sup>4</sup> Researchers believe that high-risk patients may require more aggressive interventions.<sup>5</sup> Major pulmonary embolism, defined as a large central PE with haemodynamic instability, has been shown to carry a mortality rate of 17.4-28 %.<sup>6</sup> The complication rate reported for thrombolytic therapy is 3%. A high frequency rate of bleeding complication of thrombolysis for PE has also been reported.<sup>7</sup> The current treatment options are haemodynamic and respiratory support, thrombolysis, surgical pulmonary embolectomy, percutaneous catheter embolectomy and fragmentation, Initial anti-coagulation, therapeutic strategies, high-risk pulmonary embolism,

non-high-risk pulmonary embolism, long-term anti-coagulation and secondary prophylaxis, venous filters.<sup>8</sup> There have been studies looking for an alternative for thrombolytic therapy in patients suffering from massive PE who might suffer adverse outcomes if treated only with anti-coagulation and inferior venacaval filter insertion.<sup>9</sup> Prior to 2003, embolectomy for massive PE had never been performed at the study site. The current study was conducted to evaluate the outcomes of patients with massive pulmonary thrombo embolism at our center.

### Patients and Methods

The retrospective study was done on the basis of data related to patients diagnosed with acute pulmonary embolism (APE) according to the European Society of Cardiology (ESC) guidelines,<sup>10</sup> and who were hospitalized from 2003 up to July 2011 and then underwent embolectomy at Madani Heart Center in Tabriz. APE was diagnosed based on the following diagnostic tests: computed tomography (CT) angiography, or CT scan, echocardiography, Doppler ultrasound (US) of the proximal deep veins of the lower extremity scintigraphy. Those with persistent systolic blood pressure (SBP) less than 90mmHg in spite of inotrope use or drop of systolic pressure more than 40mmHg were considered as cases of haemo-dynamically significant PTE. Details of echocardiography included the investigation of right ventricular (RV) systolic function which had been evaluated using tricuspid antero-posterior systolic excursion (TAPSE) on M-mode. Also the peak of systolic

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velocity of tricuspid annulus in the basal segment of tricuspid valve (TV) on tissue Doppler with the annulus aligned with the Doppler beams were considered for determination of RV systolic function. TAPSE less than 16mm and s' less than 11 cm/s were considered as mild RV systolic dysfunction while TAPSE less than 12 mm and s' less than 8cm/s were defined as moderate RV systolic dysfunction. Patients with TAPSE of 10mm and s' less than 6cm/s, together with RV dilation were judged as suffering from severe RV dysfunction. RV systolic pressure (RVSP) was estimated with tricuspid regurgitation (TR) jet velocity with the addition of right atrium (RA) pressure, with the RA pressure estimated from inferior vena cava (IVC) size and its collapsibility. IVC diameter in 4 chambers sub costal view  $\leq 21$ mm that collapse  $>50\%$  with sniff, suggested a normal RA pressure about 6mmHg. RA pressure was considered to be less than 10mmHg in these patients. The IVC diameter 21 mm with collapse rate  $<50\%$  with sniff suggested high RA pressure (15mm Hg). Distended IVC  $\geq 21$ mm that collapsed to be  $<30\%$  or did not collapse at all represented RA pressure equal to 20mm Hg. For the management of RV systolic dysfunction series of interventions, including better control of tidal volumes, early oral feeding, adequate fluid replacement and pulmonary vasodilators were resorted to the inotropic therapy was the last of our choices. In-hospital observation included the rate of the following complications: all causes of morbidity and mortality,

cardiac events, inotropic drug administration, cardiogenic shock, electrocardiography (ECG) findings before and after embolectomy, and ventilatory support. Furthermore, we kept in touch with the patients either through visits or telephone calls for 2 years after the discharge. The statistical calculations were performed using SPSS version 17. All P-values of  $<0.05$  (two-tailed) were considered statistically significant. Continuous variables with normal distributions were presented as mean  $\pm$  standard deviation.

## Results

During the study period, 16 patients underwent embolectomy. Ten (62.5%) of them were women and 6(37.5%) were men. The ages ranged between 16 and 76 years, with a mean of  $53 \pm 17.75$ . Four (25%) patients had pre-operative placement of IVC filter (Table). Predisposing factors for PE was cancer in 2 (12.5%) patients, protein C and S deficiency in 1(6.25%) case and immobility in 6 (37.5%) patients. In the rest of the cases, there were no provocative factors. All patients had large central emboli in main, right and left pulmonary arteries (PA). Pre-operative ECG was performed in all cases and 9(56.25%) patients had poor RV function which improved significantly after embolectomy. Only 3(33%) of these patients suffered from RV dysfunction and needed inotropic support for RV stunning. One (6.25%) patient (No 6) developed progressive systemic hypotension and

Table: Demographics, presentations and outcomes.

No	Age	SEX	Symptom	RVF-Pre	RVF-Post	PAP-Pre	PAP-Post	Finding	IVC filter	D/C	complications
1	46	F	Chest pain	poor	good	100	40	RPA Endarterectomy	N/D	+	N/C
2	53	M	DOE	Poor	impaired	120	35	LPA& RPA Endarterectomy	N/D	+	CVA after SK
3	33	M	DOE	impaired	impaired	110	75	LPA& RPA Endarterectomy	N/D	+	N/C
4	60	F	Palpitation& DOE	N/A	N/A	100	N/A	LPA& RPA Endarterectomy	N/D	+	N/C
5	39	M	DOE	N/A	N/A	100	50	Endarterectomy & ASD Closure	+	+	N/C
6	49	F	DOE	N/A	N/A	90	N/A	Endarterectomy M,R,L PA	N/D	NO	N/C
7	72	F	N/A.	impaired	NL	57	N/A	Embolectomy LPA& RPA	+	+	N/C
8	41	F	syncope	impaired	NL	70	45	Embolectomy LPA& RPA	N/D	+	N/C
9	75	F	DOE	N/A	N/A	80	N/A	Embolectomy LPA& RPA	+	+	N/C
10	65	M	syncope	impaired	N/A	97	40	Embolectomy	N/D	+	N/C
11	74	F	DOE	impaired	NL	70	31	LPA& RPA	N/D	+	N/C
12	65	F	DOE	impaired	NL	110	60	Embolectomy	N/D	+	N/C
13	51	M	N/A	N/A	N/A	N/A	N/A	LPA& RPA	N/D	+	N/C
14	33	M	DOE	N/A	N/A	110	75	Embolectomy	+	+	N/C
15	16	F	DOE	NL	NL	80	35	LPA& RPA	N/D	+	N/C
16	76	F	DOE	poor	poor	90	N/A	Embolectomy	N/D	NO	N/C

D/C: Discharge. NO: Died. PAP Pre: PA Pressure before operation.

N/D: Not one. PAP Post: PA Pressure after operation. N/A: Not Available. N/C: No Complication.

DOE: Dyspnea on exertion.

hypoxaemia, and died in the intensive care unit (ICU). One (6.25%) patient (No.16) died in the operation room with massive lung haemorrhage. The remaining 14 (87%) patients survived and the median follow-up was more than 24 months for them. Pre-discharge ECG revealed significant drop in RVSP from mean  $93.61 \pm 15.48$  mm/Hg of pre-embolectomy to  $50.25 \pm 19.85$  mm/Hg of post-embolectomy ( $p < 0.001$ ). However, RVSP never dropped enough to be considered normal. RV function during the follow-up period was near normal in patients  $< 50$  years, but mild to moderately reduced in older cases.

## Discussion

Acute massive PE can be defined as the obstruction of more than 50% of pulmonary vasculature, leading to a progressive carcinogenic shock. RV afterload increases with PE which leads to the right heart strain and dilatation. The subsequent displacement of interventricular septum reduces left ventricular preload and cardiac output. This vicious cycle, if not terminated, leads to RV failure and the subsequent cardiac arrest. Thus, early diagnosis and management would be life-saving.<sup>11</sup> The main change concerns risk stratification, which now classifies patients as high-risk, intermediate or low-risk, replacing the former terminology of acute massive, sub-massive or no massive PE.<sup>12</sup> Risk stratification is now oriented toward the evaluation of the risk of early PE-related death. Thrombolysis is the mainstay of therapy in high-risk PE. Surgical embolectomy has become more frequent due to the reduction in the mortality risk associated with this technique.<sup>13</sup> However, it remains limited to patients unsuitable for thrombolysis. Catheter-based embolectomy is reserved for situations in which neither thrombolysis nor surgical embolectomy is possible. According to a study treatment for all patients with acute massive PE surgical embolectomy should be used as first-line therapy.<sup>14</sup> Though thrombolysis and catheter-based embolectomy are efficacious in the initial treatment of massive PE, the long-term implications of these procedures have yet to be studied. In addition, it is not available for every nation, which is one of the limitations of catheter embolectomy.<sup>15</sup> Catheter embolectomy is performed by devices. As such those are mainly designed for removing small arterial clots rather than large massive emboli. As such, surgical embolectomy could be the next option.<sup>16</sup> High-risk cases need more complete intervention in the setting of multi-disciplinary approaches by a team of physicians and expert surgeons. Complications of thrombolysis are high mortality rate, major bleeding especially the intracranial bleeding and reduced thrombolysis in the management of PE.<sup>17</sup> Minimally invasive catheter embolectomy has been 80% effective, but carries the risk of showering

emboli to distal vasculature. Also catheter has been shown to fragment the embolus rather than complete its extraction.<sup>18</sup> Residual PA hypertension is high with catheter embolectomy because of the incomplete embolectomy and so it affects long-term survival. However, the combined clot fragmentation and aspiration method recently developed looks promising for the management of patients with massive PE in the future.<sup>19</sup> In the past years, surgical mortality rate of massive PE has been high (30%) with the poor outcomes of procedure.<sup>20</sup> In a recent study, the mortality rate decreased to 20%. The mortality rate for those who had suffered cardiac arrest prior to pulmonary embolectomy was 59% compared to 29% for patients who had not had pre-operative cardiac arrests.<sup>21</sup> In some reports, with the pre-operative cardiac arrest patients dropped from consideration, the mortality rate decreased to 0%.<sup>22</sup> The choice of treatment for massive PE, thrombolysis or catheter-based intervention or surgical embolectomy depends on the local institutional expertise.<sup>23</sup> According to a 2009 study, comparison of percutaneous ultrasound-accelerated thrombolysis versus catheter-directed thrombolysis in patients with acute massive PE revealed no significant difference in the relative Miller score improvement between the two groups.<sup>15</sup> The current study had a mortality rate of 12.5 % which was lower than the results of an earlier study,<sup>21</sup> but higher than that of another study.<sup>22</sup> The discrepancy may have been because of the deferred embolectomy in the latter case where patients underwent embolectomy after showing resistance to thrombolytic therapy.<sup>24</sup> The current study revealed a significant decrement of RVSP of post-embolectomy, but it never returned to normal levels even after surgical interventions. It is supposed that even during surgical embolectomy, clots at the main and proximal portion of PAs will be extracted and distal vessel clots are responsible for high PA pressure after surgical interventions. One study has shown a significant drop of RVSP after fibrinolysis corresponding to the improvement of pulmonary circulation.<sup>25</sup>

## Conclusion

The high proportion of survival in the study population patients can be attributed to quick diagnosis, careful patient selection and also improvement of surgical techniques. Embolectomy is recommended for high-risk cases.

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