International Journal of Cardiology 203 (2016) 579–583

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Management of acute massive pulmonary embolism: Is surgical embolectomy inferior to thrombolysis?☆

Yang Hyun Cho [a,1], Kiick Sung [a,1], Wook Sung Kim [a,*], Dong Seop Jeong [a], Young Tak Lee [a], Pyo Won Park [a], Duk-Kyung Kim [b]

[a] Department of Thoracic and Cardiovascular Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea
[b] Department of Internal Medicine, Division of Cardiology, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Korea

ARTICLE INFO

Article history:
Received 18 May 2015
Received in revised form 28 October 2015
Accepted 29 October 2015
Available online 31 October 2015

Keywords:
Pulmonary embolism
Surgical embolectomy
Fibrinolysis
Shock

ABSTRACT

Background: Although current guidelines for pulmonary embolism (PE) treatment recommend surgical embolectomy when thrombolysis is contraindicated or has failed, their clinical outcomes rarely have been compared directly.
Methods: After excluding patients aged under 18 years and those with submassive or non-massive PE, 45 consecutive patients (median age, 68 years; 62% female; 31% experienced cardiac arrest before PE treatment onset; 33% had cancer diagnosis history; and 29% received extracorporeal membrane oxygenation [ECMO]) who underwent only thrombolysis (TL group; n = 19) or surgical embolectomy (SE group; n = 26, including 4 who had failed thrombolysis) for acute massive PE from 2000 to 2013 at Samsung Medical Center were enrolled to assess cardiac mortality as primary outcome.
Results: Median follow-up duration was 17.2 months. In the SE group, significantly higher proportions of patients had recent surgery and ECMO. Overall 30-day all-cause mortality rate was 24% (n = 11), without significant difference between the SE (15%) and TL (37%) groups ($P = 0.098$); however, cardiac mortality rate was significantly higher in the TL than SE group (Log rank $P = 0.023$). TL was an independent multivariate predictor of cardiac death ($P = 0.03$).
Conclusion: In this small retrospective single center experience, surgical embolectomy is associated with lower cardiac mortality risk than thrombolysis, which might render it first-line treatment option for acute massive PE for patients without life-limiting comorbidities.

1. Introduction

Massive pulmonary embolism (PE) is associated with hemodynamic instability [1,2], with development of hypotension dramatically increasing expected mortality. The rapid reinstitution of sufficient pulmonary blood flow and right ventricular unloading therefore is important to save the patient's life. Although surgical embolectomy theoretically offers faster and more complete removal of thrombi in the major pulmonary arteries than systemic thrombolysis, surgical mortality is as high as 32% [3] and studies and guidelines therefore recommending it be reserved for patients with contraindications or who have failed to respond to systemic thrombolysis. However, surgical embolectomy is not a complicated procedure and its outcomes seem to be highly dependent on preoperative patient condition [3,4]. The aim of this study therefore was to comparatively review clinical outcomes of acute massive PE management with surgical embolectomy or systemic thrombolysis.

2. Methods

2.1. Patients

From 2000 to 2013, 75 adult patients were diagnosed with massive PE at Samsung Medical Center. Of these 75 patients, 20 (27%) underwent neither surgical embolectomy nor systemic thrombolysis. Exclusion criteria for this study were age under 18 years, history of chronic PE, diagnosis of submassive or non-massive PE, and conservative management of PE, such as anticoagulation without thrombolysis or surgical embolectomy. The median follow-up duration was 17.2 (interquartile range, 53–74) months. The Samsung Medical Center Institutional Review Board approved this study and waived the need for patient consent.

Abbreviations: PE, pulmonary embolism; ECMO, extracorporeal membrane oxygenation; tPA, tissue plasminogen activator.

☆ All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

* Corresponding author at: Department of Thoracic and Cardiovascular Surgery, Samsung Medical Center, Sungkyunkwan University School of Medicine, 50 Irwon-dong, Gangnam-gu, Seoul 135-710, Korea.
E-mail address: wooksung.kim@samsung.com (W.S. Kim).

[1] Drs. Y.H.C. and K.S. contributed equally to this work.

http://dx.doi.org/10.1016/j.ijcard.2015.10.223
0167-5273/

2.2. Definitions and outcomes

Massive PE was defined as sustained hypotension, pulselessness, or persistent profound bradycardia with signs or symptoms of shock in the presence of a newly developed thrombus in the common trunk or right or left main pulmonary artery [1]. The primary outcome was cardiac mortality, which includes death by cardiac origin and sudden death from unknown cause. Patients who underwent surgical embolectomy, regardless of previous thrombolysis, were categorized into the SE group (n = 26), while those who had thrombolysis without any surgical intervention for PE were included in the TL group (n = 19).

2.3. Patient management

Selection between thrombolysis and surgical embolectomy was mainly decided according to the presence of refractory shock, respiratory failure, or cardiac arrest (Fig. 1), with preference at our ceneter to employ extracorporeal membrane oxygenation (ECMO) or immediate surgery in such patients [5]. If the duration of cardiac arrest, profound hypotension, or hypoxia was long, the patient was evaluated while on ECMO to exclude futility.

Our institutional thrombolysis protocol for acute PE varied according to patient age. Tissue plasminogen activator (tPA) was intravenously administered at 1.4 mg/kg (minimum 50 mg, maximum 100 mg) over 2 h, while for those patients with high risk of bleeding such as age > 65, tPA 50 mg was infused over 2 h.

Surgical embolectomy was performed via median sternotomy. Thrombectomy was performed under cardiopulmonary bypass with or without cardioplegic arrest. Thrombi were completely removed up to the segmental pulmonary arteries (Fig. 2). When there is too much of back bleeding from the pulmonary arteries, we decreased the flow of cardiopulmonary bypass or briefly (less than five minutes) stopped the extracorporeal circulation in moderate hypothermia. ECMO was weaned off before leaving operation room whenever possible.

2.4. Statistical analysis

SPSS version 21.0 (SPSS, Chicago, IL, USA) was used for statistical analyses. Descriptive statistics for categorical variables are reported as frequency and percentage while continuous variables are reported as mean ± standard deviation or median and interquartile rage as appropriate. Categorical variables were compared between the SE and TL groups using the Chi-squared test or Fisher's exact test, and continuous variables were compared using the two-sample t-test or Wilcoxon rank sum test where appropriate.

The Kaplan–Meier method was used to construct survival curves. The binary logistic regression method was used to compare early mortality between the two groups. Cox regression models were used to determine the univariate and multivariate predictors of overall survival and cardiac death. The multivariable model included all variables that were significant in univariate analysis ($P < 0.2$). All statistical tests were two-sided with the alpha level set at 0.05 for statistical significance.

3. Results

3.1. Patient characteristics and early outcomes

The median age was 68 years (interquatile range, 53–74). There were 28 (62%) female patients. The risk factors for acute PE were deep vein thrombosis in 20 (46%), malignancy in 15 (33%), major surgery within three months in 15 (33%), bedridden status in 6 (13%), and pregnancy in 4 (9%). Fifteen patients (33%) experienced cardiac arrest before definitive treatment (thrombolysis or surgical embolectomy). ECMO was used in 13 (29%) patients to manage cardiac arrest or refractory shock. Primary surgical embolectomy and rescue surgery after failed thrombolysis were conducted in 22 and 4 patients, respectively. No patient underwent thrombolysis after surgical embolectomy. Patient characteristics are summarized in Table 1. Thirty-day, 90-day, and one-year mortality was 24% (n = 11), 31% (n = 14), and 42% (n = 18), respectively.

3.2. Thrombolysis versus surgical embolectomy

There was no difference in all-cause mortality during early follow-up between the TL and SE groups, which included four cases of failed thrombolysis (Table 2, Fig. 3). All four patients who had surgical embolectomy after thrombolysis failure survived. The SE group showed better cardiac death-free survival than the TL group (Log rank $P = 0.024$, Fig. 4). In univariate and multivariate analysis for cardiac death, the TL group was a significant predictor of cardiac death (Table 3).

3.3. Causes of death

There were 20 deaths (9 in the thrombolysis only group and 11 in the SE group) after acute massive PE diagnosis. Among nine deaths in

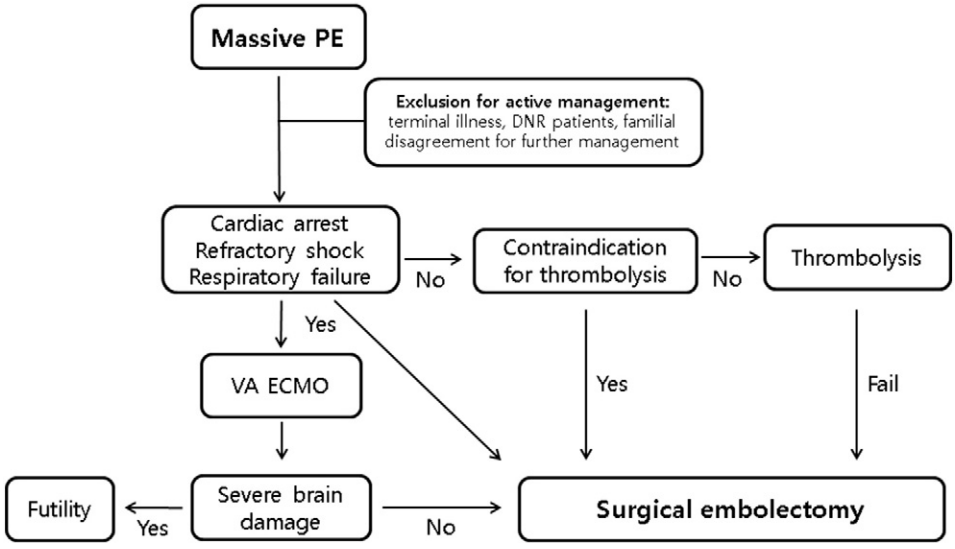

Fig. 1. Management strategy for acute massive pulmonary embolism at Samsung Medical Center. PE: pulmonary embolism, DNR: do not resuscitate, VA ECMO: venoarterial extracorporeal membrane oxygenation.