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Pulmonary Thromboembolectomy for Acute Pulmonary Thromboembolism

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Background: Acute pulmonary thromboembolism is fatal because of abruptly occurring hypoxemia and right ventricular failure. There are several treatment modalities, including anticoagulation, thrombolytics, ECMO (extracorporeal membrane oxygenator), and thromboembolectomy, for managing acute pulmonary thromboembolism. ***Materials and Methods:*** Medical records from January 1999 to December 2004 at our institution were retrospectively reviewed for pulmonary thromboembolectomy. There were 7 patients (4 men and 3 women), who underwent a total of 8 operations because one patient had post-operative recurrent emboli and underwent reoperation. Surgery was indicatedfor mild hypoxemia and performed with CPB (cardiopulmonary bypass) in a beating heart state. ***Results:*** The patients had several symptoms, such as dyspnea, chest discomfort, and palpitation. Four patients had deep vein thromboembolisms and 3 had psychotic problems, specifically schizophrenia. Post-operative complications included hemothorax, pleural effusion, and pericardial effusion. There were two hospital deaths, one each by brain death and right heart failure. ***Conclusion:*** Emergency operation should be performed when medical treatments are no longer effective.

Key words: 1. Pulmonary thromboembolism
2. Thromboembolectomy

INTRODUCTION

Acute pulmonary thromboembolism is a fatal disease that can cause patients to take a sudden turn for the worse from the moment of symptom manifestation due to right heart dysfunction, hypotension, and hypoxia, if there is no precise and fast diagnosis and treatment for it [1]. For medical therapy of acute pulmonary thromboembolism, we can use anticoagulants and thrombolytics. However, when it comes to patients who have unstable vital signs or for whome medical therapy is not indicated, ECMO (extracorporeal membrane oxygenator) application and emergent thromboembolectomy can be considered. On the basis of the authors' surgeries, we wanted to determine the indications and results of thromboembolectomy.

MATERIALS AND METHODS

Eight patients underwent surgery due to acute pulmonary embolisms from January 1999 to December 2004. Among them, we reviewed 7 patients who could be investigated by

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Table 1. Characteristics of patients

Sex	Age	Symptoms	Combined disease	AaDO2* (mmHg)	DVT†	Preoperative heparinization	Preoperative inotropics	Preoperative CPR‡
M	23	Dyspnea	Nephrotic syndrome, mental retardation	42.9				
F	52	Dyspnea	Schizophrenia		O	O		
M	25	Chest discomfort, Syncope		60.9		O	O	O
M	32	Chest pain	CVA§, PFO‖	229.3	O	O		
F	39	Palpitation	Schizophrenia	52.6	O			
M	54	Dyspnea	TKR¶, Lt	67.6	O			
F	68	Chest pain	TKR, both	63.8		O	O	

*AaDO2=Alveolar arterial oxygen difference; †DVT=Deep vein thrombosis; ‡CPR=Cardiopulmonary resuscitation; §CVA=Cerebrovascular attack; ‖PFO=Patent foramen ovale; ¶TKR=Total knee replacement.

medical records. One of these underwent reoperation due to recurrence of pulmonary embolism on the 13th postoperative day.

Patients who had needed vasopressors for hypotension or had shown right heart dysfunction by echocardiography underwent surgery. We performed median sternotomy under general anesthesia and then performed cardiopulmonary bypass without cardiac arrest. After making incisions to the pulmonary arteries longitudinally, we removed the thromboembolisms and cautiously compressed both lungs after opening both pleurae using an uncapped Yankauer sucker. For artery cannulation, we used the ascending aorta in 7 cases and the femoral artery in one case. On the other hand, for venous cannulation, we used both the Superior Vena Cava (SVC) and Inferior Vena Cava (IVC) in 7 cases and the femoral vein in one case. The one case of using the femoral artery and vein was the patient who had suffered from hypotension in the operating room, so we cannulated the femoral artery and vein and ran the CPB first and then continued the surgery. The mean CPB time was 80.5±48.9 minutes. The mean pharyngeal temperature was 34.4°C during the CPB time.

RESULTS

The mean duration from admission to operation was 3 days, which included the cases referred from other departments. The mean age was 41.9 years old (23 to 68). The total patients were 7 cases (4 males, 3 females). Because one female had a reoperation on the 13th postoperative day, there were a total of 8 operations.

The main symptoms were dyspnea in 4 cases, chest pain and discomfort in 2 cases, palpitation in one case, and syncope in one case. Four of six cases showed deep vein thrombosis in the lower extremity sonography. The preoperative blood pressure in 5 cases were in the normal range. However, a vasopressor was infused into the two patients who had suffered from hypotension. The mean respiratory rate was 27 breaths per minute (22 to 36) and the mean pulse rate was 113 beats per minute (98 to 120). The body temperature was 38°C in one patient and normal in the others. We diagnosed the disease using chest computed tomography and lung perfusion scan, echocardiography and pulmonary angiography. In the chest computed tomography scans, more than two lobar pulmonary arteries were plugged with thromboembolisms. Echocardiography showed right heart dilatation in 6 cases, and moderate Tricuspid regurgitation was noted in 3 of them. A preoperative check of D-dimer was performed in 4 cases, which were found to be elevated to >1.0, 3.28, 1.84, and 16.8 mcg/mL. Troponin I was elevated to 2, 2, and 3.43 ng/mL in 3 cases. We calculated the difference in oxygen pressure (AaDO2) and the values were elevated in 6 cases (Table 1). The causes of pulmonary artery thromboembolism were deep vein thrombosis in 4 cases, previous knee transplantation in 2, cases and schizophrenia in 2 cases. Of the remaining cases, one each was caused by right

Table 2. Managements and outcomes of patients

Sex	Age	IVC* filter	Recurrence	Death	CPB time (min)	CPB BT (°C)
M	23				68	36
F	52	O	O		60	31
M	25			O	180	32.5
M	32	O			70	35
F	39	O			38	35
M	54	O			43	36
F	68			O	105	35.9

*IVC=Inferior vena cava (IVC filters were inserted when patients were transferred from the intensive care unit to general ward after thromboembolectomy).

atrial thrombosis, patent foramen ovale (PFO) with cerebral stroke (for which we performed thromboembolectomy with PFO primary closure) and steroid taking due to renal failure. There were two patients who had used vasopressors before surgery and one of them underwent cardiopulmonary resuscitation. We infused heparin to 4 patients before surgery, and we inserted an IVC filter below the renal vein in 4 cases. After that, we continued anticoagulation with warfarin.

The mean hospital day was 33.2 days (16 to 67). Hemothroax occurred in one case and was cured by reoperation. One patient suffered from pleural and pericardial effusion, but went home without any special treatment. The patients who had a long hospital stay needed treatment for psychotic problems, and reoperation made for a long hospitalization. Two patients died, one on the operative day and the other on the first postoperative day. One was in brain death after CPR, and the other died of right heart failure with myocardial infarction. The patient in brain death underwent the operation due to the family's insistence (Table 2). Four patients who came back for follow-up among the five surviving cases lived at least 5 years after their operations.

DISCUSSION

Acute pulmonary thromboembolism can be fatal. In our cases, the main clinical symptoms were acute dyspnea and chest comfort, and other symptoms are hypoxemia and hypotension without specific previous disease. Twenty percent of patients show the normal range of arterial oxygen pressure and the normal difference between alveolar and arterial oxygen pressure (AaDO2). Hemodynamic changes can be shown in the time when 30～50% of pulmonary arteries are plugged with thrombi [4].

Acute pulmonary thromboembolism can be categorized into massive and sub-massive groups. In massive acute pulmonary thromboembolism, there can be cases of systolic blood pressure below 90 mmHg, systolic blood pressure decreases of more than 40 mmHg over the course of 15 minutes or more, and cardiogenic shock. On the other hand, sub-massive acute pulmonary thromboembolism evidences right heart dysfunction even when it shows a hemodynamically stable state [2].

The risk factors of acute pulmonary thromboembolism include old age, history of deep vein thrombosis, four-limb limitation due to neurogenic problems, long bedridden periods due to cardiac or acute pulmonary injury, neoplasm, hormonal therapy, congenital or acquired thrombophilia, oral contraception, pericarditis, and history of pulmonary thromboembolism. In patients with deep vein thrombosis in the proximal lower extremity without chest symptoms, pulmonary embolism can be detected in 50% of cases by a lung perfusion scan. Seventy percent of the detected pulmonary thromboembolisms are combined with deep vein thrombosis in the lower extremities. Among these combined cases, limitation of movement due to neurogenic disease, being over 75 years old, and cardiopulmonary disease or neoplasm are risk factors for death by acute pulmonary thromboembolism [3,4]. Danilo et al. reported that moderately depressive patients with movement limitations were in danger of pulmonary thromboembolism [10].

The revised Geneva score can be used clinically for pulmonary embolism classification. The score takes into account age over 65 years, history of arrhythmia, thrombus and pulmonary embolism, history of operation within the most recent one month, history of fracture, progressive cancer, pain of a unilateral lower extremity, hemoptysis, heart rate over 75 beats per minute, pain on palpation of the lower extremity vein, and unilateral edema in the lower extremity. Clinical possibilities can be classified into three grades (low, intermediate, high) according to the grade of individual risk factors. Other diagnostic tools are chemical tests such as

pro-BNP, BNP, troponin, echocardiography, chest computed tomography, and lung perfusion scan [4].

Echocardiography can reveal the level of pressure overload to the right ventricle, through the signs of a diameter ratio between the right and left ventricle of more than 1, right ventricular dilatation, right ventricular hypokinesis, and the degree of ventricular septal bowing. In particular, it is said that the degree of ventricular septal bowing is useful in predicting death [3,5].

Among the patients diagnosed with pulmonary thromboembolism, hemodynamically unstable patients should be treated immediately with thrombolytics, operations, and catheterized embolectomy. However, hemodynamically stable patients without right heart dysfunction can be treated with anticoagulation. If there is an abnormal finding of the right heart, the patient can be treated with thrombolytics under close observation.

Initial therapies include anticoagulation (unfractionated heparin, low molecular weight heparin, fondaparinux, warfarin), thrombolytics, percutaneous thromboembolectomy, and operative treatment. Warfarin therapy must be continued for three months (Target INR: 2.0～3.0). In the cases with risk factors such as male gender, old age, malignancy, and pulmonary embolism without special preceding causes, however, warfarin therapy must be continued at least three months due to the increased possibility of recurrence. Thrombolytics cannot be used in cases of cerebral diseases, intractable hypertension, or within three weeks post-operatively [3].

An IVC filter is indicated for cases of contraindication of anticoagulation therapy, the failure of anticoagulation therapy, cardiopulmonary dysfunction with arrhythmogenic thrombosis, high risk patients for operation and the patient taking thrombolytics due to proximal arrhythmogenic thrombosis [6].

Pulmonary thromboembolectomy has to be performed whenever several medical treatments do not show the effect in the cases of unstable blood pressure, hypoxemia, imbalance of electrolytes, or acidosis. If an emergency operation is difficult to perform, the application of ECMO can be helpful to maintain survival [8].

The death rate from pulmonary thromboembolectomy has been reported to be 20%. We can perform it as follows. The first indication is the case of confirmed massive pulmonary thromboembolism with hemodynamic changes. In this case, right heart dysfunction or the need for vasopressors becomes evident. The second one is hemodynamic instability such as shock, in spite of heparin infusion or supportive care for stable vital signs. The last one is the case of a contraindication or intractable state of anticoagulation [7]. If there is a massive thrombus in the proximal lower limb and a percutaneous thromboembolectomy using a catheter cannot be performed, an operation has to be considered even though the vital signs are stable [9].

CONCLUSION

Although noninvasive therapies such as anticoagulation and thrombolytics tend to gradually replace surgical interventions, in light of this study, we suggest that emergency pulmonary thromboembolectomies are needed for patients who are in a hemodynamically unstable state or have a right heart dysfunction. Furthermore, patients whose movements are limited due to psychotic problems are in danger of pulmonary thromboembolism. Therefore, careful observation of such patients is necessary.

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