Rapid Sequence Pulmonary Embolectomy in Patient with Asystolic Cardiac Arrest due to Massive Pulmonary Thromboembolism: Brief Report

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Abstract

Background: Massive pulmonary embolism (PE) is a devastating medical situation which correlated to a much higher mortality rate rather than non-massive PE. While surgical embolectomy can be an effective way to treat asystolic patients with massive PE, a satisfactory outcome is heavily reliant on the technique and skill with which the surgery is performed. **Objectives**: In this article, we suggest the procedure with a single technique to subject the pulmonary arteries to a minimal amount of damage. **Patients/Methods:** We have performed this sequence of techniques on 19 patients who were experiencing asystole due to massive PE. These patients, while continuing to perform closed cardiac massage on the non-beating heart of the patient, transferred to the operating room. In the operating room, following a median longitudinal sternotomy, open chest cardiopulmonary resuscitation is performed. After that, one incision is made on the main pulmonary artery the thrombus is then removed using forceps and suction. **Results:** 14 of these patients survived the embolectomy and 5 died due to failure to reverse asystole, culminating in a mortality rate of 26%. When diagnosing the patients, it was observed that the RV/LV diameter in all of them was greater than one. Upon the discharge of the surviving patients, this value had returned to <0.9 in all of the patients. **Conclusions:** Eventually, we suggest that surgical embolectomy, in our experience, has been shown to have merit over other modes of treating PE patients experiencing cardiac arrest, esp. cardiac arrests with a non-shockable rhythm such as asystole.

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Key words:

Embolectomy, Heart Arrest, Thromboembolism, Pulmonary Embolism, Pulmonary Artery.

Introduction:

Acute pulmonary embolism (PE) is the sudden obstruction of part of the pulmonary arterial vasculature, usually as a result of embolization of thrombus from the deep veins within the lower limbs and pelvis (1). The American Heart Association defines massive PE as acute PE coupled with sustained hypotension (systolic blood pressure 40mmHg for at least 15 minutes or requiring inotropic support), pulselessness, or persistent profound bradycardia (heart rate <40 bpm with signs or symptoms of shock)(2). As expected, hemodynamic instability is correlated to a much higher mortality rate: patients with massive PE have been demonstrated

to have a 90-day mortality rate as high as 52%, as opposed to patients with non-massive PE who have a mortality rate of 14% (3). The outcome becomes even more grim when patients at the operation room are undergoing cardiac arrest and thus need of continuous cardiopulmonary resuscitation (CPR): 80 percent of these patients do not survive (4). PE, as one possible cause of cardiac arrest, has an exceedingly poor prognosis, and the mortality rate, despite medical intervention, remains very high (5).

Asystole _the terminal rhythm of a cardiac arrest_ represents the cessation of electrical and mechanical activity of the heart. Asystole typically occurs as a deterioration of the initial shockable ventricular rhythms. Additionally, pulseless electrical activity (PEA) can cease and become asystole (6). When cardiac arrests occur, the survival rate of patients undergoing cardiac arrests with non-shockable rhythms, esp. asystole, is significantly lower (7).

In the past, surgical pulmonary embolectomy was reserved as a salvage procedure for patients who either failed or had an absolute contraindication to thrombolysis (8), but the procedure has reemerged as an effective strategy for managing patients with massive PE (2). The American college of chest physicians recommends surgical embolectomy in cases where death is likely before thrombolysis can take effect, (9) as is the case for patients who are experiencing asystole due to pulmonary embolism. A compelling study by Leacche et al. has concluded that an aggressive approach to large pulmonary embolus, including rapid diagnosis and prompt surgical intervention, has improved results with surgical embolectomy. In the study, 47 patients underwent surgical embolectomy with an operative mortality rate of 6% and 3-year survival of 83%. Nevertheless, significantly higher mortality rates were observed in patients who undergo CPR(10).

While surgical embolectomy can be an effective way to treat asystolic patients with massive PE, a satisfactory outcome is heavily reliant on the technique and skill with which the surgery is performed (11, 12). There have been studies that provide guidance in the method of surgical embolectomy and assess the outcome in patients undergoing cardiac arrest(4, 13-17), yet there are no studies that explain the sequence of measures that must be taken when encountering a patient who is specifically experiencing asystole _arguably the deadliest rhythm of cardiac arrest_ due to PE. Also, It's noteworthy that while the standard methods of embolectomy employ either two(18) or three (19) incisions on the pulmonary arteries, we carry out the procedure with a single incision (Zeraatian's single incision technique) with the purpose of subjecting the pulmonary arteries to a minimal amount of damage.

With the goal of providing guidance for the acquisition of the necessary skill in performing the procedure, we provide a description of the technique of surgical embolectomy in asystolic patients with massive PE, and then we discuss the outcome of our approach in patients.

Description:

This case series study has been reviewed and approved by the Iran University of Medical Sciences ethics committee (ethics code). The informed consent form of the study assessed by the committee and following their approval has been signed by all the participants before the procedure. This study has not considered as a clinical trial in our research committee according to the established fundaments of the procedure.

When encountering a patient experiencing PE coupled with asystolic cardiac arrest, it is crucial to keep performing CPR at all of the steps of the treatment until the asystole is reversed. The first step in the treatment of an asystolic patient suspected of PE is to confirm the diagnosis. To do so, trans-thoracic echocardiography should be performed as soon as possible. In order to confirm the diagnosis, patients experiencing asystole should have a right ventricle to left ventricle (RV/LV) diameter ratio of greater than 0.9.

After PE is confirmed, a full dose of heparin (500 unit/kg) is administered to the patient, all while continuing to perform closed cardiac massage on the non-beating heart of the patient. Afterwards a median longitudinal sternotomy is performed and, upon gaining access to the thoracic cavity, CPR is continued in the form of open cardiac massage. In most cases, either norepinephrine or vasopressin should be administered to the aortic root. CPR then must be continued until the heart starts beating.

After the asystole is reversed, bicaval cannulation is undertaken and cardiopulmonary bypass is commenced.

A perfusionist must then correct the values of arterial blood gas and hemoglobin of the patient. Subsequently, and unlike what is routinely done in this procedure, only one incision is made on the main pulmonary artery to gain access to the pulmonary arteries' structure. The next step is to expose interior of the right and left pulmonary arteries by using retractors. This step must be performed very carefully not to damage the fragile structure of the pulmonary arteries. The thrombus is then removed using forceps and suction. (Fig. 1)

Discussion:

To this date, we have performed this sequence of techniques on 19 patients who were experiencing asystole due to massive PE. 14 of these patients survived the embolectomy and 5 died due to failure to reverse asystole, culminating in a mortality rate of 26%. When diagnosing the patients, it was observed that the RV/LV diameter in all of them was greater than one. Upon the discharge of the surviving patients, this value had returned back to <0.9 in all of the patients. Additionally, upon arrival at the operation room, all patients were suffering from hypoxia, hypercarbia, and severe respiratory acidosis. Before the patients were admitted for embolectomy, all of them had received epinephrine in a custom dose to remedy the asystole. Further information about the patients can be seen in Table 1.

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Massive PE, reported that in the 47 patients with massive PE, 6 patients experienced pre-operative cardiac arrest, 2 of whom did not survive, culminating in a 33% mortality rate. Ullman et al. reported that of the 19 patients who required CPR at the operation room, 12 did not survive, which resulted in a mortality rate of 63% (4). Clarke and Abrams et al., who described a 25-year experience of encountering patients with PE, reported that 84% percent of the patients who experienced asystole or Ventricular fibrillation did not survive(13). An account of 15 years of experience in treating PE patients with surgical embolectomy by Messer et al. detailed that of the 14 PE patients who experienced cardiac arrest or failure, 8 did not survive (=57% mortality)(14). Meyer et al. described a 20-year experience of encountering 96 PE patients. The mortality rate of patient who experienced pre-operative cardiac arrest was reported to be 58% (15). Schmid et al. also reported a 50 percent mortality rate in patients who were in need of any form of cardiac massage(16). Granted, the span and the publishing date of these studies indicates that they include patients who were treated in as early as 1961, so some of the difference in results may be attributable to the difference in emergency services, hospital policies, equipment, etc. However, the extent of the effect of these factors can only be measured in a study that compares the routine treatment to the technique sequence described in this study in two groups of patients at the same time.

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Acknowledgement

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Conflict of interest statement

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Author contributions statement

MA: Editing and writing the article; IM: Writing the manuscript; SF: Gathering the data; MH: Gathering the data; SZ: Performing the operation and supervising; FE: Supervising.

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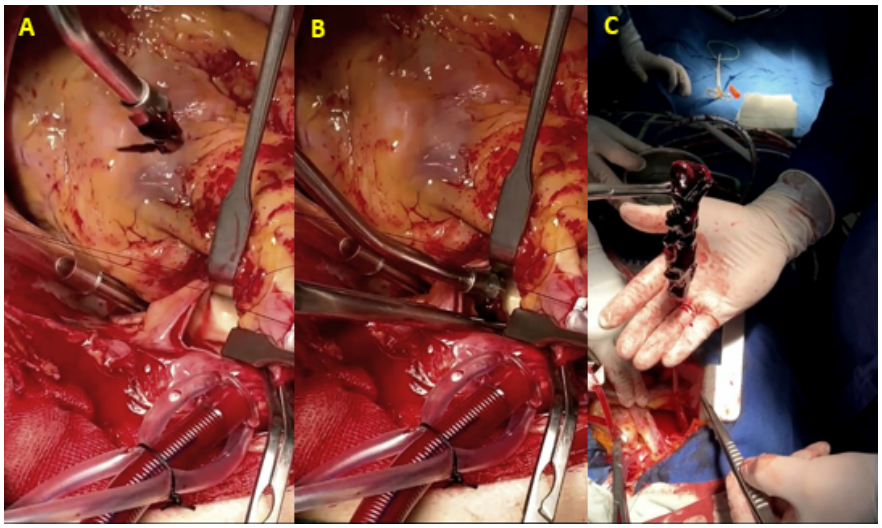
Fig.1: A) The picture presenting single incision of pulmonary trunk; B) Evacuation of the blood clot; C) Evacuated blood clot.



Patient number	Age	Gender	Dispatch to scene interval (minutes)	Asystole to drug interval (minutes)	Reversal of Asystole (ROA)	Pre-treatment SpO2 (percent)	Spo2 post treat (percent)	Pre-treatment GCS	GCS upon discharge	time of discharge (days)
1	61	m	20	10	30	60	85	3	15	7
2	52	m	30	10	30	63	88	3	12	8
3	65	m	20	11	33	61	92	3	13	9
4	57	m	22	12	45	62	91	3	14	10
5	52	m	30	13	40	58	90	3	15	7
6	45	m	25	15	45	60	93	3	15	8
7	50	f	30	14	50	61	90	3	14	9
8	60	f	26	13	32	60	85	3	13	10
9	65	m	27	10	36	59	93	3	12	7
10	59	m	30	11	48	63	90	3	15	8
11	65	m	29	13	50	62	89	3	14	9
12	74	m	25	14	32	65	87	3	13	10
13	65	m	26	13	44	61	85	3	13	7
14	78	m	28	15	45	60	90	3	13	14
15	71	f	29	10	0	59	_	3	_	_

Patient number	Age	Gender	Dispatch to scene interval (minutes)	Asystole to drug interval (minutes)	Reversal of Asystole (ROA)	Pre-treatment SpO2 (percent)	Spo2 post treat (percent)	Pre-treatment GCS	GCS upon discharge	time of discharge (days)
16	63	f	30	12	0	59	_	3	_	_
17	75	f	21	11	0	55	_	3	_	_
18	78	f	20	13	55	60	_	3	_	_
19	83	f	25	14	0	58	_	3	_	_

Table 1: Results of rapid sequence pulmonary embolectomy in the patient with asystolic cardiac arrest.

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Fig.1: A) The picture presenting single incision of pulmonary trunk; B) Evacuation of the blood clot; C) Evacuated blood clot.

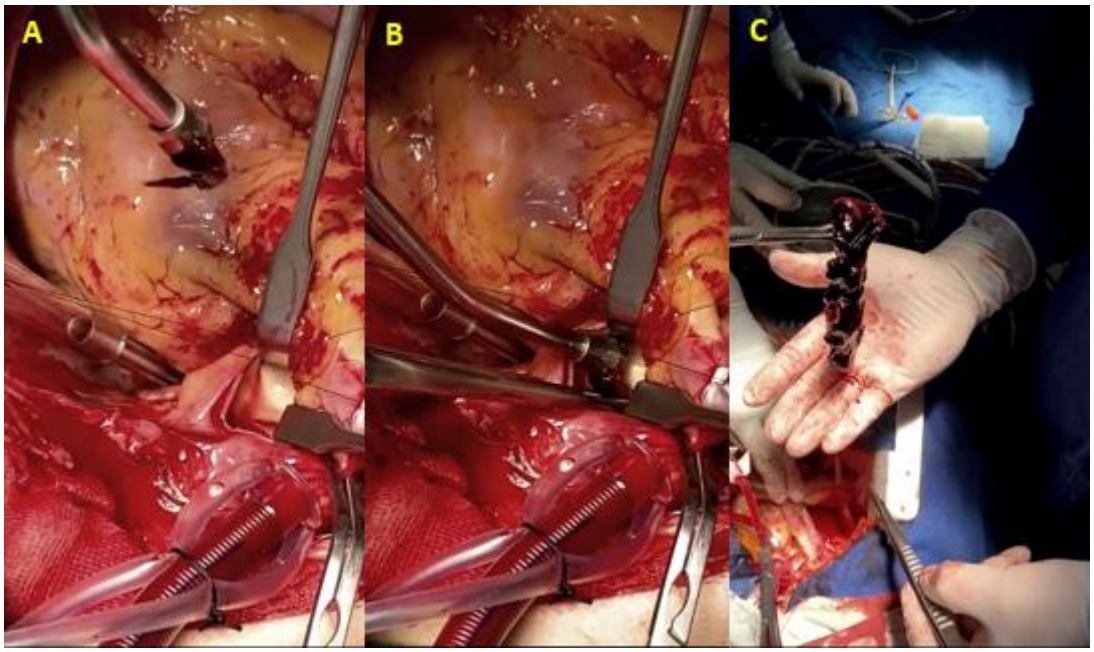

Table 1: Results of rapid sequence pulmonary embolectomy in the patient with asystolic cardiac arrest.

Patient number	Age	Gender	Dispatch to scene interval (minutes)	Asystole to drug interval (minutes)	Reversal of Asystole (ROA)	Pre-treatment SpO2 (percent)	Spo2 post treat (percent)	Pre-treatment GCS	GCS upon discharge	time of discharge (days)	Outcome
1	61	m	20	10	30	60	85	3	15	7	Successful
2	52	m	30	10	30	63	88	3	12	8	Successful
3	65	m	20	11	33	61	92	3	13	9	Successful
4	57	m	22	12	45	62	91	3	14	10	Successful
5	52	m	30	13	40	58	90	3	15	7	Successful
6	45	m	25	15	45	60	93	3	15	8	Successful
7	50	f	30	14	50	61	90	3	14	9	Successful
8	60	f	26	13	32	60	85	3	13	10	Successful
9	65	m	27	10	36	59	93	3	12	7	Successful
10	59	m	30	11	48	63	90	3	15	8	Successful
11	65	m	29	13	50	62	89	3	14	9	Successful
12	74	m	25	14	32	65	87	3	13	10	Successful
13	65	m	26	13	44	61	85	3	13	7	Successful
14	78	m	28	15	45	60	90	3	13	14	Successful
15	71	f	29	10	0	59	_	3	_	_	Death; failure to reverse asystole
16	63	f	30	12	0	59	_	3	_	_	Death; failure to reverse asystole
17	75	f	21	11	0	55	_	3	_	_	Death; failure to reverse asystole
18	78	f	20	13	55	60	_	3	_	_	Death; failure to reverse asystole
19	83	f	25	14	0	58	_	3	_	_	Death; failure to reverse asystole