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Official publication of the American College of Chest Physicians



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Dis Chest 1969;56;139-142

DOI 10.1378/chest.56.2.139

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ISSN:0096-0217





Selection of Patients for Pulmonary Embolectomy*

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A point of view in opposition to that proposed by Drs. Fred and Natelson is presented in the editorial by Dr. Sasahara and colleagues on page 89.

Editor

Despite a renewed and expanding interest in pulmonary embolectomy, criteria for selection of patients remain controversial.¹⁻⁵ Indeed, the wide divergence of opinion is difficult to reconcile. One author states, "All but minor emboli should now be treated by pulmonary embolectomy."⁶ Others believe, "The successful completion of emergency angiography virtually precludes the need for embolectomy."⁷ We examine here commonly cited indications for pulmonary embolectomy and demonstrate the need for flexibility in their application.

DISCUSSION

We separate potential candidates for pulmonary embolectomy into one of three types, depending upon duration of symptoms after the embolic episode. Type I consists of patients in whom death ensues rapidly. In this group, classification often must be retrospective. About 50 to 75 percent of patients with massive, fatal pulmonary thromboembolism die within the first hour.^{8,9} Some become agonal so quickly that their only hope for survival would seem to be immediate pulmonary arteriotomy performed without angiographic confirmation of the diagnosis or use of cardiopulmonary bypass. Four of 42 patients so treated left the hospital without cerebral damage.¹⁰

Type II patients survive the immediate thromboembolic insult, thereby providing the physician with time to establish a precise diagnosis and to institute a planned therapeutic approach. The bulk of medical literature on pulmonary embolectomy concerns patients of this type.

Patients in the Type III category have chronic obstruction of their major pulmonary arteries. Only a few of them have undergone embolectomy.¹¹⁻¹⁶ Indications for the procedure in this group are especially difficult to define. Nevertheless, the operation has alleviated the chief manifestation of dyspnea on exertion,^{13,15} returned the angiographic appearance of the pulmonary arterial tree to normal,¹¹ and reduced the degree of pulmonary arterial hypertension.¹²

Our comments hereafter pertain to indications for pulmonary embolectomy in the Type II patient. Currently, angiography is indispensable for establishing the presence of surgically accessible pulmonary thromboemboli in this group.¹⁷⁻²² Clinical findings alone are deceptive²³⁻²⁵ and have led to unnecessary pulmonary arteriotomy with disastrous consequences.¹⁸

The angiographic demonstration of massive pulmonary thromboembolism (occlusion of greater than 50 percent of the pulmonary arterial tree) is not necessarily an indication for embolectomy. Angiograms performed serially have demonstrated spontaneous resolution of large pulmonary thromboemboli.²⁶⁻²⁹ Moreover, we have observed angiographic evidence of massive pulmonary thromboembolism in acutely ill patients who have survived without embolectomy.

Systemic arterial hypotension unresponsive to vasopressor therapy is the most frequently cited and probably the most reliable indication for pulmonary embolectomy.^{9,30-32} But how long should one administer vasopressors before deciding upon such operative management? Some investigators

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suggest that 20³³ to 30³¹ minutes constitute an adequate trial; however, patients with systemic arterial pressures recorded as low as 50/0 mm Hg⁷ have received vasopressors for at least an hour and have survived without embolectomy.

In some patients pulmonary embolectomy should be done ideally before the onset of systemic arterial hypotension. Support for this contention comes from observations made at Ben Taub General Hospital on nine critically ill patients treated by embolectomy for acute, massive, pulmonary thromboembolism (Table 1). Of the four patients (Cases 2, 7, 8, 9) normotensive at the time of operation, three survived the procedure and are still living, six months to five years later. By contrast, only one (Case 1) of the five patients hypotensive at the time of embolectomy survived the operation. Baker and Wagner³⁴ have had a similar experience. In their nine cases of embolectomy for acute, massive, pulmonary thromboembolism, the three surviving patients were normotensive, whereas the six who died were hypotensive before induction of anesthesia. We cannot dismiss the possibility that the survivors among their patients and ours might have lived without embolectomy. Yet in our patients, the combined clinical, hemodynamic, and angiographic findings were sufficient to convince us that death was imminent.

Another point deserves emphasis. Two of our normotensive patients (Cases 7 and 8) showed significant clinical and angiographic worsening despite optimal heparin therapy for five and six days, respectively. One of these (Case 8) also underwent a second, preoperative hemodynamic study which demonstrated further rise in the already elevated right ventricular and pulmonary arterial pressures. We, like others,³⁵ believe that such serial measurements, though not always possible or necessary,

provide excellent evidence on which to base decisions for or against pulmonary embolectomy.

Several investigators require the demonstration of either elevated right ventricular end-diastolic pressure^{31,36} or increased "mean right ventricular pressure"^{37,38} before recommending embolectomy. A number of patients, however, with elevated right ventricular pressure have survived without embolectomy.^{5,39} *Conversely, the need for embolectomy may exist even when pressures in the pulmonary artery and right side of the heart are normal.* We have observed two patients with acute, massive, fatal pulmonary thromboembolism in whom right ventricular and pulmonary arterial pressures were normal, but the brachial arterial pressure was 80/50 mm Hg. In retrospect, pulmonary embolectomy might have helped these patients.

Some authors stress severe pulmonary arterial hypertension, with or without elevated right ventricular end-diastolic pressure, as an indication for pulmonary embolectomy.²⁴ Others emphasize a mean pulmonary arterial pressure greater than 30 percent of mean systemic arterial pressure as a basis for such surgical intervention.⁴⁰ Nevertheless, patients with massive pulmonary thromboembolism, severe pulmonary arterial hypertension, and/or systemic arterial hypotension have recovered without embolectomy.^{2,7,28,39,41}

The advent of fibrinolytic activators ultimately may affect the selection of patients for pulmonary embolectomy. At present, however, we believe that available information is insufficient to permit firm conclusions about indications for these agents in therapy for pulmonary thromboembolic disease. These drugs, with special reference to urokinase, undoubtedly facilitate dissolution of recently formed pulmonary thromboemboli,⁴²⁻⁴⁴ but their administration has not brought about significant change in the mortality rate.⁴⁵ Furthermore, urokinase is not widely available and its use carries the ever present risk of hemorrhagic diathesis.

SUMMARY

1. From a review of medical writings on pulmonary embolectomy and analysis of our own experience with such cases, we caution against strict adherence to a single criterion or set of criteria for the operation.

2. Systemic arterial hypotension unresponsive to vasopressor therapy is the most frequently cited and probably the most reliable indication for pulmonary embolectomy. In some patients, however, the procedure should be done ideally before the onset of systemic arterial hypotension, particularly when hemodynamic and angiographic studies demonstrate

Table 1—Hemodynamic and Angiographic Data in Nine Cases of Pulmonary Embolectomy

Case	Age (yr), Sex	Blood Pressure—mm Hg			Estimated % Pulmonary Vasculature Occluded
		Systemic	Right Ventricle	Pulmonary Artery (mean)	
*1	54M	90/60			no angiogram
**2	64F	160/80	80/20	90/26 (44)	65
3	88M	100/60	48/12	51/19 (27)	85
4	47F	30/0			90
5	82M	70/0			90
6	46F	85/50	75/16	72/25 (34)	65
7	50F	130/70	60/15	65/29 (39)	60
**8	49F	145/90	70/6	65/17 (36)	60
**9	63F	115/75	39/14		60

*Died 6 weeks postoperatively. Cause of death was not evident at autopsy.

**Alive

progressive worsening despite optimal anticoagulant therapy.

3. Embolectomy may be necessary even when pressures in the pulmonary artery and right side of the heart are normal.

4. Angiography is indispensable for establishing the presence of surgically accessible pulmonary thromboemboli and should precede embolectomy in all but patients who rapidly become agonal.

ACKNOWLEDGMENTS: Our associates in the sections of surgery, cardiology, and radiology, Ben Taub General Hospital, kindly made available some of the material presented.

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TRIUMPH OF SCIENCE

The city of Leyden, The Netherlands, had just heroically withstood the onslaught by its Spanish besiegers. To reward the burghers for their gallant stand, William the Silent asked them to choose between two gifts: freedom from taxes for ten years, or the establishment of a university. Intellectual interests prevailed. Leyden University opened the next year and its fame spread around the world. Leyden's rising fame as a medical school rested on two pillars, anatomical research and clinical instruction. Francis de la Boe Sylvius introduced bedside demonstration in Leyden in

1658. This was the most important innovation. Sylvius himself described it: I have led my students . . . daily to visit the sick at the public hospital. There I have put the symptoms of disease before their eyes; have let them hear the complaints of the patients . . . and have asked them their opinion in each case . . . Then I have given my judgment on every point.

Bettmann, O. L.: *A Pictorial History of Medicine*, C. C Thomas, Springfield, (Third printing) 1962

AN EARLY PATHFINDER IN CARDIOLOGY

Raymond Vieussens (1641-1715), who graduated at Montpellier and, in 1671, became physician to the Hospital of St. Eloys, is worthy of remembering by posterity. During the first ten years of his service he dissected 500 bodies. His investigations were published in his *Neurographia Universalis*, a work which gained for its author immediate fame, election as a member of the Academy of Sciences of Paris and as a Fellow of the Royal Society of London. His last book, *Traité Nouveau de la Structure et des Causes du Mouvement*

Naturel du Coeur, published in 1715, the year of his death, is a classic in the history of cardiology. It contains the first accurate detailed illustration of the coronary vessels, the first illustration of mitral stenosis, and the first recognizable description of the characteristic pulse of aortic insufficiency, which was full, bounding, and "struck the tips of my fingers like a cord which had been tightly stretched and violently agitated."

Major, R. H.: *A History of Medicine*, C. C Thomas, Springfield, 1954

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DOI 10.1378/chest.56.2.139

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