Midwest Surgical Association

Surgical pulmonary embolectomy in a community hospital

Zachary J. Osborne, M.D.*, Peter Rossi, M.D., John Aucar, M.D., Sadru Dharamsy, M.D., Scott Cook, M.D., Brian Wheatley, M.D.

General Surgery Department, Carle Foundation Hospital, 611 W Park Street, Urbana, IL 61801, USA

KEYWORDS:
Pulmonary embolectomy; Community hospital; Pulmonary embolism; Venous thromboembolism

Abstract

BACKGROUND: Surgical pulmonary embolectomy (SPE) is indicated for a pulmonary embolism associated with hemodynamic instability. A review of the literature demonstrates that most studies of SPE are conducted at large academic medical centers. This series is from a 325-bed community hospital.

METHODS: A retrospective chart review was performed of patients undergoing SPE from January 2008 to December 2012. All patients aged >18 years were reviewed for 30-day mortality, length of hospital stay, comorbidities, and preoperative hemodynamic parameters.

RESULTS: Fifteen patients (7 men and 8 women; median age, 55.5 years; range, 20–72 years) underwent SPE. There were 2 deaths (13.3%). Four of the patients underwent catheter-directed interventions before SPE. The mean length of hospital stay was 12 days.

CONCLUSIONS: These data suggest that SPE is associated with favorable outcomes in the appropriate community setting, and the mortality rate seen in this study compares favorably with the nationwide average of 27.2%.

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Pulmonary embolism (PE) can be classified as nonmassive, submassive, or massive.1,2 PEs can also be classified by physiologic severity. This system classifies PE as low, intermediate, or high risk.1,2 Surgical pulmonary embolectomy (SPE) is indicated for patients who sustain massive (high-risk) PEs, demonstrated by right heart dysfunction and hemodynamic instability, and is typically reserved for those with contraindications to systemic anticoagulation or who are refractory to thrombolytic therapy, either systemic or catheter-directed thrombolysis (CDT). Despite great advances in technology, the mortality rate of patients with massive PEs remains at about 30% to 50%.3,4 with a recent nationwide outcome analysis demonstrating the inpatient mortality of SPE to be 27.2%.6

Stein and Matta7 analyzed the database of the Nationwide Inpatient Sample, Healthcare Cost and Utilization Project, of the Agency for Healthcare Research and Quality and found that the case-fatality rate of pulmonary embolectomy for unstable patients was 39% to 40% from 1999 to 2008, and mortality rates were 27% and 23% for those who were hemodynamically stable before undergoing SPE in the periods from 1999 to 2003 and from 2004 to 2008, respectively. Several studies have demonstrated even further reductions in mortality rates, down to 6% to 12%, which have been attributed to hemodynamic stability status before surgery.8–10

* Corresponding author. Tel.: +1-217-383-3311; fax: +1-217-326-1300.
E-mail address: zachary.osborne@carle.com

The authors declare no conflicts of interest.

This paper was presented at the 2013 annual meeting of the Midwest Surgical Association, July 28 to 31, 2013, Acme, Michigan.
A review of the literature demonstrates that most studies of SPE are conducted at large academic medical centers. Few studies have been performed at community hospitals in the United States. In looking for original data on the community hospital experience specifically, we were able to find only 1 publication, a case series describing 3 successful pulmonary embolectomies performed at 1 hospital. The purpose of this report is to describe our experience with 15 cases of SPE in a small 325-bed community hospital.

Methods

The institutional review board approved this retrospective chart review of our experience with SPE over the 5-year period from January 2008 to December 2012. The hospital’s electronic medical record and administrative records were reviewed for all patients over 18 years old who underwent SPE. The 30-day mortality rate, length of hospital stay, comorbidities, demographics, and preoperative hemodynamic parameters were reviewed.

The study population was identified by reviewing the electronic medical record searching for all patients diagnosed with PE. These patients were identified using International Classification of Disease, Ninth Revision, codes 415.1, 415.11, 415.12, and 415.19. Current Procedural Terminology codes 38.05, 38, and 38.7 were used to identify patients who underwent SPE. Each identified chart was reviewed to verify that the patient underwent SPE.

Our hospital employed 3 full-time cardiothoracic surgeons at the time of our study. On average, over 350 open-heart procedures are performed annually. Our hospital has an agreement that all patients shown on computed tomography performed by emergency medicine physicians, radiologists, and internal medicine physicians to have large centrally located PEs with hypotension are personally referred to the cardiothoracic surgeon on call for review. Patient selection for SPE is based on the individual patient’s condition at the time of evaluation. Patients with massive and submassive PEs are considered for SPE given their risk profiles, hemodynamic profile, and comorbidities. Patients who sustain submassive PEs are also frequently considered for CDT. This is discussed between the interventional radiologists and the cardiothoracic surgeons.

Preoperative transesophageal echocardiography was performed on all patients. SPE was performed through a median sternotomy using standard cannulation techniques. Patients were fully heparinized and cannulated in routine fashion for cardiopulmonary bypass. An arterial return cannula was placed into the aorta, and then 2 separate venous cannulas were placed, 1 through the superior vena cava and the other through the inferior vena cava. The operation was performed under normothermic conditions without cardioplegic arrest. Pledgede purse-string sutures were placed in the pulmonary artery. Longitudinal arteriotomies of the main pulmonary artery or the right or left branch of the main pulmonary artery when appropriate were performed. Thromboembolectomy was performed with forceps extraction. Closure of the pulmonary artery incision was done using pledgede sutures. Two large-bore drainage tubes were placed. Hemostasis was verified. Patients were typically kept in the cardiac intensive care unit for 48 hours for monitoring.

One off-pump pulmonary embolectomy was performed for an intraoperatively diagnosed PE. A median sternotomy was performed, and the patient was not placed on pump. Purse-string pledgede sutures were placed into the main trunk of the pulmonary artery. A longitudinal arteriotomy was performed, and the embolus was removed. The chest was packed, and the patient underwent delayed sternal closure 48 hours later.

Results

Fifteen patients (7 men and 8 women; median age, 55.5 years; range, 20–72 years) underwent SPE. Patient demographics, results of diagnostic imaging, and outcomes are presented in Table 1. Eight emergent (53.3%) and 7 salvage (46.7%) embolectomies were performed. The perioperative risk factors for thromboembolic events and complications were also reviewed and are presented in Table 2. The mean length of hospital stay was 12 days. Catheter-directed interventions were attempted in 4 patients before SPE. Of the 15 patients, 13 underwent –computed tomographic angiography to assist in diagnosis. Twelve patients were unstable at the time of surgery. CDT failed in 4 patients who received alteplase and heparin before undergoing SPE.

There were 2 deaths (13.3%). The first was in a 32-year-old man with no known risk factors who presented with acute-onset shortness of breath and was found to have a massive PE with severe right ventricular dysfunction and unstable hemodynamics. He was originally referred for CDT, during which he developed pulseless electrical activity and was referred for salvage PE. He developed cardiac arrest on the operating table and was unable to come off cardiopulmonary bypass. The second patient was a morbidly obese 37-year-old female smoker with a family history significant for recurrent PE. She was noncompliant with her anticoagulation medications and presented with severe respiratory compromise. She developed asystole on induction, and cardiac massage was initiated, which was unsuccessful. Her twin had undergone successful SPE 19 months previously.

One PE was diagnosed intraoperatively, in a 56-year-old woman who had presented for lower limb ischemia and undergone CDT in the lower limb. She failed to improve and was referred for amputation. During the first 30 minutes of the procedure, the patient became profoundly hypotensive and hypoxic. Intraoperative transesophageal echocardiography was unable to demonstrate any thrombus but showed an extremely dilated right ventricle. A clinical diagnosis of PE was made, and salvage SPE was performed. The patient was found to have a large clot burden,
and her hemodynamic status improved upon removal of the embolus.

A 67-year-old woman with diabetes mellitus, hypertension, lower extremity venous insufficiency, and morbid obesity was referred for emergent SPE and found to have a large renal cell carcinoma that had embolized. This was removed and found on pathology to be renal cell. At the time of follow-up for the patient’s renal cell carcinoma, —computed tomography was performed, and it was noted that cardiac strain had resolved.

Four patients developed complications requiring subsequent intervention after SPE. Two patients developed new-onset atrial fibrillation that required cardioversion. One patient developed symptomatic pleural effusions that required thoracentesis, and 1 patient developed symptomatic pericardial effusion requiring drainage. Thus, our major

Patient 14 underwent 2 SPEs.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Patient risk factors and outcomes</th>
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<tbody>
<tr>
<td>Patient</td>
<td>Risk factors</td>
</tr>
<tr>
<td>1</td>
<td>Smoker, immobilization</td>
</tr>
<tr>
<td>2</td>
<td>Immobilization</td>
</tr>
<tr>
<td>3⁺</td>
<td>PVD, immobilization</td>
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<tr>
<td>4</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>Smoker, immobilization, trauma</td>
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<tr>
<td>6</td>
<td>Renal cell cancer</td>
</tr>
<tr>
<td>7</td>
<td>PFO/ASD, pregnancy</td>
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<tr>
<td>8</td>
<td>Recent surgery</td>
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<tr>
<td>9</td>
<td>Factor V Leiden, mutation, smoker</td>
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<tr>
<td>10</td>
<td>PFO, smoker</td>
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<tr>
<td>11</td>
<td>None</td>
</tr>
<tr>
<td>12</td>
<td>PVD, immobilization</td>
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<tr>
<td>13⁺</td>
<td>Prior DVT, ex-smoker</td>
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<tr>
<td>14⁺*</td>
<td>Smoker, morbid obesity, noncompliance, prior PE</td>
</tr>
<tr>
<td>15⁺*</td>
<td>Smoker, morbid obesity, noncompliance, prior PE</td>
</tr>
</tbody>
</table>

Patient 14 underwent 2 SPEs.

AF = atrial fibrillation; ASD = atrial septal defect; DVT = deep vein thrombosis; HITT = heparin-induced thrombocytopenia; PE = pulmonary embolism; PFO = patent foramen ovale; PVD = peripheral vascular disease; SPE = surgical pulmonary embolectomy.

*Twin siblings.
†Mortality.
‡Intraoperative diagnosis.
complication rate, after excluding mortalities, was 4 of 15 (26.7%). No bleeding or mediastinitis complications were noted. One patient developed atrial fibrillation that was treated medically, and 1 patient developed pneumonia. Our overall complication rate was 6 of 15 (40%).

Two patients were lost to follow-up. The remaining were seen at 1 month and were followed for an average of 2 to 8 months. No specific follow-up imaging was ordered. A 20-year-old female smoker who had been admitted for trauma underwent repeat echocardiography, which demonstrated significant postoperative pulmonary hypertension.

Comments

The majority of studies of SPE have been conducted at large academic facilities or outside the United States.11 Our series demonstrates favorable outcomes in the community hospital setting for a disease pattern that is associated with a high mortality rate. Our mortality rate of 13.3% (2 of 15) for SPE compares well with the currently reported nationwide mortality rate of 27% to 28%.6,7 Several studies have questioned the accepted mortality rate (29.6%–54%) of SPE.3–5 These studies have demonstrated that earlier intervention in patients who have not yet developed cardiac arrest is the key to reducing mortality.7,8–10 Patients undergoing SPE with preoperative shock have mortality rates between 11% and 31%. When cardiac arrest occurs before SPE, the mortality rate ranges from 58% to 64%.4,5,11 Other groups have proposed a more aggressive approach to SPE, to include patients with submassive PEs. These groups have reported mortality rates as low as 6% to 12.5%.8–10

The 2 deaths in our study occurred in patients who developed nonperfusing rhythms (necessitating salvage SPE), either preceding surgery or during induction. All 8 of our patients who underwent emergent SPE survived. Salvage SPE is performed on the basis of a subjective preoperative assessment of the operating surgeon of very poor prognosis given the clinical conditions. We had a mortality rate of 2 of 12 (16.7%) in patients with unstable hemodynamic profiles, which is very good compared with the literature.

Our overall mortality rate was 13.3%. This compares with even the best reported mortality rates.8–10 Our institution has developed a multidisciplinary approach for diagnosis and treatment of acute PE. This includes participation of radiologists, interventional radiologists, cardiothoracic surgeons, cardiologists, and the critical care team. Early computed tomography and echocardiography facilitate quick diagnosis. If patients are selected for CDT, frequent reevaluation and assessment of medical management are performed. If CDT fails over a period of 24 to 48 hours, the patient is reconsidered for SPE. We feel that because of this multidisciplinary approach, our patients have better outcomes. We believe that it is our multidisciplinary approach, with open and frequent communication among practitioners, frequency of the procedure, as well as nursing and critical care support, that accounts for our high success rate.

There were some limitations to this study. Given our case-by-case evaluation and determination, we feel that we offer our patients the best care. However, this introduced some selection error and bias into our series. Our results may be limited in their extrapolation to the general community; nevertheless, our data demonstrate that this approach is successful in maximizing our patients’ welfare, even in a community hospital, with appropriate support.

Conclusions

Our data suggest that SPE can be performed with favorable outcomes in the community hospital setting. Our mortality rate of 13.3% compares favorably with the nationwide average of 27.2%.

References


Discussion

M. Ashraf Mansour, M.D. (Grand Rapids, MI): All surgeons will recall 1 or more patients who die of a massive pulmonary embolus while the medical personnel remain helpless watching this event unfold. My first question
regards the technique and the team that does the emergency embolectomy. You commented on putting the patients on cardiopulmonary bypass. Do you do a v-fib arrest? Are all these cases done during the day? How many are done in the evenings or on weekends? My second question relates to the diagnosis of pulmonary embolus. Specifically, did you get a CT angiogram on all the patients that you presented today? And did all the patients have a lower extremity duplex scan to diagnose the DVT? My last question is, how many patients had DVT prophylaxis and despite DVT prophylaxis ended up with a pulmonary embolus?

Zachary J. Osborne, M.D. (Urbana, IL): I am going to answer the last question first. It’s more straightforward. Two of the patients in our series were on prophylactic dose. One was on Arixtra from an orthopedic surgery and still developed a PE. Another one was on prophylactic sub-q heparin from a trauma. The majority of them were new patients admitted to the hospital, and so they weren’t on prophylactic therapy. The diagnosis is typically made with both CTA, as well as an echo, a transthoracic echo to diagnose the right heart failure, especially in patients with clinical scenario of hypotension and hypoxia. With regards to cannulation, as we mentioned, we do the right atrial appendage in the aortic route. We do not do a cardioplegic arrest on our patients typically. And we do these at all hours of the night and we pull everybody in to take care of these.

A. Peter Ekeh, M.D. (Dayton, OH): What kind of guidelines, checks, balances, would you propose to prevent every single patient that has a PE from getting this procedure?

Dr Osborne: There is a very in-depth conversation that occurs between the cardiothoracic surgeon, the interventional radiologist, because we do offer catheter-based therapies at our hospital as to what this patient is going to benefit from the most. Is it someone who will benefit from the immediate restoration, is it somebody that know her comorbidities, their comorbidities would be more devastating to do this type of procedure, and let’s give them the chance to do the catheter-based therapy.