A Swan-Ganz Catheter Related Complication in a Patient with Eisenmenger’s Syndrome

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The maternal and perinatal mortality rates in patients with Eisenmenger’s syndrome are 30.3% and 28.3%, respectively.¹ The use of pulmonary artery flow-directed (Swan-Ganz) catheters in pregnant patients with Eisenmenger’s syndrome has not been associated with complications. We describe a patient with Eisenmenger’s syndrome who we believe died as a result of a Swan-Ganz-related complication.

REPORT OF A CASE

A 28-year-old, 30-week pregnant woman was admitted to the hospital complaining of moderate hemoptysis and pleuritic chest pain. Eight months previously, she was hospitalized for investigation of an asymptomatic heart murmur. A cardiac catheterization study was undertaken from which the diagnosis of Eisenmenger’s syndrome with a VSD was made. She had one previously successful pregnancy three years prior to the present admission. She had no complaints during her current pregnancy and continued her job as an assembly line worker until three days before her admission when she coughed up blood-tinted sputum.

On admission, she was in mild respiratory distress with a respiratory rate of 24 breaths/min. Her oral temperature was 36.4° C. She was mildly cyanotic. Decreased air entry as well as some rales were heard in the right lower lung field. Examination of the cardiovascular system revealed a heart rate of 100 beats/min and an arterial blood pressure of 112/78 mmHg. The apex was felt to be slightly hyperdynamic and a grade 2/6 pansystolic murmur was heard along the left sternal border. Marked clubbing was evident and a prominent A wave was noticed in the jugular venous pulses. Swelling of the ankles, ascites, and hepatomegaly were not present.

An electrocardiogram showed a sinus rhythm with a normal axis. A prominent R wave was noted in lead V1. While breathing room air, $p_{O_2}$ was 7.44 mmHg, $p_{CO_2}$ 29 mmHg, and $p_{CO_2}$ 39 mmHg. The electrolytes were within the normal limits. Her hemoglobin was 13.2 g/dl and the white blood cell count was 11,100/mm³. Atelectasis in the right lower lobe with a mildly elevated right hemidiaphragm were seen on the chest roentgenogram. A lung scan was interpreted as being normal. Since the diagnosis of pulmonary embolism was possible, heparin was given for anticoagulation. Oxygen was also administered via a face mask. Her seven-week prepartum hospital course was uneventful except for several episodes of moderate hemoptysis. She was estimated to be 37 weeks pregnant as assessed by ultrasonography in the week prior to her delivery. Heparin was stopped three days prior to cesarean section and betamethasone was given im.

An emergent cesarean delivery was planned, because a non-stress test showed lack of beat-to-beat variability and a persistent fetal tachycardia of 170 beats/min. There also was a persistent low maternal $p_{O_2}$ of 40 mmHg.

An arterial and a Swan-Ganz catheter were inserted prior to the induction of anesthesia. Table 1 indicates pulmonary and systemic pressures and arterial oxygenation. The electrocardiogram and temperature also were monitored.

The patient was prepped and draped while awake. A rapid sequence induction technique with cricoid pressure was used and anesthesia was induced with 2 mg pancuronium bromide, 100 mg ketamine, and 100 mg succinylcholine. Oxygen, 100%, with a succinyl choline drip to facilitate muscle relaxation were administered. After delivery of a viable infant, 50 µg fentanyl was administered iv and 30% nitrous oxide inhaled.

Preoperatively, the systemic arterial pressure was 10 mmHg higher than the pulmonary artery pressure, while during induction of anesthesia both rose by 10 mmHg. The gradient between these pressures remained unchanged throughout the procedure and the postoperative period (table 1). Postoperatively, the patient was awake and the trachea extubated. She was sent to the intensive care unit where her recovery was uneventful.

Throughout her postoperative course she continued to have a significant shunt with a $p_{O_2}$ of 42 mmHg with a $p_{CO_2}$ of 0.7. Chest roentgenograms obtained at this point were interpreted as normal.

On the fourth postoperative day, the Swan-Ganz catheter was removed as the patient was asymptomatic and, except for poor oxygenation, was doing well. The catheter was not providing any useful information. Immediately on attempted withdrawal, the patient rolled her eyes up and became unconscious. The pressure trace from the arterial cannula disappeared and no pulses could be obtained while the EKG showed a normal sinus rhythm. Basic cardiac life support was instituted and resuscitation attempted with calcium, adrenaline, and noradrenaline. At no time was a pulse obtained. Her rhythm deteriorated to a profound sinus bradycardia and eventually asystole over a 20 min period. Attempts at transvenous pacemaking were unsuccessful. Permission for an autopsy was denied.

The infant did well and was discharged home on the twenty-sixth day of life with a weight of 2,720 g.

DISCUSSION

While the diagnosis could not be proven, the temporal sequence of events strongly points to an intravascular thrombosis with a subsequent pulmonary or systemic embolization across the ventricular septal defect to either the cerebral or coronary circulations during the attempted withdrawal of the Swan-Ganz catheter. There-
TABLE 1. Arterial Oxygenation and Pulmonary Artery and Systemic Pressures

<table>
<thead>
<tr>
<th>Time</th>
<th>F_{O_2} (%)</th>
<th>P_{O_2} (mmHg)</th>
<th>Systemic Arterial Pressure</th>
<th>Pulmonary Arterial Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Systolic/Diastolic (mmHg)</td>
<td>Mean (mmHg)</td>
</tr>
<tr>
<td>Admission</td>
<td>0.21</td>
<td>48</td>
<td>112/80</td>
<td>89</td>
</tr>
<tr>
<td>Preoperative</td>
<td>0.8</td>
<td>58</td>
<td>100/70</td>
<td>80</td>
</tr>
<tr>
<td>Intraoperative</td>
<td>0.7</td>
<td>56</td>
<td>105/80</td>
<td>88</td>
</tr>
<tr>
<td>Immediate</td>
<td>0.5</td>
<td>52</td>
<td>150/90</td>
<td>111</td>
</tr>
<tr>
<td>Day 1</td>
<td>0.5</td>
<td>37</td>
<td>130/84</td>
<td>99</td>
</tr>
<tr>
<td>Day 2</td>
<td>0.7</td>
<td>47</td>
<td>97/73</td>
<td>81</td>
</tr>
<tr>
<td>Day 3</td>
<td>0.7</td>
<td>42</td>
<td>99/72</td>
<td>79</td>
</tr>
<tr>
<td>Day 4</td>
<td>0.8</td>
<td>39</td>
<td>101/72</td>
<td>82</td>
</tr>
</tbody>
</table>

fore, we decided to reassess the risks and benefits of pulmonary artery catheterization as a monitor in patients with Eisenmenger’s syndrome. Of particular importance to patients with Eisenmenger's syndrome are the complications of embolization, pulmonary artery rupture, and arrhythmias.

Embolization is important in this group of patients for two reasons. First, the pulmonary vascular tree has a reduced compliance and reserve. Further obstruction, no matter how small, may have a profound effect on the pulmonary vascular resistance and therefore the degree of right-to-left shunt. The second reason is the threat of systematic embolization across the congenital cardiac defect.

Rupture of the pulmonary artery is also a problem in these patients. Patients with pulmonary hypertension are more susceptible to this complication. The mechanism is believed to be a result of the increased pressure gradient across the balloon of the catheter. With pulmonary artery pressures approaching systemic on one side of the balloon opposed by the wedge pressure on the other side, there is a tendency for increased vessel trauma by impaction of the balloon into a smaller more peripheral vessel. Second, the sclerotic pulmonary vessels are less compliant and may not tolerate dilation of the balloon.

Finally, arrhythmias also pose a serious risk. Life-threatening ones such as complete heart block or ventricular fibrillation are more difficult, if not impossible, to terminate because of increased shunting and deterioration in oxygenation. Arrhythmias which are considered more benign, such as atrial or ventricular premature beats or atrial fibrillation, will not be as well-tolerated because of a reduced cardiac output.

The use of Swan-Ganz catheters in patients with Eisenmenger’s syndrome during pregnancy and labor has been described several times. In fact, one group of authors have suggested that every patient with Eisenmenger’s syndrome in labor should have such a monitor inserted. Before adopting such a position, the clinical usefulness of the information provided by the pulmonary artery catheter should be considered.

The various congenital cardiac lesions associated with Eisenmenger’s syndrome should be considered separately. In the presence of a large interatrial communication the use of the Swan-Ganz catheter seems to be of benefit. It gives a simultaneous reading of the right atrial pressure and, by measuring the pulmonary capillary wedge pressure, a close approximation of the left atrial pressure. The degree and direction of the shunt can be estimated by monitoring the interatrial pressure gradient. If the atrial septal defect is large enough, giving a functionally common atrium, a pulmonary artery catheter may not be required, as there is no interatrial pressure gradient. Patients with Eisenmenger's syndrome secondary to an aorto-pulmonary communication also can be monitored with a Swan-Ganz catheter by simultaneously measuring the pulmonary arterial and systemic arterial pressures. The degree and direction of the shunt can be predicted. Patients with an interventricular communication and Eisenmenger's syndrome appear to be different because at best, only part of the systolic events can be monitored with pulmonary and systemic arterial pressures. Because the pulmonary and aortic valves are closed in diastole, pulmonary and systemic pressure monitors can not detect pressure gradients within the ventricles. There, the clinician is blind to the hemodynamic events in diastole when using both pulmonary artery and systemic pressure monitoring. Ideal monitoring in this situation would be the ability to continuously monitor both right and left ventricular pressures which presently is impractical.

Thermodilution cardiac output determinations are meaningless because of the type and varying degree of shunt. In the presence of a right-to-left shunt, some of the indicator will be lost across the defect, thus giving a falsely high determination. In a left-to-right shunt the cold indicator will be diluted by shunted blood giving an accurate reading of an elevated pulmonary blood flow. The actual determination will be difficult to interpret as
the degree of shunt may vary within a cardiac cycle or from beat to beat. Cardiac output must be determined by some other means, such as Fick's principle.

The use of heparin-coated pulmonary artery catheters has been described with the thought that they may reduce the incidence of thrombotic complications. These were unavailable when our patient presented to hospital. Chastre et al.3 recently reported their incidence of jugular venous thrombosis after Swan-Ganz catheterization. It is interesting to note that of the 22 patients that developed angiographically proven thrombosis, 14 patients were receiving low dose heparin and one was fully hepari- nized. The use of indwelling introducer sheaths may negate any benefit derived from heparin-coated catheters.

Finally, the length of time the catheter was left in situ deserves comment. Because of the potential complications associated with these devices, they should be removed when no further useful information is provided. In our patient this corresponds to about four to six hours in the postoperative period rather than four days it remained in situ.

In summary, patients with Eisenmenger’s syndrome due to interatrial or aorto-pulmonary communications will benefit from the use of Swan-Ganz catheters to monitor pressure gradients between the right-to-left circulations. However, the situation in patients with an interventricular communication is different because the ability to monitor both right and left intraventricular pressures is unavailable. It appears the risk of pulmonary artery catheters far outweighs the benefits in patients with Eisenmenger’s syndrome associated with interventricular communications. Knowledge of pulmonary hypertension alone is relatively meaningless. It is critical, however, that the state of oxygenation can be rapidly and accurately assessed. Perhaps a better and safer method of determining the degree of right-to-left shunting and oxygenation instantaneously, in these patients, is the use of either cutaneous oximetry or transcutaneous PO2 measurements in conjunction with the use of a central venous pressure catheter. However, any monitor of the central circulation is not without its complications. It appears that ketamine and succinylcholine are a reasonable choice of agents for induction of general anesthesia for cesarean delivery in patients with Eisenmenger’s syndrome.

In our patient, the Swan-Ganz catheter did not help in her management and may have contributed to her demise. We wonder if the outcome would have been different if she had been monitored in a different manner.

REFERENCES