CASE REPORTS

Aortic Valve Replacement Complicated by Bronchial Artery Hemorrhage

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Intrapulmonary bleeding after cardiopulmonary bypass (CPB) is an uncommon but well-known adverse event that presents both diagnostic and therapeutic challenges. Diagnostic challenges relate to the lung’s dual arterial supply, and therapeutic challenges involve concerns with the amount of ventilatory capacity that may need to be sacrificed to achieve hemostasis. The pulmonary artery (PA) is, by far, the most common source of bleeding in such cases. Drawing on extensive documentation of PA hemorrhage in the literature, efforts have been made to standardize localization and therapeutic management of such hemorrhages. A case of bronchial artery bleeding after aortic valve replacement is reported here, as the authors found the literature to be completely devoid of discussion on hemorrhage from such rare sources in the setting of CPB.

CASE REPORT

A 55-year-old, 53-kg, female with a past medical history significant for bipolar disorder, psychogenic polydipsia, and hypertension had been evaluated for syncope. A transthoracic echocardiogram found critical aortic stenosis and a mildly dilated (4.4 cm) proximal ascending aorta with preserved ventricular function. Chest x-ray, cardiac catheterization, coagulation, and renal parameters were unremarkable. She was scheduled later for elective aortic valve replacement.

After uneventful anesthetic induction, a 7.5-Fr endotracheal tube (Teleflex Medical, Research Triangle Park, NC) easily was introduced. Via the right internal jugular vein, an 8.5-Fr Cordis catheter (Arrow International Inc, Reading, PA) was placed, and a pulmonary artery catheter (Edwards Lifesciences LLC, Irvine, CA) was floated into the PA without difficulty and no wedging was performed. A transesophageal echocardiography (TEE) probe (Philips, Bothell, WA) also was placed without difficulty. Her preCPB period was uneventful, and before initiation of CPB, the PA catheter was withdrawn by 3 cm.

Separation from CPB after AVR with a #21 pericardial tissue bio-prosthesis (Carpentier-Edwards, Irvine, CA) was complicated by a severely hypokinetic right ventricle as visualized by TEE. The right coronary artery was grafted as the ostium was occluded by the new valve, and she was weaned uneventfully from CPB with norepinephrine and epinephrine infusions. Cardiac ischemia lasted a total of 165 seconds, hypothenar hyperemia and a venous stula were found in a peripheral portion of the right bronchial artery (BA). Tortuous bronchial vasculature was visualized, and a large clot in the right lower lobe bronchus, which subsequently was removed with the bronchoscope. A right lower lobe bronchial blocker (Storz, El Segundo, CA) was performed. This found a large clot in the right lower lobe bronchus, which subsequently was removed with the bronchoscope with difficulty. Thereafter, oxygenation and ventilation significantly improved, but the patient became hemodynamically unstable, requiring significant doses of epinephrine, norepinephrine, and milrinone.

Mediastinal re-exploration was negative for bleeding, but the patient’s oxygenation remained consistently marginal, with PaO2 values in the realm of 60 mmHg on 100% oxygen. Coagulation studies showed an activated partial thromboplastin time (aPTT) of 116 seconds, hypofibrinogenemia (116 mg/dL), and a platelet value of 45,000 per microliter and TEG revealed severe coagulopathy. In response, 4 units of fresh frozen plasma, 1 unit of platelets, and 1 unit of packed red blood cells were administered, and coagulopathy and anemia were corrected; significant improvement was noted in the follow-up TEG. Intraoperative bronchoscopy revealed persistent bleeding in the right lower lobe, with clot reorganization. Ten milliliters of a 1/10,000 solution of epinephrine was directed into the right lower lobe bronchus via the bronchoscope. A right lower lobe bronchial blocker (Fuji Systems Corporation, Bunkyo-ku, Tokyo) was placed, with no significant change in PA pressures. The patient then was transferred to the interventional radiology suite with the aim of identifying and embolizing responsible feeding vessels (Fig. 2). Upon catheterization, hyperemia and a venous fistula were found in a peripheral portion of the right bronchial artery (BA). Tortuous bronchial vasculature prevented focal embolization of the bleeding site, and the entire right intercostobronchial trunk was embolized. After embolization, the patient’s oxygenation mildly improved with a PaO2 of 101 mmHg. She was transferred to the ICU still requiring significant doses of inotropes and vasopressors with the lobar blocker still in place.

The bronchial blocker was removed after a few hours when follow-up bronchoscopy revealed no active bleeding. The patient’s clinical course continued to be complicated by respiratory failure warranting tracheostomy, and subsequently, the patient was transferred to home nursing care on postoperative day 28.

DISCUSSION

In the setting of CPB, pulmonary hemorrhage can originate from either the PA or bronchial circulation; the former is much more common with an incidence of between 0.05 and 0.2%. Most of these events are ascribed to pulmonary artery...
catheter-induced injury of the pulmonary artery and, less commonly, from the insertion of vents into either the pulmonary vein or artery. The clinical course of such hemorrhage is highly variable, ranging from rapid exsanguination requiring immediate surgical intervention to insidious bleeding manifested only by hemoptysis that is addressed solely by heparin reversal. PA hemorrhage as a complication of pulmonary artery catheterization has a mortality rate of between 41% and 50%. Because of the high rate of morbidity and mortality associated with PA hemorrhage, all cases of intrapulmonary bleeding merit rapid identification of the source and immediate treatment, which includes either withdrawal or removal of the PA catheter in a controlled environment. When confronted with exsanguinating hemoptysis, defined as 150 mL per hour or 1000 mL overall, rigid bronchoscopy has been suggested as an optimal tool for initial management because its large lumen allows for the use of various diagnostic and therapeutic modalities including bronchoscopy and bronchial blockers.

Because as many as 90% of PA injuries in the setting of CPB present as right middle lobe and/or right lower lobe airway hemorrhage, the initial work-up of the fiberoptically confirmed right lower lobe hemorrhage consisted of ruling out a source that could be corrected on re-exploration of the chest. Once this was done and no obvious bleeding source was identified, alternative sources of bleeding from the bronchial circulation were considered while correcting the coagulopathy with appropriate blood products. While preparing for bronchial angiogram in the hybrid operating room, hemostasis was attempted with noninvasive methods, including use of bronchial blocker and installation of an epinephrine solution directly into the bronchus.

A bronchial artery source of bleeding was suggested by the subacute presentation and more closely resembled cases of intraparenchymal hemorrhage seen in chronically ventilated patients. Such bleeding presents as hemoptysis and in up to 90% of cases emanates from bronchial artery circulation. In our case, bronchial artery bleeding detected as extravasation (Fig 2). In addition, bronchial arteriovenous fistulae were found. An association between aortic stenosis and vascular anomalies especially in the gastrointestinal tract has previously been noted in the literature.
Embolization of BA has proven extremely effective since first reported in 1973, with initial success rates between 77% and 94% when a BA source is identified. To minimize complications associated with interrupting one of the two principal arterial supplies to the lungs, focal embolization of only the bleeding bronchial arterial branches is desired. In the present case, passage of the radiologist’s microcatheter into the small bleeding branches was prevented by the unusually tortuous anatomy of the patient’s bronchial artery tree, necessitating embolization of the entire right intercostobronchial trunk. Functionally, the BA supplies the trachea, visceral pleura, extrapulmonary and intrapulmonary airways, bronchovascular bundles, nerves, supporting structures, regional lymph nodes, and esophagus, as well as the vasa vasorum of the aorta, pulmonary vein, and pulmonary artery (Fig 3). Accordingly, embolizing the main arterial supply to numerous vital pulmonary structures carries substantive risk. The complication rate is between 21% and 94%, with chest pain being the most frequent complaint followed by dysphagia, which may present in up to 18% of cases. Spinal cord ischemia is the most feared complication, with an incidence between 1.4% and 6.5%. The metabolic function of the lung can be compromised, and pulmonary infarction is a known but rare complication. In the present case, persistent failure to wean from ventilation may have been a complication of eliminating the entire right-sided branch of this critical arterial supply, but this is not certain.

Supportive measures for hemostasis have been described previously. The authors attempted a direct intrabronchial instillation of a 1/10,000 solution of epinephrine, a technique for which the literature reports varying degrees of success. Isolation of the bleeding region of the lung is a temporizing measure designed to prevent hemorrhage into healthy lung until definitive hemostasis is achieved. In the present case, the localized bleeding allowed for the use of a lobar blocker, thus preserving oxygenation in unaffected lung segments and minimizing the degree of ventilation/perfusion mismatch. If lobar localization is not possible, a double-lumen tube may be used to isolate either lung. Other minimally invasive methods to achieve hemostasis include endobronchial thrombin-fibrinogen and endobronchial balloon tamponade. Both techniques have shown high success rates but were not attempted in the present case. For cases in which hemorrhage leads to severely compromised gas exchange, extracorporeal membrane oxygenation or even partial lung resection may be necessary.

CONCLUSION

Intrapulmonary hemorrhage in the setting of CPB is not uncommon, and awareness of diagnostic challenges and appropriate therapeutic options for this rare source of bleeding is important.

REFERENCES