Anesthetic Considerations for the Patient with Hereditary Hemorrhagic Telangiectasia (Osler-Weber-Rendu Syndrome)

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Hereditary hemorrhagic telangiectasia (HHT), Osler-Weber-Rendu Syndrome, is an uncommon disease but may be present in many people who remain undiagnosed. It is an autosomal dominant disorder characterized by multiple arteriovenous malformations (AVMs) and telangiectases that affect multiple organ systems. Hereditary hemorrhagic telangiectasia patients have a propensity for bleeding, especially from the oropharynx, nasopharynx and gastrointestinal tract, as well as from rupture of AVMs of other organ systems. Anesthetic care of patients with HHT involves very specific interventions with regard to control of bleeding, maintaining adequate oxygenation, and balancing hemodynamic values to optimize perfusion without compromising anesthetic depth.

Keywords: Arteriovenous malformations, hereditary hemorrhagic telangiectasia, Osler-Weber-Rendu syndrome, telangiectasia.

Hereditary hemorrhagic telangiectasia (HHT), also known as Osler-Weber-Rendu syndrome, is an autosomal dominant vascular dysplasia that affects multiple organ systems. The condition is characterized by the lack of communicating capillaries connecting arteries and veins resulting in multiple arteriovenous malformations (AVMs) and telangiectases.[1] Telangiectases are small AVMs that lie just beneath the surface of mucous membranes and skin and are easily ruptured with resultant bleeding.

Arteriovenous malformations are arteries and veins that are connected without the usual capillary bed.[2] Without normal growth, the arterial vessels become thinner causing shunting of arterial blood to the venous system, from high pressure to low pressure without the capillary network that predisposes them to rupture. Arteriovenous malformations have the capacity for rupture and resultant hemorrhage regardless of their location.

Although this condition is considered to be uncommon, it is not rare. As many as 1:5,000 individuals are affected and many more are thought to be living with this disease undiagnosed.[1] Diagnostic criteria include (1) a first-degree relative (parent, sibling, or child) with the disorder, (2) telangiectases of lips, nose, oral cavity, and/or fingers, (3) any of the internal AVMs discussed above or gastrointestinal (GI) telangiectasia, and (4) recurrent, spontaneous epistaxis. The presence of 3 of the above symptoms is definitive for a diagnosis of HHT. The patient with 2 of these symptoms is likely to have HHT and should be evaluated more thoroughly.

The most common manifestations of HHT include epistaxis (90%-95% incidence), facial telangiectases (33% incidence) and telangiectases of the hands and wrists (41% incidence).[1] Up to 15% of individuals have at least 1 cerebral AVM and although the incidence of hepatic AVMs is unknown, those reported are quite large.[1,3] Pulmonary arteriovenous malformations (PAVMs) may occur in as many as 50% of patients with HHT and are a significant cause of morbidity.[1,4]

Pulmonary arteriovenous malformations are often of such significance to cause a right-to-left shunt resulting in hypoxemia and/or heart failure.[3,5] In normal lungs the capillary matrix connecting the arteries and veins acts as a filter for thrombi, air, and bacteria. In the absence of this filtering network they pass directly into arterial circulation. If this material becomes lodged in small arterioles, it may result in dyspnea, hypoxemia, and pulmonary hemorrhage, as well as ischemic strokes and brain abscesses with subsequent neurological deficits.

Hepatic AVMs also impose a great risk to the patient with HHT. Liver complications are noted in up to 31% of HHT cases including hepatic fibrosis and cirrhosis.[6] Hepatic AVMs cause shunting to occur and may allow thrombi, bacteria, and other infiltrates from the enteric circulation into the systemic circulation.[1,3] Loss of the downgrade of pressure from arteries to veins creates a high pressure blood flow through the hepatic portal system and vena cava. This high-pressured blood flow returning to the right side of the heart may result in right heart failure from hyperdynamic circulation.[3] Likewise, portal hypertension may occur subsequent to a thrombotic event in the liver resulting in esophageal varices. A hepatic thrombus traversing the venous circulation may end up in the pulmonary vasculature or even in the brain. Cirrhosis is a documented end result of the destructive nature of hepatic AVMs in HHT.[3]

Anesthetic Management

Patients with HHT may present for embolization procedures of AVMs, as well as for non–HHT-related procedures. Regardless of the procedure or underlying cause, the diagnosis of HHT will have an impact on many aspects of the anesthetic plan of care. Patients with HHT require as first priority of anesthetic management the prevention of bleeding from telangiectases in the oropharynx, trachea, and lungs.[7] It is important to assess the patient's hemoglobin and hematocrit, platelet count, and coagulation studies to evaluate the propensity for bleeding and to ascertain if the patient has had any recent occult bleeding.

Since the telangiectases are frequently located in the oropharynx, a thorough airway assessment is essential. The intubation plan should include a gentle direct laryngoscopy with minimal manipulation of the airway using lubricated materials to minimize tissue trauma. Avoidance of instrumentation of the nose and nasal mucosa may reduce the incidence of epistaxis in patients with HHT. Nasotracheal intubation should be performed only when necessary and then the anesthesia provider should anticipate extensive bleeding as a result. Progressive dilatation of the nares using nasopharyngeal airways of increasing size may mitigate the tissue trauma of nasotracheal intubation. Suctioning or insertion of devices in the oropharynx or nasopharynx should be done only when warranted using extreme caution.

As mentioned previously, the loss of the filtering capacity from the capillary network in AVMs may result in thrombus formation and embolic events, this time in the lungs. Therefore, filters should be placed in the intravenous (IV) line at the hub to protect the patient from the air bubbles and micro-air emboli that are often found in IV tubing.[1] Pulmonary AVMs cause a right-to-left shunt and may result in a hypoxemia or mimic symptoms of airway obstruction.[1,8] In the presence of a pulmonary AVM, oxygenated arterial blood bypasses the microcirculation where gas exchange occurs. Hypoxemia results from the loss of gas diffusion.

Positive pressure ventilation may exacerbate shunting in PAVMs and worsen arterial hypoxemia. Spontaneous ventilation should be maintained or restored as early as possible.[8] During positive-pressure ventilation, lower airway pressures should be maintained and hemoptysis should be investigated thoroughly.[9]

Endocarditis, another condition secondary to AVMs, is caused by bacterial invasion of the myocardium.[2] PAVMs support the development of endocarditis by allowing unfiltered blood to return to the heart. Prophylactic antibiotic coverage is therefore necessary before surgical and dental procedures.[1]

Patients presenting with a cerebral AVM require meticulous hemodynamic management. Increased blood pressures could cause an AVM rupture with subsequent cerebral bleeding.[8] Therefore, maintaining the patient's blood pressure within 20% of their normal limit blood pressure is warranted throughout the procedure, especially during the critical periods of induction and emergence. Controlled hypotension may be an option for the management of patients with known cerebral AVMs, as well as those with a propensity toward bleeding.

Pregnant women with HHT are at increased risk for pulmonary hemorrhage both during pregnancy and postpartum because of an increase in blood volume and cardiac output.[1] Epidural analgesia for labor is contraindicated if coagulation studies are abnormal; however, epidurals have been safely used in parturients with HHT.[9] A pulmonary evaluation should be done as soon as pregnancy is confirmed in patients with HHT to evaluate for the presence of pulmonary AVMs.[10] The physiologic changes that accompany pregnancy, increased blood volume and cardiac output, render AVMs more vulnerable to rupture leading to excessive blood loss that could result in fetal distress.

Patients with thrombi or in atrial fibrillation usually tolerate low-molecular-weight heparin well.[1] Nonsteroidal anti-inflammatory drugs are often tolerated for short periods.

Patients with systemic AVMs will have left-to-right shunts resulting in a baseline decreased systemic vascular resistance.[8] Anesthetic-induced decreases in systemic vascular resistance should be avoided.[11] Because AVMs lack vascular tone, the HHT patient will have an unpredictable response to induced hypotension. Additionally, these vascular anomalies do not respond to vasoconstrictor medications as do normal vessels. Optimizing fluid status before induction is the first step in maintaining an adequate blood pressure in any patient, especially the patient with HHT.

Excessive bleeding intraoperatively should be anticipated as well. In addition to hepatic-mediated coagulopathies, interference with thrombus formation can result from an increase in plasminogen activator levels in the endothelium of the telangiectatic tissue itself.[8] In addition to fluid replacement, the administration of fresh frozen plasma and platelets may be indicated in this situation.

Case Summary

A 61-year-old female, 165 cm, 72 kg, presented at the outpatient surgery area for an anterior and posterior colporrhaphy, bladder neck suspension, and pubovaginal sling placement for the repair of the cystocele and rectocele. Initial vital signs included a noninvasive blood pressure of 116/74 mm Hg, radial pulse of 78/min, respiratory rate of 16/min, and oral temperature of 97.9°F. An 18-gauge angiocath with an attached filter at the hub was inserted with an infusion of lactated Ringer's solution at 100 mL/h.

A preoperative assessment was completed. The patient's medical history was significant for asthma, hy-

pothyroidism, gastroesophageal reflux disease, and hereditary hemorrhagic telangiectasia. History, as it related to HHT, included rosacea, bleeding gums with oral care, occasional epistaxis, and verified cerebral, esophageal, and intestinal AVMs. She reported a previous embolization of a PAVM 3 months earlier. The patient also reported hemorrhage following aspirin administration in childhood.

Non–HHT-related history included a total vaginal hysterectomy 12 years earlier, left mastoidectomy 15 years earlier, and a tonsillectomy and adenoidectomy in childhood. She was a nonsmoker and denied using alcohol or illicit drugs.

Current medication therapy included levothyroxine, minocycline, pantoprazole, fluticasone proprionate inhaler, albuterol inhaler, ezetimibe, polyethylene glycol, calcium with vitamin D, vitamin A, magnesium, and zinc (all taken daily except for the albuterol inhaler). The patient took her levothyroxine, minocycline, and ezetimibe with a sip of water the morning of surgery and brought the inhalers with her to the hospital.

Allergies and sensitivities to medications included aspirin that resulted in bleeding; sulfa, dicyclomine, cetirizine, and tolterodine tartrate, that resulted in bronchospasm; ciprofloxacin, augmentin; and morphine that resulted in GI distress.

Pertinent laboratory data were obtained 13 days before surgery. Hemoglobin/hematocrit, 14.0 g/dL and 42.0% respectively; platelet count, 205 k/μL. Her white blood cell count and renal and hepatic function studies were within normal limits. Coagulation studies were also within normal limits.

The patient's airway was determined to be a Mallampati class II with adequate neck extension and an estimated 5-cm thyromental distance. She was declared an ASA physical status 2 and general anesthesia with an endotracheal tube was planned including avoidance of unnecessary manipulation of her airway and oropharynx and nasopharynx.

The patient was premedicated with 2 g ampicillin, 2 mg midazolam, and a total of 100 μg of fentanyl in 2 divided doses during which time she was preoxygenated with 8 L of 100% oxygen via face mask. Monitors were applied during the preoxygenation period as well as including a 5-lead cardiac monitor for evaluation of leads II and V5 and continuous ST segment evaluation. Pulse oximetry and blood pressure cuff also were used. Intravenous lidocaine, 75 mg, was administered before induction to further blunt the sympathetic nervous system response to direct laryngoscopy and endotracheal intubation.

A smooth IV induction was achieved using propofol, 200 mg, and succinylcholine, 100 mg, after which an atraumatic rapid sequence intubation with cricoid pressure, a Miller 2 blade and 7.0-mm endotracheal tube (ETT) was completed. The ETT was lubricated with water-based lubricant before insertion. The view of the larynx on direct laryngoscopy was Cormack-Lehane grade I with significant vascularity of the oropharynx noted. Multiple telangiectases were observed in the posterior oropharynx and the posterior tongue.

The patient was repositioned to lithotomy position and the surgery commenced. The decision was made to forego an orogastric tube or any further manipulation of the oropharynx. Gentle positive pressure ventilation was provided at a tidal volume of 6 mL/kg in order to maintain low peak inspiratory pressures of up to 15 mm Hg throughout the case. Her respiratory rate was titrated between 8 and 12/min to maintain an Sa_{O_2} of 99% to 100% and $ETCO_2$ at 29 to 31 mm Hg.

Metaclopramide, 10 mg, and dolasetron, 12.5 mg, were administered for postoperative nausea and vomiting prophylaxis. Total lactated Ringer's solution was infused throughout the 2-hour case was 1,200 mL; the patient did not have an indwelling catheter for measurement of urine output because of surgeon preference following bladder neck suspension.

Spontaneous breathing was resumed early in the case and the patient maintained tidal volumes greater than 300 mL and respiratory rate of 12 to 16/min throughout the remainder of the case. The oropharynx was delicately suctioned with a lubricated small suction catheter tip at the conclusion of the procedure. No additional airway adjuncts were used throughout the case. The patient was extubated with 1.4% end-tidal sevoflurane and tidal volumes of greater than 300 mL and respiratory rate of 12/min. She did not cough or buck from extubation of the ETT. Estimated blood loss was approximated to be less than 100 mL and no blood products were used.

Discussion

Key aspects of the anesthesia management of the patient with HHT include interventions to maintain normal hemodynamic parameters and to prevent bleeding and the formation of emboli. The existence of AVMs require diligent attention to the particular organ systems involved. Particular attention should be paid to known AVMs and their locations, the high incidence of oropharyngeal and nasopharyngeal telangiectases, and the propensity toward excessive bleeding.

Most patients with HHT will have telangiectases in the airway. Disturbance of these lesions with instrumentation or irritation may cause excessive bleeding. Anesthesia providers should use extreme caution with airway techniques whether it is direct laryngoscopy or laryngeal mask airway insertion. Nasal penetration should be avoided, if at all possible.

Because of the high incidence of esophageal varices and oropharyngeal telangiectases, bleeding from the GI tract is common. Instrumentation of the esophagus

should be carefully performed only when necessary. Lubricants and gentle insertion of gastric tubes are paramount. An air filter was inserted inline with the IV infusion set to capture air bubbles or particulate matter from intravenous infusions and injections. A broad spectrum antibiotic was administered preoperatively for bacterial infection prophylaxis. Continuous 5-lead electrocardiograph monitoring was maintained in leads II and V5 for dysrhythmias and ischemia. ST segments also were monitored for signs of intraoperative ischemia. A smaller-sized ETT was chosen for this patient, and the tube was adequately lubricated to prevent any undue tissue trauma. Likewise, gentle airway manipulation during endotracheal intubation was a priority in this case.

Increases in intracranial pressure/systolic blood pressure during intubation were avoided using 1 mg/kg lidocaine IV before induction. Peak airway pressures were maintained at or below 15 mm Hg, and ventilation was delivered using gentle positive pressure. Adhesive tape was not used over the lips when securing the ETT to protect the integrity of the skin.

The oropharynx was noted to have extraordinary vascularity, and telangiectases were visualized on direct laryngoscopy. The patient's history of gastroesophageal reflux may have warranted placement of an orogastric tube. However, in this patient's case and with consideration to the presence of several oropharyngeal telangiectases and a known GI AVM, the choice was made not to decompress the stomach with an orogastric tube but to administer metoclopramide for its GI prokinetic activity. No oral or nasal airways were used during induction or emergence for the reasons stated above. The oropharynx was suctioned using a small lubricated suction catheter. The patient was extubated deep with attention to and documentation of a smooth, gentle emergence to avoid bucking or coughing and to prevent blood on suctioning and extubation.

Conclusion

Patients with HHT, in most cases, have lived with the disease many years before diagnosis and are often very educated on their condition. Reassurance that the anesthetist is familiar with the syndrome and the anesthetic adaptations to prevent an adverse outcome will engage the patient's trust and confidence in his or her anesthesia provider and help ease anxieties. A basic knowledge of the challenges presented with a patient with HHT is the first step in providing a safe and effective anesthetic technique.

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