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Cardiac Ablation
Preeclampsia
Difficult Airway
Kidney Transplant
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<tr>
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<td>University of Pennsylvania, Villanova University</td>
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<tr>
<td>Diana Faulk, CRNA, MS</td>
<td>Harbor-UCLA Medical Center</td>
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<tr>
<td>Sandy Ouellette, CRNA, MEd, FAAN</td>
<td>President, International Federation of Nurse Anesthetists</td>
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<td>Mary Wojnakowski, CRNA, PhD</td>
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<tr>
<td>Allen Benfield, LCDR, NC, USN, MS, CRNA</td>
<td>Naval Regional Medical Center, Portsmouth, Va.</td>
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<tr>
<td>Marjorie E. Geisz, CRNA, MS</td>
<td>Louisiana State University Health Science Center</td>
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**Front Cover:** Colleen C. Walser, MSN, SRNA, University of Scranton, administers anesthesia for robotic surgery.

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Anesthesia for Robotic Assisted Laparoscopic Surgery
Colleen C. Walser, MSN
Wyoming Valley Health Care System
University of Scranton

Key words: robotic, telemanipulator, da Vinci system, laparoscopic, minimally invasive

During the past decade there has been an increase in the use of minimally invasive surgical procedures which include laparoscopic or endoscopic surgery. A laparoscopic approach may be utilized for gastrointestinal, gynecological and urological procedures. Advantages of laparoscopic surgical procedures include a decrease in postoperative pain, reduction in hospital stay, return to normal activities more quickly, and cost savings. Robotic assisted laparoscopic surgery enhances the dexterity and precision with three dimensional imaging to overcome the limitations of traditional laparoscopic surgery but presents additional anesthesia challenges. This case study discusses anesthetic management for robotic assisted laparoscopic ovarian cystectomy surgery.

Case Report

A 13 year old, 88 kg, 63 in, ASA 2 female presented for laparoscopic robotic assisted excision of an abdominal cystic mass. The patient’s past medical history was significant for seasonal allergies, a history of anemia which had resolved, obesity, and menometrorrhagia. While being evaluated for menometrorrhagia, a computed tomography scan revealed a large cystic mass within the abdomen and pelvis which was most likely of left ovarian origin. The patient had no prior surgical history. No known drug allergies were reported. Current medications consisted of cetirizine hydrochloride, iron, and medroxyprogesterone acetate. No baseline electrocardiogram or chest X-ray was obtained preoperatively due to patient’s age and lack of cardiac history. Complete blood count was normal. Her lungs were clear; heart rate and rhythm were regular. She had a Mallampati class 1 airway.

In the preoperative holding area the patient had an 18 gauge intravenous (IV) in place with plasmalyte infusing. Midazolam 1 mg IV was administered. In the operating room standard monitors were applied. The patient received an additional dose of midazolam 1 mg IV. The patient was preoxygenated with 100% O\textsubscript{2} by face mask. General anesthesia was induced with fentanyl 150 mcg, propofol 200 mg, lidocaine 60 mg, and cisatracurium 10 mg. The trachea was intubated, endotracheal tube (ETT) placement was confirmed, and mechanical ventilation was initiated. Anesthesia was maintained with isoflurane 1.2 % end tidal, oxygen 1 L/min, and air 1 L/min. A second peripheral 18 gauge IV was started. Pressure points were padded.

The operating table was placed in reverse Trendelenburg position. Insufflation of the abdomen to 15 mm Hg and manual placement of the trocars followed. The robot was then placed in position over the patient. The patient-side surgical cart of the robotic system con-
tained the arms for the endoscopic camera and for holding surgical instruments. As the robot was being positioned and the arms attached to the trocars the patient’s face, shoulder, and arm were checked to be free of contact with the robot. Abdominal carbon dioxide insufflation pressures were kept at 15 mm Hg during the surgical procedure. End tidal carbon dioxide (CO₂) readings were maintained between 32-35 mm Hg by adjusting tidal volume and respiratory rate. Peak inspiratory pressure was 34-35 cm H₂O. Neuromuscular blockade was maintained with cisatracurium and titrated based on train-of-four response. Fentanyl was titrated based on vital signs for a total of 650 mcg. Ondansetron 4 mg, famotidine 20 mg, and metoclopramide 10 mg IV were administered for postoperative nausea and vomiting prophylaxis.

Upon completion of surgery, neuromuscular blockade was antagonized with glycopyrrolate 0.6 mg and neostigmine 3 mg IV. Ketorolac 30 mg was administered. The trachea was extubated after the patient had spontaneous respirations, tidal volumes of 5 cc/kg, and sustained head lift for 5 seconds. The patient was transferred to post anesthesia care unit while breathing O₂ by 100% nonrebreather mask.

**Discussion**

The development of robotic surgery has expanded upon minimally invasive surgical procedures. The growth of robotic surgery can be attributed to the enhancement in instrumentation precision and control and is anticipated to continue to grow.

The robotic assisted laparoscopic procedure in this case utilized a telemanipulator robot, the da Vinci Robotic Surgical System. This system consists of a console, a surgical cart and a three dimensional vision tower. The surgical cart consists of three arms. One arm contains the endoscopic camera and the other two arms are used to hold instruments. The surgeon is not physically at the operating table; instead robotic arms are placed over the patient. The surgeon is located at the console and controls the robotic arms. An assistant is present at the operating table and changes the instruments as needed.

During robotic surgery access to the patient may be difficult. The ETT will need to be adequately secured and placement confirmed before the robot is engaged. The placement of an IV catheter in each arm is valuable due to limited patient access during surgery. Monitoring devices and electrodes need to be properly positioned because it will be difficult to make adjustments during surgery. Pressure points must be carefully padded prior to and after positioning of the robotic cart and documented. The benefit of invasive arterial monitoring versus the risk of such is controversial and should be evaluated on an individual patient basis.

The patient’s head and chest need to be closely monitored upon placement and removal of the robot. The side cart of the robot is located close to the patient’s head, and thus, access to the patient’s airway and neck is limited. Due to the proximity of the robot to the patient, the patient must be protected from inadvertent contact with the robotic arms while they are in motion.
Cardiopulmonary emergencies are the most serious problems encountered with laparoscopic surgery. Insufflation of the abdomen results in the following changes: decreased lung volumes, increase in mean arterial pressure (MAP), decrease in cardiac index, and hypercarbia due to CO₂ absorption. Hemorrhage or CO₂ embolism can occur due to inadvertent injury to blood vessels. The proper use of capnometry is essential in laparoscopic cases in monitoring the adequacy of mechanical ventilation. While the risk of cardiopulmonary emergencies is not any greater with robotic assisted laparoscopic surgery, treatment of such emergencies is more complicated. Once the robot has been engaged the position of the patient cannot be adjusted; therefore, personnel should be able to quickly disengage the robotic device in the event of an emergency. Removal of the robot involves disengagement of the instruments and camera from the robot arms, the arms being unlatched from the trocars, and the robot moved away from the patient.

Since any patient movement could be disastrous, neuromuscular blockade is required. Any patient movement is to be avoided while the surgical instruments are in place in the abdomen. Thus, neuromuscular blockade must be closely monitored with a peripheral nerve stimulator.

Space is another factor to be taken in to consideration with robotic assisted laparoscopic surgery. Sufficient workspace for the anesthesia practitioner upon positioning the robot needs to be addressed. Additionally, adequate space is necessary to navigate the robot easily out of the way. General anesthesia time may initially be longer during robotically assisted surgical procedures. There may be prolonged operative time as surgeons are developing robotic technology technique. A balanced anesthetic technique can be used to decrease the likelihood of a slow emergence due to prolonged surgery. With prolonged operative time the negative effects of insufflation of the abdomen can be exaggerated. Additionally, as pneumoperitoneum leads to a reduction in venous return, lower extremity edema can occur, particularly with reverse Trendelenburg position.

In addition to the anesthetic implications for laparoscopic surgery, robotic assisted laparoscopic surgery has unique anesthetic considerations. As robotic assisted surgery continues to expand, anesthesia practitioners need to be knowledgeable concerning this technology and the impact it has on anesthetic care. Anesthetic implications include patient access issues, patient safety issues (such as preventing patient contact with the robot and emergency removal of the robot), the importance of neuromuscular blockade, space considerations, and prolonged surgical time.

References


Mentor: JoAnn Platko, CRNA, MSN

Prolonged Neuromuscular Blockade after Laparoscopic GYN Surgery
Amy M. Hostelley, MSN
Wyoming Valley Health Care System/University of Scranton School of Nurse Anesthesia

Key words: Prolonged neuromuscular blockade, rocuronium, peripheral nerve stimulator, Train of Four

Prolonged weakness after the use of neuromuscular blocking agents is a concerning complication. Reversal of neuromuscular blockade depends on redistribution, gradual metabolism and excretion, or administration of specific reversal agents that inhibit acetylcholinesterase enzyme activity. This inhibition increases the amount of acetylcholine that is available at the neuromuscular junction to compete with the nondepolarizing agent.1 A new reversal agent, Org 25969 (sugammadex), is designed to reverse a rocuronium-induced neuromuscular block.2 With the availability of this novel reversal agent, prolonged neuromuscular weakness in the postoperative period may be averted.

Case Report

A 39 year old female, 125 kg, 170.2 cm tall, presented for a laparoscopic oophorectomy related to a complex ovarian cyst diagnosed by ultrasound. The patient’s medical history included hypertension, back problems, depression, morbid obesity, ½ pack of cigarettes per day smoking history for 20 years, and the use of illicit drugs in the past. Past surgical history included tonsillectomy, lumbar spinal fusion, and left ganglion cyst removal. She denied any personal or family history of anesthetic complications. Her preoperative medications included metoprolol, alprazolam, oxycodone, and modafinil, and her allergies were to penicillin and cephalosporin. Preoperative physical examination, baseline vital signs, complete blood count and chemistry profile were unremarkable.
including a negative human chorionic gonadotropin level. Her airway classification was Mallampati II with a thyromental distance of 3 centimeters.

After receiving midazolam 2mg and ondansetron 4mg intravenously (IV) in the preoperative holding area, the patient was taken to the operating room. Standard monitors were applied and the patient was preoxygenated with 100% FiO$_2$ via facemask. General anesthesia was induced with fentanyl 250 mcg, propofol 200 mg, rocuronium 40mg and an additional 2 mg of midazolam IV. A successful and atraumatic intubation was performed with a Macintosh #3 blade. Desflurane was initiated for maintenance, and rocuronium was utilized for muscle relaxation during the entire case.

During the anesthetic, fentanyl 150 mcg and hydromorphone 2 mg were additionally titrated for postoperative analgesia. A total rocuronium dose of 120 mg was used during the case with the last dose of 20 mg IV given 45 minutes prior to the end of the procedure which lasted a total of 130 minutes. Following skin closure, train of four monitoring revealed 2/4 twitch response with fade. The neuromuscular blockade was antagonized using neostigmine 3 mg and glycopyrrolate 0.6 mg IV. No spontaneous respiratory effort or patient movement was observed for 30 minutes. Naloxone 80 mcg IV was administered without return of spontaneous respiratory effort so an additional 2 mg of neostigmine and 0.4 mg of glycopyrrolate was administered. The patient began spontaneous respiration with a tidal volume of 500 ml per breath 5 seconds and able to squeeze a hand upon command. She was extubated without difficulty, placed on 100% O$_2$ via nonrebreather mask and taken to the post anesthesia care unit (PACU). Upon arrival to the PACU, her respirations were shallow with a SpO$_2$ reading of 88%. Following an albuterol nebulizer treatment, her SpO$_2$ improved to 96%.

Several hours after surgery, the patient’s postoperative vital signs were BP 115/50 mmHg, HR 84, RR 12, and SpO$_2$ of 98%. The patient denied recall of events in operating room. Specifics of the emergence were described to the patient postoperatively, and she surprisingly verbalized a similar occurrence with a previous anesthetic and surgery.

**Discussion**

The anesthesia professional should make every effort to ensure that all patients leave the operating room with adequate muscle strength. This task is usually accomplished by one of two strategies. First, professionals may choose to allow for spontaneous recovery from neuromuscular blocking agents by incorporating an adequate time period into their anesthetic for the drug to be metabolized and eliminated from the body. Muscle recovery can be supported by the documentation of objective indices such as train of four and sustained tetany from the judicious use of a peripheral nerve stimulator. Secondly, reversal agents may be used to accelerate the recovery of the neuromuscular blockade. This approach is most often accomplished by administering an antagonism to the neuromuscular blocking agent, such as neostigmine or edrophonium. These agents act by inhibiting the enzyme acetylcholinesterase which facilitates an increase in the amount of acetylcholine needed to restore normal neuromuscular transmission and muscle contraction. Occasionally these commonly used anticholinester-
rase agents antagonize the block slowly or inadequately when the block is dense despite the appearance of sufficient nerve stimulator responses.

The depth of neuromuscular blockade is monitored most accurately with the use of a peripheral nerve stimulator. The peripheral nerve stimulator is an electrical device that delivers a series of shocks to the patient through electrodes applied to the skin near a nerve. Upon activation of the peripheral nerve stimulator, muscle contraction is visible in the absence of neuromuscular blockade. The most commonly used method of assessing neuromuscular blockade with a peripheral nerve stimulator is by observing train of four (TOF). Train of four is a method for measuring magnitude and type of neuromuscular blockade, based upon the ratio of the amplitude of the fourth evoked mechanical response to the first one, when four supramaximal 2-hz electrical currents are applied for 2 seconds to a peripheral nerve.

Several studies have suggested that residual neuromuscular blockade is seen commonly in the PACU after surgery. The speed and extent to which a neuromuscular blockade is reversed by anticholinesterase agents are influenced by a number of factors. These factors primarily include the intensity of the neuromuscular blockade at the time the reversal agent is initiated (TOF visible twitches) and the specific nondepolarizing neuromuscular blocking agent being reversed. The incidence of residual neuromuscular blockade in the PACU using a long acting neuromuscular blocking agent is as high as 42%. The incidence using an intermediate acting agent is less but still has been reported as high as 20%. A TOF ratio of greater or equal to 0.8 has been described as an adequate indicator of recovery from a neuromuscular block.

A new agent called Org 25969 (sugammadex) is a modified cyclodextrin which acts by rapidly encapsulating a steroidal neuromuscular blocking agent such as rocuronium. Org 25969 forms a stable complex which prevents the pharmacological action of the neuromuscular blocking agent at the neuromuscular junction. This mechanism for reversal of neuromuscular block is independent of acetylcholinesterase inhibition and does not require the coadministration of anticholinergic agents. Preclinical studies and studies in human volunteers have shown the ability of Org 25969 to reverse profound neuromuscular block induced by rocuronium within 10 minutes of administration without the presence of muscarinic side effects.

The administration of neuromuscular blocking agents imposes a risk to patients that can extend into the postoperative period if muscle recovery is not complete. Because of the compromise on respiratory function, adequate monitoring of the neuromuscular blockade is essential. The timing and choice of an anticholinesterase agent for reversal of the blockade is of utmost importance to prevent residual postoperative weakness in the PACU and the clinical deterioration that may follow. Perhaps with the development of a new reversal agent, Org 25969, the incidence of prolonged neuromuscular weakness after anesthesia can be reduced.

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Minimally Invasive Video-Assisted Thoracoscopic Approach to Ablation of Atrial Fibrillation
Jennifer M. Judeikis, BSN
University of Pennsylvania

Key words: Atrial Fibrillation, video-assisted thoracoscopic surgery, VATS, MiniMaze, anesthesia

Atrial Fibrillation (AF) is the most common sustained cardiac arrhythmia, affecting approximately 2.5 million patients in the United States. An estimated 300,000 new cases are diagnosed each year. It is predicated by the year 2050 that 5.6 million patients will be diagnosed with AF. AF is associated with increased mortality, exacerbation of heart failure, and a seven-fold increased risk of stroke. However, antiarrhythmic medications have limited efficacy in maintaining sinus rhythm and might have serious adverse effects, as do anticoagulants. Achieving and maintaining sinus rhythm could result in fewer symptoms, lower stroke risk, eventual discontinuation of anticoagulants, better exercise tolerance, improved quality of life, and lowered mortality. Until recently, nonpharmacological surgical approaches for the treatment of AF have proven effective, but require an extremely invasive sternotomy incision, and the risks associated with the cardiopulmonary bypass machine. A new, minimally invasive, video-assisted thoracoscopic (VATS) surgical technique has been demonstrated to be safe and effective in the treatment of AF. The following case report describes the intraoperative management...
of a patient undergoing bilateral VATS pulmonary vein isolation with excision of the left atrial appendage (LAA), or MiniMaze procedure for the treatment of AF.

**Case Report**

A 60-year-old male patient presented to the hospital for minimally invasive video-assisted bilateral pulmonary vein isolation and ablation of AF, with removal of the LAA, also known as a Minimaze procedure. This patient had a three-year history of AF with two failed cardioversion attempts within the last six months. Since diagnosis he had been medically managed with atenolol, dofetilide, warfarin, and aspirin. Despite taking antiarrhythmic medications for the management of AF, the patient continued to have episodic symptomatic paroxysmal AF, and reported poor tolerance and dislike of the drug’s side effects. After learning of the Minimaze on a local news channel, the patient sought to have the procedure performed to treat his arrhythmia.

Preoperative evaluation of the patient determined he would be an excellent candidate for the Minimaze. Preoperative transesophageal echocardiogram (TEE) revealed normal left ventricular systolic function, an estimated ejection fraction of 55%, mild to moderate mitral regurgitation, trace tricuspid regurgitation, and mild atrial enlargement (left greater than right). Chest x-ray was normal, and the patient was free from any pulmonary disease according to pulmonary function testing. Coagulation studies had normalized since discontinuing warfarin one week prior to the scheduled operation. Aspirin was discontinued at the same time. Preoperative electrocardiogram demonstrated normal sinus rhythm (NSR), and the patient remained in NSR during the majority of the intraoperative period. For the Minimaze procedure, it is not necessary for AF to be occurring in order to properly identify the arrhythmia triggering regions.

On the day of surgery, two large bore peripheral intravenous lines and a radial arterial line were placed preoperatively. Standard induction of general anesthesia was followed by placement of a 39 French left-sided double lumen tube (DLT), which was confirmed by fiberoptic bronchoscopy. Standard measures to minimize hypoxemia due to one lung ventilation (OLV) were utilized intraoperatively, including positive end-expiratory pressure (PEEP) to the dependent lung, continuous positive airway pressure (CPAP) to the nondependent lung, and fraction of inspired oxygen of 100%. These measures helped to maintain pulse oximetry readings above 95% and arterial partial pressure of oxygen greater than 80 mmHg through out the procedure. All intraoperative arterial blood gas measures were within normal range limits. TEE was performed in the operating room prior to incision to verify absence of any left atrial thrombi, which would prohibit exclusion of the LAA and therefore require procedure cancellation. The patient did not have any left atrial clots. Also, transcatheter pacer pads were placed on the patient in preparation for an intraoperative need for pacing.

Surgical approach for the Minimaze procedure was via small bilateral thoracotomies. There are two additional small incisions bilaterally for insertion of assistive surgical devices. Initially the patient was positioned with the left side
down and the right arm abducted so that the right pulmonary veins could be accessed first. This required OLV to the dependent left lung and deflation of right lung to allow surgical exposure. Upon completion of the right-sided portion of the procedure, the patient was repositioned with the right side down and the left arm abducted. At this time, OLV occurred to the dependent right lung and the left lung was now deflated for surgical exposure. The same ablation technique completed on the right was repeated on the left with the addition of removing the LAA. The additional excision of the LAA is incorporated into this procedure because it is the major source of thromboemboli associated with AF.

The patient tolerated all aspects of the surgery. With completion of the procedure on each side, the incisions were closed and chest tubes were inserted for lung re-expansion. On Que pain management devices filled with Bupivacaine 0.25% were placed in bilateral chest walls for postoperative pain management. The DLT was changed without difficulty to an 8.0 mm oral endotracheal tube over an airway exchange catheter. The patient was then transported to the intensive care unit (ICU) paralyzed and sedated, and extubated uneventfully after a few hours of positive pressure mechanical ventilation and successful weaning from the ventilator. This was to decrease the atelectasis that ensued intraoperatively from bilateral OLV. On postoperative day one, the bilateral chest tubes were removed and the patient reported his pain management to be satisfactory. The remainder of his postoperative period was uneventful and he remained in normal sinus rhythm without any episodes of AF.

Discussion

There exist a few invasive methods for the treatment of AF, including catheter ablation and the original MAZE procedure. The goal of all these procedures is to permanently disable the region of the heart responsible for this aberrant rhythm. Catheter ablation is noted to have limited success, and a high incidence of recurrence associated with serious complications. Although the original MAZE procedure does have a high success rate, its usefulness is limited due to associated surgical complexity and morbidity. The MAZE procedure requires an open chest via sternotomy and a still heart, necessitating cardiopulmonary bypass (CPB). For these reasons, this procedure is considered too invasive to be used in patients with lone AF, and is only sometimes performed simultaneously on those having cardiac surgery that requires CPB.

Recent improved understanding of the pathogenesis of AF has prompted efforts to develop a less invasive surgical approach to cure AF. The anatomical region where the pulmonary veins connect with the left atrium has been identified as the major originating locale of AF. Most AF comes from the left atrium and usually originates from within or near the area where the pulmonary veins converge on the left atrium. Autonomic nervous system fibers also connect to the heart in this area. Abnormal electrical impulses from the nerves and pulmonary veins in this region is the cause of AF in many patients.

The Minimaze procedure uses small incisions between the ribs by which the surgeon places a clamp like tool on the left atrium near the pulmonary veins. Cauterizing the desired atrial tissue loca-
lized by the clamp causes the ablation. The nerves that contribute to the cause of AF in this region are also eliminated. This new technique enables a surgical cure of AF through an epicardial approach on a beating heart. A bipolar radiofrequency ablation device is the key tool for performing this procedure. This device creates bilateral, transmural, linear lesions around the atrial cuff of the right and left pulmonary veins, effectively achieving electrical isolation of the pulmonary veins without any need for CPB. The Minimaze approach to the ablation of AF was determined safe and effective at intermediate follow up. The Minimaze reliably and rapidly achieves ablation of the source of AF in the heart. This technique is an attractive, safe and effective alternative to antiarrhythmic and anticoagulant medications, and other invasive means to curing AF.

References


Mentor: Russ Lynn, MSN, CRNA

Posterior Reversible Encephalopathy Syndrome in the Setting of Preeclampsia
Elissa Grimm, MSN
Wake Forest University Baptist Medical Center Nurse Anesthesia Program
University of North Carolina at Greensboro

Key words: hypertension, preeclampsia, encephalopathy, posterior reversible encephalopathy syndrome

Identified as early as the fourth century B.C., hypertension is the most common complication of pregnancy. In some women with preeclampsia, cerebral autoregulation may become compromised leading to cerebral edema, particularly in the white matter of the parietal and occipital lobes. Clinically, this is characterized by headache, nausea and vomiting, seizures, visual disturbances, altered sensorium, and sometimes a focal neurologic deficit. Early recognition and treatment of this (PRES) can lead to complete recovery for the patient.
Case Report

A 17 year old G1P0, 35 week gestation African American woman presented for induction of labor with a blood pressure of 180/110. The patient was 61” tall and weighed 60kg. She complained of blurred vision bilaterally, and a random urinalysis was positive for protein. Platelets were 180K/mm$^3$. She had no abnormal health history prior to pregnancy, although her pregnancy had been complicated by multiple admissions for blood pressure management. Labor was induced with an oxytocin infusion, while concomitantly receiving a magnesium sulfate infusion. A well-functioning lumbar epidural was in place.

During second stage of labor, the patient abruptly became unresponsive and the fetal heart rate declined precipitously. The patient was rushed to the operating room where she was discovered to be in full cardiopulmonary arrest. The patient’s trachea was intubated without difficulty and CPR was initiated while the patient was prepared for emergent caesarean section. The electrocardiogram showed an idioventricular rhythm, and 1mg of epinephrine was administered IV along with a fluid bolus and CPR was continued. A male fetus was delivered by caesarean section four minutes after arrival in the operating room. One and five minute Apgar scores were 1 and 7, respectively, with an umbilical blood pH of 7.02. Immediately after delivery, the patient’s pulse returned and CPR was stopped. Her heart rate was in the 170s and blood pressure was elevated to 180/100. By the end of the case she had resumed spontaneous respirations and her vital signs were as follows: heart rate 120-140 bpm, blood pressure 140-160/90-100 mmHg. A serum magnesium level drawn immediately post delivery was found to be within normal limits at 4mg/dl. Uterine tone was adequate and blood loss was approximately 700ml, with administration of 40 units of pitocin total in 2000ml of fluid.

Post-operatively the patient was responsive to verbal commands. Airway reflexes appeared to be intact and the endotracheal tube was removed. Her neurological exam was grossly normal except she complained of complete blindness bilaterally. A neurologist was consulted and a CT scan and MRI were completed and reviewed. The neurologist diagnosed probable PRES syndrome, and the patient was monitored in the intensive care unit with a magnesium sulfate infusion for seizure prophylaxis and labetalol to control the hypertension. Her vision returned within twenty-four hours and she had no neurologic sequelae. Mother and baby were discharged on post-operative day six with no further complications.

Discussion

Although the exact etiology of PRES remains to be identified, many authors state that it is related to a disruption in cerebral autoregulation, leading to changes in the vascular endothelium and leakage of fluid and proteins resulting in cerebral edema, especially in the white matter of the parietal and occipital lobes of the brain$^{3,8}$. It is believed that the posterior part of the brain is more sensitive to this disruption because the vessels arising from the basilar artery are not as heavily innervated (and thus protected) by the sympathetic nervous system as those in the frontal circulation$^{3,5}$. This disruption may occur as the result of sustained hypertension, or with an abrupt, transient increase in blood pressure$^{3,4}$. According to Vaughn and Delanty there may be individual differences in the lim-
its of hypertension that cause this auto-regulatory problem and even differences in one person over time depending on other co-morbid factors\textsuperscript{3}. Those with pre-existing hypertension may in fact have adapted vascular changes that protect them from acute hypertensive complications such as hypertensive encephalopathy and PRES\textsuperscript{3}.

The patient with preeclampsia presents a multitude of challenges for the anesthesia professional. As a front-line professional for obstetrical anesthesia, the anesthetist may be the first to note signs and symptoms of PRES and therefore may benefit from knowledge regarding etiology and treatment. Garg states that prompt recognition of symptoms with control of blood pressure can lead to complete reversal of the syndrome\textsuperscript{4}. However, multiple authors have also stated that there is a risk of permanent brain injury if treatment is delayed or if the syndrome is not correctly identified in time\textsuperscript{3,4,6,9,10}.

Treatment for PRES, as with other complications of preeclampsia primarily involves control of blood pressure and ultimately delivery of the baby and placenta\textsuperscript{3}. Magnesium sulfate is commonly used for seizure prophylaxis and its mild hypotensive effect, both of which are desirable in this setting\textsuperscript{2,3}. Any number of commonly used anti-hypertensives may be used to obtain control of blood pressure including hydralazine, sodium nitroprusside, nitroglycerine, labetalol, and nifedipine\textsuperscript{2,3}. Most importantly, adequate control must be obtained while avoiding wide swings in cerebral perfusion pressure. Vaughn and Delanty recommend decreasing the mean arterial pressure 20-25% within a period of minutes to two hours or a decrease in diastolic blood pressure to 100 to 110 over the same time period\textsuperscript{3}.

It is important to make a distinction between treatment for PRES versus ischemic stroke. In the setting of cerebral ischemia, a degree of hypertension is maintained in the patient in order to hyper-perfuse damaged areas of the brain\textsuperscript{3}. However, in the patient with PRES, ongoing hypertension worsens cerebral edema as the damaged vascular endothelium does not heal and more fluid and proteins leak out with potentially lethal consequences\textsuperscript{3,4,6,9,10}. According to Garg, the clinical features of PRES are often preceded by seizure and rarely include focal deficits\textsuperscript{4}. Alternatively, in cases of venous thrombosis there is often papilledema, whereas in patients with PRES fundal examination is usually normal, and focal neurologic deficits are common\textsuperscript{2,4}.

Although an anesthetist cannot expect to differentiate these conditions based upon symptoms alone, rapid neurological consult and prompt diffusion weighted MRI scanning is indicated to confirm the etiology of the cerebral edema\textsuperscript{4,6,9,10}.

The clinical symptoms most often associated with PRES include headache, seizures and visual loss in the setting of an acute increase in blood pressure such as that experienced by women with preeclampsia\textsuperscript{4,9}. In this case study the patient experienced temporary vision loss following resuscitation from cardiopulmonary arrest and emergency cesarean section. Fortunately, she did not experience complications associated with general anesthesia for cesarean section, despite the presence of preeclampsia. For example, we were not hindered by a difficult edematous airway or pulmonary edema\textsuperscript{1,2}. The obstetric anesthesia practi-
tioner should always be prepared to treat changes in blood pressure, particularly when the index of suspicion for PRES is high as it was in this patient who presented pre-operatively with visual changes.

References


Mentor: Michael Rieker, DNP, CRNA

Identification of the Difficult Airway

David K. Eisenbath, BHS, BSN
Goldfarb School of Nursing at Barnes-Jewish College

Key words: Difficult Airway, difficult mask ventilation, difficult intubation, airway assessment

The American Society of Anesthesiologists (ASA) defines difficult airway as “the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway, difficulty with tracheal intubation, or both.” The inability of the anesthesia practitioner to maintain an adequate airway can have devastating results. Critical airway incidents remain responsible for up to 50% of today’s anesthesia related deaths. Morbidity and mortality can be decreased with the identification of potentially difficult
Case Report

The patient was a 73 inch, 119 kg, (body mass index (BMI) 34.4 kg/m²) 52 year old male scheduled for an excision of left pharyngeal and tonsillar mass, a right tonsillectomy, and a left modified radical neck dissection. The patient received chemotherapy and radiation to the left neck. His ASA physical status was classified as 4, with a significant medical history including the following: aortic valve endocarditis requiring an aortic valve repair, coronary artery disease requiring one coronary artery bypass graft, dyslipidemia, hypertension, left vocal cord paralysis secondary to radiation therapy, obstructive sleep apnea, dysphagia requiring gastric tube placement, and benign prostate hypertrophy. Medications included amlodipine, acetylsalicylic acid, tamsulosin, indomethicin, hydrocodone, and paroxetine. A recent neck computed tomography scan revealed a left tonsillar mass which was smaller than on the prior scan.

Physical examination showed an obese male with a supple neck. His speech was difficult to understand but appropriate. The patient had a Mallampati Classification of 3 with a thyromental distance greater than 6 cm. His mouth was dry and edentulous, and full cervical spine range of motion was noted. Oxygen at 2 L/min via nasal cannula was administered as room air oxygen saturation ranged from 87% to 94%. Breath sounds were clear to auscultation in all lung fields.

Standard monitors and equipment for general endotracheal anesthesia were utilized. In addition, a fiberoptic bronchoscope and an intubating laryngeal mask were ready for use and the difficult airway cart was present in the operating suite. Anesthesia personnel present included an SRNA, CRNA, attending anesthesiologist, and an anesthesia technician.

After transferring to the operating table, oxygen was administered by face mask. Monitors were placed and the patient was instructed to breathe slowly and deeply. Midazolam 2 mg was administered, followed by lidocaine 100 mg, etomidate 10 mg, and propofol 100 mg 3 minutes later. Manual mask ventilations were attempted by a single professional but were unsuccessful. Oxygen saturations were noted to be 90% - 92%. An oral airway was placed and single practitioner ventilation was again attempted without success. The oxygen saturation decreased to 86%. A two-handed mask holding technique was then applied by a second practitioner while the first practitioner compressed the reservoir bag. Chest rise and positive ETCO₂ were noted, and the oxygen saturation increased to 96%.

Initial laryngoscopy with laryngeal manipulation did not provide visualization of any portion of the vocal cords. Successful manual ventilation was resumed with some difficulty. Propofol 100 mg was administered. A second laryngoscopy was performed by the anesthesiologist. Firm laryngeal manipulation provided a Cormack and Lehane grade 4 glottic view. The trachea was intubated with a 7 mm oral endotracheal tube. Placement was confirmed by bilateral equal breath sounds and ETCO₂. Anesthesia was maintained with desflurane, and propofol 110 mg, fentanyl 100 mcg,
rocuronium 50mg, and dexamethasone 10 mg were administered during the case.

The decision to perform a tracheostomy with the scheduled procedure was made in order to secure the airway. The patient emerged from anesthesia without deficit and was hemodynamically stable. He was transferred to the post-anesthesia care unit with oxygen via tracheostomy collar, and was discharged to home on his 4th post-operative day.

**Discussion**

Difficult mask ventilation in combination with difficult intubation is an airway emergency in anesthesia practice. Inability to ventilate may result in hypoxemia, increased incidence of regurgitation and aspiration, bradycardia, and cardiac arrest. In an ASA closed claims review from 1985 – 1999, 63% of difficult airway claims resulted in either death or brain damage. The overall incidence of difficult intubation is reported at 5.8% but is as high as 15.8% for those who are obese.

Difficult mask ventilation is a less common problem with an incidence of 1.4%. Ventilation via mask is a valuable rescue technique in the presence of a difficult intubation. Anticipation of difficult mask ventilation may influence anesthetic management. According to Han’s four point grading scale, difficult mask ventilation can be designated as a grade 3 or 4. Grade 3 is mask ventilation inadequate to maintain oxygenation, unstable mask ventilation, or mask ventilation requiring two professionals. Grade 4 is defined as inadequate mask ventilation indicated by the absence of end-tidal carbon dioxide and lack of chest rise and fall. Risk factors associated with grade 3 difficult mask ventilation include the presence of a beard, BMI of 30 kg/m², Mallampati classification of III or IV, age 57 or older, severely limited jaw protrusion, and snoring. Those with 3 or more risk factors were 20 times more likely to be difficult to mask ventilate than those with no risk factors. Grade 4 predictors were a thyromental distance less than 6 cm and snoring.

There are also a variety of risk factors associated with difficult intubation which can be identified on pre-operative exam. The above patient had a known upper airway mass predictive of a difficult intubation and the need for alternative airway strategies and equipment present at the time of induction. Common pre-operative findings associated with difficult intubation include obesity defined as a BMI greater than 30 kg/m², the presence of airway pathology, Mallampati Classification grades III or IV, thyromental distance less than 6 cm, sternomental distance less than 12.5 cm, and interincisor gap or mouth opening less than 5 cm. Often, the presence of a single abnormal finding is a poor indicator of difficult intubation. The combination of an abnormal Mallampati test and short thyromental distance more than doubled the risk than if either was found alone (16% and 15%, respectively, if found alone compared to 34% in combination).

A model to predict difficult intubation was developed and tested using thyromental distance, Mallampati score, interincisor gap, and height, stating a sensitivity of 82.5% and a specificity of 85.6%. The following formula was utilized: 0.2262 – (0.4621 x thyromental distance) + (2.5516 x Mallampati score) – (1.1461 x interincisor gap) + (0.0433 x
height), with thyromental distance, intercincisor gap, and height in centimeters and 0 for a Mallampati score of 1 or 2 and 1 for a score of 3 or 4. In this equation, intubation should be easy if the result is less than zero, and may be difficult if the result is more than zero. Other simpler scoring models such as the Wilson risk score and the Arne simplified score model award points for clinical findings. Wilson’s model includes weight, head and neck movement, jaw movement, presence of receding mandible, and protruding incisors. Arne’s model accounts for history of difficult intubation and diseases associated with difficult intubation, symptoms of airway pathology, intercincisor gap, mandible subluxation, thyromental distance, head and neck movement, and Mallampati score. The sum of accrued points indicates whether or not intubation may be difficult.

In this case, the patient was at increased risk for difficult mask ventilation as well as difficult intubation due to the presence of a known upper airway mass, elevated BMI, Mallampati Classification of III, and history of snoring and obstructive sleep apnea. In recognition of these risk factors, the presence of additional anesthesia personnel and emergency equipment, as well as an alternate plan should initial intubation attempts fail was readily available. In summary, identification of those patients at high risk for difficult airway is a crucial aspect of anesthesia care. By using physical assessment tools and reviewing the patient’s history, instances of unanticipated difficult airway may be reduced. Of course, no model or assessment for prediction of the difficult airway is 100% accurate; therefore anesthesia practitioners should always be prepared to manage the unanticipated difficult airway.

References
Kidney transplantation is the treatment of choice for patients with end stage renal disease (ESRD). Approximately 50% of all kidney transplants in the United States are from living donors because kidney transplantation provides a better survival rate and quality of life than receiving either hemodialysis or peritoneal dialysis. Advances in patient management along with better preparation of patients for surgery and anesthesia has lead to dramatic improvements of patient perioperative and postoperative outcomes for kidney transplantation surgery. This case study describes a young gentleman undergoing living-donor kidney transplantation.

**Case Report**

A 31 year old, ASA 3, 101 kilogram, male presented for a living donor kidney transplant. Three months prior to his surgery he presented to his family physician’s office with complaints of weakness and fatigue. Through a series of lab work and testing, he was found to have only one kidney; it was in Stage V chronic kidney disease. He avoided being dialyzed because a living-related donor was found. The procedure for a living donor kidney and transplant was scheduled. His past medical history included hypertension and anemia. He had no known allergies. The patient’s daily oral medication regime included prednisolone 10 mg, furosemide 40 mg, metoprolol 50 mg, nifedipine 30 mg, docusate sodium 100 mg, two tablets calcium acetate daily, one tablet B-complex multivitamins. Epoetin alfa 20,000 units was administered each week subcutaneously (SQ). Physical examination revealed a Mallampati class I airway, a thyromental distance of 3 fingerbreadths, and full neck ROM. His vital signs included a heart rate of 74 bpm with a blood pressure of 165/101 mm Hg. His lungs were clear to auscultation bilaterally with a regular respiratory rate of 20 breaths per minute. Oxygen saturation was 99% on room air obtained via pulse oximeter. His significant laboratory findings included: BUN 113 mg/dl, creatinine 9.1 mg/dl, potassium 5.0 mg/dl, hemoglobin 11.1 mg/dl, and hematocrit of 35.3 mg/dl. He had no oral intake after midnight the day prior to his surgery. An infusion of Alemtuzumab 30 mg for lymphoid suppression was started one hour prior to surgery and infused over two hours. Other preoperative medications included: methylprednisolone 1000 mg intravenously (IV), acetaminophen 500 mg PO, diphenhy
dramine 50 PO mg, metoclopramide 10 mg IV, and ranitidine 50 mg IV.

Prior to the completion of the donor’s nephrectomy, the recipient was premedicated with midazolam 2 mg IV and was taken to the operating room. In the operating room, oxygen and standard monitors were applied. Full-stomach precautions were taken and a rapid sequence induction of general anesthesia with a Sellick maneuver was successfully accomplished. Induction was achieved by the administration of Fentanyl 150 mcg IV, lidocaine 100 mg IV, propofol 200 mg IV, and rocuronium 120 mg IV. Normal saline 0.9% was the infusion of choice. An #8.0 mm endotracheal tube was atraumatically inserted into the trachea, and once placement was confirmed an orogastric tube was then placed without difficulty. Two large bore #16 gauge intravenous lines and a left brachial arterial line was inserted after induction. Cisatracurium 0.2 mg/kg was used for maintenance of muscle relaxation and desflurane at a concentration of 5% in oxygen at 2 liter/minute flow was the inhalational anesthetic utilized. An arterial blood gas and basic metabolic profile were completed after induction for baseline comparison. Abnormal values included: HCO$_3$ 18.6 mmol/L, Hgb 9.6 g/dL, HCT 29.6%. Sodium Bicarbonate NaHCO$_3$ 50 mEq was administered intravenously.

Once the kidney had been procured from the donor, it was placed in the patient for anastomosis to begin, mannitol 25 gm and furosemide 80 mg IV were then administered. When the anastomosis was finished, cefazolin 1 gm IV was administered. As per protocol, an arterial blood gas and a basic chemistry were obtained 10 minutes after completion of the anastomosis and unclamping of the renal vessels. These labs were repeated prior to extubation. Abnormal labs 10 minutes after unclamping included: HCO$_3$ 16.5 mmol/L, Hgb 8.5 g/dL, HCT 26.3%, ionized calcium 0.91 mmol/L, and K+ 6.3 mEq/L. The patient was given 50 ml of 50% dextrose, 10 units of regular insulin and 50meq of NaHCO$_3$ to treat the hyperkalemia. The patient was also given Calcium chloride 500mg in two divided doses and hyperventilated. An ABG and basic chemistry were obtained prior to extubation, which revealed: HCO$_3$ 16.9 mmol/L, Hgb 8.7 g/dL, HCT 27%, and K+ 5.8 mEq/L. The patient was given additional 50 ml of 50% dextrose, 8 units of regular insulin and 50meq of NaHCO$_3$.

A total dose of fentanyl 1250 mcg IV was used for the entire procedure providing analgesia. Prior to emergence the patient became progressively hypertensive with a BP 180/100’s mm Hg. A total dose of labetalol 25 mg IV was given in divided doses. The patient’s neuromuscular blockade was antagonized with glycopyrrolate 0.6 mg IV and neostigmine 3 mg IV. With protective reflexes and a sustained head lift present, the patient was extubated and given 100% oxygen via a nonrebreather mask. Upon emergence, the patient remained hypertensive with BP 190/100’s mm Hg and heart rate 110-120 bpm. Metoprolol 10 mg was administered IV and nitropresside was titrated for a total of 200 mcg IV. The patient was stabilized and with a BP 160/100 mm Hg, hr 104 bpm, oxygen saturation of 100% on a 100% nonrebreather mask. The patient was transported to PACU where both a nitroprusside and metoprolol infusions were initiated. Adequate urinary output was noted immediately in the postoperative
period. On Postoperative days one two the patient remained in the ICU on a labetalol drip due to SVT and hypertension. His laboratory values improved significantly during his postoperative course and he maintained good kidney function. He was discharged on postoperative day five.

Discussion

There are several preoperative considerations the anesthesiologist must be aware of with a patient undergoing a kidney transplant. These patients are usually young and relatively healthy and or old and chronically ill. Pericarditis, hypertension, congestive heart failure, dysrhythmias, pericardial effusions are common in this patient population. A common cause of ESRD is diabetes, which is associated with an increased risk for autonomic and peripheral neuropathy, PVD, and CAD. Gastroparesis may occur, especially in diabetics with autonomic neuropathy, therefore full-stomach precautions should be taken on induction of general anesthesia. Respiratory concerns include an increased incidence of pleuritis and pleural effusions. This patient population is prone to laboratory abnormalities such as metabolic acidosis, hyperkalemia, hypocalcemia, and hypermagnesemia. They are often hypovolemic post dialysis or hypovolemic if never dialyzed. Patients undergoing renal transplantation have a high incidence of anemia. Coagulation disorders, or thrombocytopenia may be present as well. Any peripheral neuropathies should be documented on the anesthesia record preoperatively.

Midazolam is safe for premedication to treat anxiety in this population. Ranitidine 50mg IV and metoclopramide 10 mg IV can be given 60 minutes prior to the procedure to aid in gastric emptying. Sodium citrate 30 ml PO can be given on transport into the OR to raise gastric pH. The procedure is done under general endotracheal anesthesia. Epidural anesthesia can be considered for postoperative pain management if no coagulopathies are present. Standard monitors are applied and an arterial line inserted. Adequate venous access should be established. A central venous line can be inserted to aid in the assessment of volume status. The use of a pulmonary artery pressure catheter is seldom required but may be indicated for patients with cardiac disease or known pulmonary hypertension.

Medications used for anesthesia induction should be titrated to minimize the possibility of hemodynamic instability. Rapid sequence induction can be facilitated by the use of succinylcholine 1mg/kg if the potassium level is than 5.0 mEq/L, cisatracurium, or rocuronium. The duration of rocuronium and vecuronium may be delayed in this population. Patients who are hypertensive are at risk for large fluctuations in arterial blood pressure and heart rate during induction and intubation. To suppress the cardiovascular response to intubation fentanyl 2-5 mcg/kg in addition to lidocaine IV can be used. A short-acting β-adrenergic blocker esmolol (0.5 to 1.0 mg/kg) can be used to blunt hemodynamic response to intubation in those patients with an adequate ejection fraction. Maintenance of muscle relaxation can be aided with cisatracurium or rocuronium. Desflurane, isoflurane, and sevoflurane are equally acceptable choices as an inhalation agent. The metabolism of sevoflurane has been implicated in renal toxicity, but no controlled studies are available to demonstrate the danger of use in this
setting. Meperidine and morphine should be used with caution in renal failure patients due to the accumulation of active metabolites dependent upon renal excretion. NSAIDS should be avoided since they aggravate due to aggravation of renal insufficiency.

The major anesthetic consideration is the maintenance of renal blood flow. Some surgeons prefer high mean arterial pressures between 80-100 mmHg. CVP should be maintained between 10-15 mmHg. Mannitol 0.25 to 1 g/kg IV, furosemide 5-20 mg IV, and dopamine are often required for reperfusion of the kidney.

Prior to emergence, a full antagonism of the neuromuscular blockade should be given. Neuromuscular blockade antagonist agents depends on renal excretion so their effects are often prolonged. The patient is usually extubated in the OR when protective reflexes have returned. Postoperative complications include respiratory depression, femoral neuropathy, hemorrhage, and electrolyte abnormalities. Hypotension may occur after unclamping the iliac vessels and reperfusion of the graft. The use of α-adrenergic agonists, such as phenylephrine, should be drugs of last resort.

This was an excellent case to demonstrate the variety of issues the anesthesia professional must be prepared for with a patient undergoing a kidney transplant. It is very important for the anesthesia professional to be vigilant of the significant comorbidities that afflict patients with ESRD. Thorough preoperative assessment, intraoperative, and postoperative management is imperative for this fragile patient population.

References


Mentor: JoAnn Platko, MSN, CRNA

Intubation of the Obese Patient
Kelly J. Antrim, BSN
Goldfarb School of Nursing at Barnes-Jewish College

Key words: obese, positioning, intubation, anesthetic management, reverse Trendelenburg

Obesity is linked with several health problems including coronary artery disease, hypertension, dyslipidemia, diabetes mellitus, gallbladder disease, de-
generative joint disease, obstructive sleep apnea, and socioeconomic and psychosocial impairment.\textsuperscript{1} Obesity has also been implicated as a risk factor for difficult airway management. However, studies have shown that weight and body mass index (BMI) alone are not adequate predictors of mask ventilation or intubating difficulty.\textsuperscript{1,2,3,4} This is a case report of an obese patient who was positioned supine for intubation and had a subsequent desaturation. Possible solutions for this problem will be discussed.

**Case Report**

A 24-year-old, 148 kg, 65” female patient presented to the preoperative area for her planned laparoscopic gastric bypass. She had a past surgical history of gastric banding in 2005 that was not successful and was removed in 2006. Past medical history included morbid obesity (BMI 45), hypothyroidism, type II diabetes mellitus, depression, and bipolar disease. She was currently taking levothyroxine, venlafaxine, rosiglitazone, quetiapine, chlorpromazine, dextroamphetamine and amphetamine, and yasmin. She had no known allergies. Her Mallampati Classification score was 1 with a thyromental distance of 3 fingerbreadths and full cervical spine range of motion. She was a nonsmoker who complained of shortness of breath on exertion and denied sleep apnea. Her lungs were clear to auscultation bilaterally. Her heart was in normal sinus rhythm with no murmurs or rubs. Laboratory results were as follows: BUN 11 mg/dl, creatinine 1 mg/dl, hemoglobin 14.1 g/dl, and hematocrit 41.2%. An 18 gauge peripheral IV was placed and lactated ringers was started. The patient was premedicated with midazolam 2 mg, cimetidine 300 mg, and metoclopramide 10 mg IV. A 1 mg scopolamine patch was placed behind the left ear and the patient was transferred to the operating room. She was classified as an ASA III and rapid sequence induction for general endotracheal anesthesia was planned.

In the operating room, the patient moved herself to the table and was lying flat with her head on a foam pillow. While standard monitors were being applied the patient received oxygen at 10 L/min via facemask. After approximately five minutes of pre-oxygenation, a rapid sequence induction was performed using fentanyl 100mcg, lidocaine 100 mg, propofol 220 mg, and succinylcholine 100 mg. The patient had an oxygen saturation (\text{SaO}_2) of 100%. When fasciculations stopped tracheal intubation was attempted with a #3 Macintosh blade. Excessive soft tissue in the pharyngeal area obstructed visualization of the vocal cords. Within 30-45 seconds, the patient desaturated to an \text{SaO}_2 of 88%. The blade was removed and mask ventilation with oxygen at 10 L/min was initiated. The \text{SaO}_2 continued to decrease to a low of 80%, and after about 45 seconds increased to 88%. After another 60 seconds the \text{SaO}_2 was up to 95%. A second laryngoscopy with a #3 Macintosh blade was attempted and the trachea was successfully intubated with a 7.0 mm endotracheal tube. End-tidal carbon dioxide (ETCO\textsubscript{2}) and bilateral breath sounds were confirmed. The patient’s \text{SaO}_2 was 92% following intubation. Anesthesia was maintained with desflurane in oxygen at 4 L/min and an atracurium infusion was started. The patient’s \text{SaO}_2 rose slowly throughout the case to a high of 98%. The case continued uneventfully. Emergence was smooth, but when the patient was extubated the \text{SaO}_2 decreased to 94%. Oxygen at 15 L/min via a partial non-rebreather mask was applied and the patient was quickly
transferred onto the stretcher, where the head of the bed was elevated. \( \text{SaO}_2 \) rose to 96%. The patient was transferred to the post anesthesia care unit (PACU) with oxygen. \( \text{SaO}_2 \) remained 96% in the PACU.

**Discussion**

A problem known to occur with the obese population is rapid desaturation with apneic periods. This desaturation is linked to functional residual capacity (FRC). FRC, which needs to be optimized to tolerate apnea, is reduced in the obese patient. The FRC is further decreased when the obese patient is placed in the supine position because of cephalad movement of the diaphragm and abdominal contents. One strategy to minimize this reduction in FRC would be to pre-oxygenate the patient in the sitting position. Altermatt, Munoz, Delfino, and Cortinez (2005) conducted a study comparing pre-oxygenation in the supine and sitting positions. They found that time to desaturation was elongated in the sitting group. Unfortunately, a sitting position is usually inappropriate in the operating room (OR) setting, however, reverse Trendelenburg is readily available. Studies have verified that the reverse Trendelenburg position optimizes FRC. Boyce et al. found that the \( \text{SaO}_2 \) of patients in a 30 degree reverse Trendelenburg position decreased the least and took the least amount of time to recover to an \( \text{SaO}_2 \) of 97% as compared to a 30 degree semi-Fowler or supine-horizontal position. In the reverse Trendelenburg position the panniculus of the obese patient moves downward, releasing pressure from the diaphragm, and thereby increasing FRC. With increased FRC, the patient can tolerate apnea for a longer period of time (i.e. time for laryngoscopy and intubation). With adequate pre-oxygenation in the present case, the patient may have experienced less desaturation.

It has long been assumed that obese patients have difficult airways and are more difficult to intubate. The American Society of Anesthesiologists (ASA) defines a difficult airway “as a situation when a conventionally trained anesthesiologist experiences difficulty with face mask ventilation of the upper airway, difficulty with tracheal intubation, or both”. Several studies or reviews have disproved this for the majority of obese patients. Brodsky, Lemmens, Brock-Utne, Vierra, and Saidman did not find a correlation between increasing BMI and increasing difficulty of intubation. Rather, they found that neck circumference was more closely related to difficulty of intubation such that a patient with a neck circumference of 40 cm would have a 5% probability of a difficult intubation, whereas someone with a 60 cm neck would have a probability of 35%.

Another study also found no increase in difficult airways among obese patients, but stressed the importance of optimal positioning for laryngoscopy. It is of note that many articles suggest proper positioning of the obese patient to ease intubation difficulties. The proper positioning is described as an elevated shoulder and head position to compensate for a flexed position of the obese patient due to posterior cervical fat. Le-vitan, et al. and Brodsky, et al. describe the same type of positioning for optimal laryngoscopic view. In a letter to the editor written by Brodsky, et al., they describe the position as one in which the shoulders and head are elevated so the tip of the chin is just higher than the chest, and the patient’s sternal notch is
aligned with the external auditory meatus.\textsuperscript{4} In this position, all of the authors found most intubations simple, even in the morbidly obese.\textsuperscript{1,2,3,4} In the aforementioned case study, utilizing this positioning technique would have made direct visualization of the vocal cords, more rapid and the patient would not have had time to desaturate.

In conclusion, the obese patient presents many concerns for anesthesia practitioners before, during, and after surgery. The scope of this case study was for the induction period. Using a combination of the techniques for pre-oxygenation and positioning can alleviate problems. Elevating the patient’s shoulders and head and placing the OR table in a 30 degree reverse Trendelenburg position is clearly the optimal situation for the induction and intubation of the obese patient because FRC is maximized and view during laryngoscopy is improved.\textsuperscript{7}

References


Mentor: Vicki C. Coopmans, CRNA, PhD
Anesthetic Management of the Patient with Scleroderma
Stephanie W. Fan, BSN
Goldfarb School of Nursing at Barnes-Jewish College

Key words: interscalene block, general anesthesia, scleroderma, limited cutaneous scleroderma (lcSc), diffuse cutaneous scleroderma (dcSc)

Scleroderma, also known as systemic sclerosis, is a chronic multisystem autoimmune disorder with unknown etiology. The incidence of scleroderma is 200-300 per million in the U.S., and most commonly occurs in adult women.1 It is characterized by skin thickening and tightening due to abnormal fibrous tissue accumulation. It can also involve other organ systems including the lungs, heart, and gastrointestinal tract.1 These pathological changes can cause difficulties in locating peripheral nerves, and in airway and ventilation management. This case report describes an interscalene block and general anesthesia management of a female patient with scleroderma.

Case Report

A 65 year old, 165 cm, 78 kg African American female presented to the preoperative holding area for left shoulder arthroplasty. Her past medical history included scleroderma, arthritis, type II diabetes, and hypothyroidism. Prior surgeries included hysterectomy, hernia repair, and thyroidectomy. She had an allergy to codeine. Social history included two packs / day tobacco use for 25 years, which she quit 20 years ago. Medications included metformin, levothyroxine, propoxyphene and acetaminophen.

Physical exam showed left shoulder pain and limited range of motion. Bilateral lungs were clear to auscultation, and she denied shortness of breath. The patient’s skin was thick and taut on her hands and forearms. A Mallampati Class I airway with good mouth opening and full neck range of motion was observed. Diagnostic studies included a negative adenosine-thallium stress test, recent echocardiogram with an ejection fraction of 65%, and normal electrolyte panel.

After informed consent, the patient was asked to lay flat with arms relaxed at her sides and head turned to the right about 30 degrees. The patient’s sternum, clavicle, sternal and clavicular heads of the sternocleidomastoid muscle, and external jugular vein were marked. The interscalene groove was palpated. The patient was premedicated with midazolam 1 mg and the area cleaned with betadine. Local infiltration with lidocaine was performed with a 25-Gauge needle. A 22-Gauge needle with nerve stimulator attached was inserted at 45 degrees angle and placed in a medial, posterior and caudad direction. The stimulator was set at 0.8mA, and the needle was advanced slowly. No muscle twitching was observed after several attempts. A decision was made by the anesthesia and surgical team to proceed to general anesthesia without an interscalene block. The patient had no hematoma, seizure, or impairment of extremity movement.

In the operating room, standard monitors were applied and preoxygenation at 8 L/min was delivered via face mask. Anesthesia was induced with propofol 150 mg and vecuronium 8 mg. The trachea was intubated without difficulty. Bilateral breath sounds and end-tidal
carbon dioxide were confirmed and mechanical ventilation was initiated. Cefazolin 2 gm and methylprednisone 100mg were administered prior to incision. The patient was repositioned to sitting while securing the airway and maintaining the head in neutral position. Bilateral lung sounds were confirmed again immediately after repositioning. Anesthesia was maintained with desflurane in a mixture of oxygen and nitrous oxide.

The surgical procedure was uneventful. Morphine was administered intraoperatively for a total of 10mg. Peak airway pressures were maintained below 40 cmH2O, with an average tidal volume of 550 ml. Neuromuscular blockade was antagonized with neostigmine 4 mg and glycopyrrolate 0.7 mg. Ondansetron 4mg was also given. The patient was extubated without incident and transferred to the post-anesthesia care unit (PACU) with O2 at 2 L/min via nasal cannula. In the PACU, the patient denied pain and maintained spontaneous respirations with an O2 saturation of 97%.

**Discussion**

Scleroderma is divided into two subgroups. Limited cutaneous scleroderma (lcSc) involves skin of the forearms, hands, legs, feet and face. Diffuse cutaneous scleroderma (dcSc) can affect the skin over almost any body area. Scleroderma varies greatly from person to person. About 90% of patients with scleroderma also have Raynaud’s’ Phenomenon, and sometimes it is the first symptom.1 Initially skin over the digits is edematous. Gradually the skin becomes firm, thickened, and eventually tightly bonded to the underlying subcutaneous tissue. Skin change starts in the digits and advances proximally.

Placement of regional anesthesia may be impossible secondary to skin and joint changes.2 When no muscle twitches could be elicited, the interscalene block was aborted. Peripheral neuropathy due to nerve compression by skin fibrosis may account for the lack of discernable muscle twitches during block placement attempts. Also, landmarks may be obscured by the thickened skin, further complicating regional anesthesia administration.

With facial skin involvement, patients can have thinning lips and difficulty with opening the mouth. This can pose a challenge when placing an endotracheal tube. The patient reported in this case had a clinical presentation more consistent with lcSc. She had a good mouth opening and no limitation in temporomandibular and atlanto-occipital joint movements.

Pathological changes in scleroderma contribute to diffuse microvascular injury, fibroblast activation and increased production of collagen which lead to extensive vascular damage and sclerosis within the skin and internal organs.3 Significant pulmonary involvement is seen in 25% of patients within 2.8 years of diagnosis and is manifested as pulmonary arterial hypertension and pulmonary fibrosis.4

African American patients represent a significantly higher percentage of pulmonary fibrosis cases compared with whites or Hispanics. Hypothyroidism has been identified as one of the factors associated with pulmonary involvement. African Americans are reported to have a more diffuse cutaneous disease, earlier onset age, and more pulmonary involvement.4 The patient reported in this
case study was an African American and had hypothyroidism, which would place her at higher risk for pulmonary fibrosis and diffuse skin involvement. She did not appear to have any symptoms indicative of pulmonary involvement. This might reflect the varied clinical course from mild and asymptomatic to severely debilitating involvement. Whether pulmonary involvement is present or not, it is very important to closely monitor $O_2$ saturation, peak airway pressure, tidal volume and end-tidal $CO_2$ intraoperatively to assure adequate gas exchange. Peak airway pressures and tidal volumes should be watched closely to avoid lung tissue damage attributable to mechanical ventilation.

Scleroderma is a multisystem autoimmune disorder. Depending on the type and severity, it can affect the skin, lungs, gastrointestinal tract, musculoskeletal system, heart, and kidneys. The patient presented in this case study only showed involvement of the skin on the hands and forearms. Again, this reflects the variability of the disease. In patients with history of scleroderma, airway assessment is extremely important. If extensive facial skin involvement is present, awake fiberoptic intubation or tracheotomy may be necessary. If there are signs of breathing difficulty preoperatively, pulmonary hypertension and fibrosis should be suspected. Anesthesia practitioners must carefully evaluate the patient with scleroderma, understand the pathology and complications of the disease, and be aware of risk factors related to anesthesia. The plan of anesthesia should be tailored to the needs of each individual patient.

References


Mentor: Vicki C. Coopmans, CRNA, PhD
than 400 million people worldwide.\textsuperscript{1} It is a hereditary X-linked enzyme deficiency consisting of more than 400 enzyme variants with an increased incidence in African-American, Eastern Mediterranean and Chinese males.\textsuperscript{2} The significance of G6PD deficiency in anesthesia has the potential to cause hemolytic anemia by commonly administered medications. Therefore, it is important to avoid these medications to eliminate potential sequelae.

Case Report

A 15-year-old male, 6 feet, 85kg, sustained a gunshot wound to the testicle and left lower extremity. Upon arrival to the emergency room, vital signs were stable. His past medical history was significant for G6PD deficiency and he was not taking medications. Preoperative laboratory values revealed a hemoglobin of 11.2 gm/dL. Premedication consisted of intravenous (IV) midazolam 2 mg, prior to transportation to the operating room for testicle exploration. Standard monitors were applied and prehydration with 1000ml of lactated Ringers via a 16g peripheral intravenous was administered. Rapid sequence intubation was employed, followed by the administration of cefazolin 1gm IV. Anesthesia was maintained with sevoflurane, oxygen at 1L/min and nitrous oxide at 1L/min. Surgical exploration was 45 minutes with no significant injury found. Upon conclusion of surgery, emergence from anesthesia was uneventful. The patient was taken to the recovery room with stable vital signs. His postoperative hemoglobin was 10.5 gm/dL. An uneventful postoperative course ensued with discharge to home the following day.

Discussion

G6PD deficiency remains the most common of enzyme defects in the world.\textsuperscript{1} It was first discovered when patients developed hemolytic anemia after administration of the antimalarial drug, primaquine. The enzyme glucose-6-phosphate-dehydrogenase initiates a critical pathway producing nicotinamide-adenine-dinucleotide phosphate. The absence of this end product leaves a red blood cell susceptible to oxidation.\textsuperscript{2} The mechanism by which hemolysis occurs is not definitive, however oxidative injury to the erythrocytes occurs and results in the formation of methemoglobin and the inactivation of enzymes. With a deficient enzyme pathway, red blood cells are eliminated and intravascular hemolysis occurs.\textsuperscript{3}

With more than 400 enzyme variants, G6PD deficiency results in a myriad of clinical manifestations. The two most common deficiencies are the Mediterranean and the African or A-variant. The G6PD Mediterranean form is more severe and is characterized by a 2% residual activity of red blood cells. The more common form in the United States is the A-variant occurring in approximately 10% of the African American population.\textsuperscript{3} It results in a 15% residual activity of the red blood cells. In addition, the degree of hemolysis can range from mild to severe forms and may destroy older red blood cells or young red blood cells in severe cases.\textsuperscript{3}

The following medications should be avoided by people with G6PD deficiency: sulfonamides, antimalarial medications, nitrofurantoin, nalidixic acid, probenecid, aminosalicylic acid, phenacetin, acetylsalicylic acid, vitamin K, methylene blue, quinine, quinidine, chloramphenicol, penicillamine, dimerca-
prol, prilocaine and nitroprusside. After administration of one of these medications to a G6PD deficient patient, a decrease in the hemoglobin is seen in one to five days. There remains a wide variability in the response to these drugs and hemolysis may occur only with high dose administration. Many of these medications are common in anesthesia practice and should be avoided in the patient with G6PD deficiency.

G6PD deficient patients are also at an increased risk for hemolysis resulting from infections. Associations have been made with G6PD deficiency and an increased incidence of bacterial infections in trauma patients and neonates. Trauma patients with G6PD deficiency have been shown in multiple studies to have a longer hospital stay than patients without the deficiency and are predisposed to septic complications and anemia.

Anesthetic management of G6PD deficiency is focused on preventing the administration of hemolysis inducing medications. Patients with G6PD deficiency should wear an identification bracelet to alert anesthesia professionals. Oxidant-induced hemolysis is typically self-limited and only severe cases require blood transfusion. Current management of G6PD deficiency includes supportive care and termination of the causative agent. Management of the A-variant can include administration of the identified medications, if the treatment is considered essential. A complete blood count must be monitored closely in this circumstance.

G6PD deficiency is the most common enzyme variant and occurs more in African American and Mediterranean descents. Avoiding medications which could result in oxidative stress to the red blood cells is essential in managing this deficiency in the anesthesia arena. This particular patient did not receive medications which could have resulted in hemolytic anemia due to early recognition and prevention of the disease process. In addition, unidentified patients with G6PD deficiency may present to the operating room. If hemolytic anemia is suspected postoperatively, G6PD deficiency should be a differential diagnosis and testing should be conducted to diagnose the disorder.

References


Mentor: Maria Magro, CRNA, MS, MSN
Key words: Tourniquet, Tourniquet pain, Clonidine, EMLA cream, Propofol, and Ketamine.

Tourniquets are frequently used during orthopedic surgery to minimize blood loss and provide a bloodless field for the surgeon. The tourniquet is inflated to a cuff pressure of 50 to 100 torr above systolic pressure for the arm and thigh respectively; recommendations for length of application range from 30 minutes to 4 hours. Deflation periods of five minutes after each hour are suggested to prevent damage to underlying vessels, nerves, and skeletal muscle; however, most institutions limit application to two hours. Patients may complain of tourniquet pain during surgical procedures under regional anesthesia. The purpose of this paper is to discuss and review the literature on this phenomenon.

Case Report

A 42 year old, 92 kg, ASA II male was scheduled for a total knee arthroplasty. Past medical history was significant for arthritis and sleep apnea. Past surgical history was not significant. Medications included hydrocodone and ibuprophen and preoperative laboratory reports were within normal limits.

Midazolam 2mg was administered in the preoperative suite prior to bringing him into the operating room. After positioning on the operating room bed, and application of standard monitors and 3 L/min nasal cannula oxygen, an additional dose of 2mg midazolam and 50mcg of fentanyl were titrated to effect prior to regional anesthesia. A bupivacaine spinal was administered and the dermatome level was determined to be at T-6 prior to positioning for surgery. An initial bolus of 300mcg/kg of propofol was administered, followed by an infusion of 50mcg/kg/min prior to placement of the tourniquet. Oxygen delivery was maintained at 3L/min nasal cannula with end tidal carbon dioxide monitoring.

Vital signs remained stable throughout the procedure. However, less than one hour from the time the tourniquet was applied, the patient became increasingly restless despite increasing doses of propofol exceeding 100mcg/kg/min and an additional dose of fentanyl 100 mcg intravenously. The patient did not verbally complain of pain, but appeared restless. The vital signs remained within 20% of baseline values. The surgeon requested decreased movement of the patient. Since the patient had a history of sleep apnea, there was concern of further increasing the dose of propofol, so ketamine was considered. 20mg of ketamine was administered intravenously which helped to attenuate the restlessness and the surgery proceeded. The patient continued to breathe spontaneously without upper airway obstruction. Additional doses of 10-20 mg of ketamine were provided every 30-45 minutes.

The surgery concluded without additional problems and the patient had no immediate recollection of the events that occurred intraoperatively. During postoperative rounds the following day, the
patient denied having hallucinations or any unusual dreams.

**Discussion**

Tourniquet pain is the subjective aching distal to the tourniquet which occurs despite adequate anesthesia. In an early description of tourniquet pain in 1950, Cole states the pain, which is totally unrelated to surgical manipulation, appears forty five to sixty minutes after application. Symptoms range from dull aching and burning to excruciating pain which may be due to activation of slow-conducting, unmyelinated C-fibers resistant to local anesthetics. In a letter to the editor, Sunder (2006), however, described an atypical presentation of tourniquet pain during an open reduction internal fixation of the tibial plateau under combined spinal and epidural anesthesia. The patient described severe bursting pain specifically localized to the plantar aspect of the right foot. This episode may represent an inadequate block yet also calls attention to the possibility that tourniquet pain may be under diagnosed.

During a general anesthetic, the anesthesia practitioner may note increases in blood pressure or heart rate requiring pharmacological treatment. The mechanism for tourniquet-induced hypertension is unclear; however, increased plasma or epinephrine concentrations have not been documented during tourniquet use and hypertension as a result of tourniquet use can be a challenge to control. Perioperative hypertension can be associated with serious cardiac complications especially in patients with documented cardiovascular disease. Zalunardo, et al. (2002) concluded that intravenous clonidine, administered preoperatively, significantly blunted hyper-adrenergic responses to tourniquet inflation on the lower limbs during general anesthesia. Additional studies are required to show if this treatment would be effective during regional anesthesia as well.

Tourniquet pain can have significant implications which may alter the anesthetic plan of care. During regional anesthesia, if the patient is having excruciating pain and cannot remain still, the anesthesia practitioner may need to convert to a general anesthetic. Regional anesthesia offers many advantages including decreased blood loss, attenuated risk of thromboembolism, reduced incidence of respiratory depression and postoperative nausea and vomiting. The physical and mental well being of the patient is paramount and finding an effective method to treat tourniquet pain may lead to increased patient satisfaction and decreased patient risk.

Current research has highlighted the dilemma of tourniquet pain and methods to treat or avoid the phenomenon altogether. Tetzlaff, et al. (1993) compared the effectiveness of regional anesthetic techniques by randomizing 60 patients to three study groups; spinal anesthesia with 0.5% bupivacaine with 0.2mg epinephrine added, lumbar epidural anesthesia with 2% mepivacaine and 1:200,000 epinephrine added, or epidural anesthesia with the same concentration of mepivacaine alkalinized with bicarbonate. Alkalinization of local anesthetics speed the onset and improve the spread of the local anesthetic. The results of this study indicate spinal anesthesia is superior to epidural anesthesia in preventing tourniquet pain unless the epidural mepivacaine is alkalinized in which case the advantage is eliminated.
Superficial application of a eutectic mixture of lidocaine and prilocaine (EMLA) before application of the tourniquet may increase the time to the onset of tourniquet pain. Lowrie, et al. (1989) evaluated EMLA to a placebo cream in ten healthy males. Both groups experienced tourniquet pain, however the tourniquet inflation time was tolerated significantly longer, about 10 minutes, in the EMLA group. This study did not evaluate if the EMLA cream would need to be applied 60 minutes prior to tourniquet application or if it needed to be covered to prevent inadvertent removal of the cream. The time needed for the onset of EMLA cream may limit its usefulness in the busy preoperative area. In addition, although ten minutes may be statistically significant, it may not prove to be clinically relevant during lengthy operations.

Use of propofol for sedation is common during regional anesthesia. Hand, et al.(2001) tested the hypothesis that propofol, given intravenously at sub hypnotic doses, would provide analgesia in human volunteers with experimentally induced tourniquet pain. Two dose protocols for propofol, either a bolus of 160mcg/kg followed by 16mcg/kg/min or 320mcg/kg bolus followed by 32 mcg/kg/min were studied compared to a placebo group with 48 subjects who were randomized to the groups. Subjects in both of the experimental groups tolerated the tourniquet significantly longer than the control group and took longer to reach a pain intensity score of 8 or greater, although one patient could not be controlled on propofol alone. This study showed that intravenous administration of sub hypnotic doses of propofol could be used to attenuate tourniquet pain.

Ketamine, a phencyclidine derivative which binds non-competitively to the N-methyl-D-aspartate (NMDA) receptor sites, produces amnesia and intense analgesia. One side effect of Ketamine is hallucinations and nightmares, however Green, et al. (2005) studied the incidence of this and found these side effects were lacking in 26 young adults aged 16-21. Takada, et al.(2005) evaluated the effect of preadministration of low dose ketamine in attenuation of tourniquet pain and arterial pressure increases in ten healthy awake volunteers. The volunteers were divided into two groups and administered either normal saline or ketamine 0.1mg/kg intravenously. The ketamine attenuated the onset of pain and arterial pressure increase during tourniquet use. Although this study is small, it highlights the need for further studies regarding the effectiveness of ketamine for preemptive analgesia in healthy patients.

Perhaps providing additional nerve blockade would increase tolerance to tourniquet pain. Fuzier, et al. (2005) examined Labat’s approach compared to the popliteal approach for combined femoral and sciatic nerve block in preventing tourniquet pain. All patients received a femoral nerve block and then were randomized into the Labat’s or popliteal approach to blocking the sciatic nerve. During Labat’s approach, the needle must be inserted through the gluteal muscles and this was found to be more uncomfortable in this group of unsedated patients. No statistically significant difference was observed between the groups, however the popliteal approach was tolerated better.

Other studies have focused on the relationship of cuff size to tourniquet pain.
toleration in patients. Estebe, et al. (2000) compared two cuff widths, 14cm and 7cm, and found that subjects in the narrow cuff could tolerate pain significantly longer than in the wide cuff. The study also demonstrated that if the wide cuff was inflated at lower pressures, 10mmHg above pulse occlusion, it was less painful than the narrow cuff.

Tourniquet pain was mentioned briefly during nurse anesthesia school lectures. Anesthesia text books have short paragraphs describing the occurrence as well. The methods most instructors state for treating tourniquet pain is removal of the tourniquet. This is unlikely to occur until the surgery is complete; therefore, anesthesia practitioners must maximize patient comfort by utilizing other modes of controlling pain.

Tourniquets provide an important service to both the orthopedic surgeon and patient. Tourniquet pain, however, can negatively impact the anesthetic plan and patient satisfaction with the experience. Knowledge of different tools to attenuate tourniquet pain may help the anesthesia practitioner continue with regional anesthesia without having to convert to a general anesthetic technique. Using bupivacaine has been shown to decrease tourniquet pain in spinal anesthesia. One can improve the efficacy of epidural anesthesia by adding bicarbonate to improve the onset and enhance the spread of the local anesthetic. Although expensive and time consuming, EMLA cream has been shown to delay the onset of tourniquet pain. Propofol and Ketamine are two intravenous agents that can be used not only to treat, but possibly prevent the onset of tourniquet pain. Tourniquet width and pressure are not something the anesthesia practitioner has control over, but this subject is worth noting and possibly discussing with the surgical team. Staying abreast of the literature will assist the anesthesia professional to utilize the most current techniques in preventing tourniquet pain.

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Mentor: Lisa Mileto CRNA, MSN

One-Lung Ventilation Utilizing a Double Lumen Tube
Jerrol B. Wallace, LT, NC, USNR, BSN
Navy Nurse Corps Anesthesia Program

Key words: thoracic surgery, double lumen tubes, hypoxic pulmonary vasoconstriction, continuous positive airway pressure, positive end expiratory pressure

One-lung ventilation is a common anesthetic technique used to isolate the lungs during thoracic surgery. Absolute indications for one lung anesthesia are: isolation of each lung to prevent contamination of a healthy lung, control of distribution ventilation to only one lung, unilateral lung lavage, and video-assisted thoracoscopic surgery. Relative indications are: thoracic aortic aneurysm, pneumonectomy, lobectomy, esophageal surgery, and thoracoscopy.¹³ Lung separation is accomplished by endotracheal intubation with bronchial blockers and double lumen tubes (DLT). The advantage of the bronchial blocker is that it is a single lumen tube that does not require replacement if postoperative ventilation is required.¹³ In addition, it is an ideal method for the pediatric patient due to their smaller anatomy. The disadvantage of the bronchial blocker is that it can be difficult to maintain proper positioning. Currently DLT remains the most widely used method for accomplishing one-lung ventilation because the ease of placement offers the ability to have separate access to each lung and allows different ventilation techniques without manipulating the position of the DLT.¹³⁻⁴

Case Report

A 35 year old ASA III, 62”, 76 kg female diagnosed with bronchopulmonary aspergillosis and recurrent pneumothoraces was scheduled for a left thoracotomy with an upper lobe lobectomy. Her past medical history revealed severe asthma
which was diagnosed in early adulthood. The patient had required multiple intubations due to asthmatic exacerbations, with the last intubation approximately two years ago. In addition, she had multiple emergency room visits within the past year, and the last visit was five days prior to surgery. At the time of surgery, her asthma was managed with montelukast, fexofenadine, fluticasone, albuterol inhaler, and chronic use of steroids which was incrementally decreased over the last two weeks. The patient has a history of allergy to penicillin. Her past surgical history consisted of two prior uncomplicated surgeries under general anesthesia unrelated to her current disease process. Laboratory findings were unremarkable with normal clotting factors and liver function tests. A recent pulmonary function test was not available, but chest Computed Topography (CT) revealed a left major fissural nodularity and thickening which had the appearance of either a postoperative or post-inflammatory change.

Upon physical exam, the lungs were clear to auscultation with diminished breath sounds to left upper and middle lobes. A preoperative airway exam revealed a Mallampati class I view with full range of motion of her neck, her dentition was intact, and the thyromental distance and mouth opening was within normal limits. Preoperative vital signs revealed a blood pressure of 116/75, pulse 92, respiratory rate of 16 and 97 percent oxygen saturation on room air. After proper positioning and standard monitor application, a thoracic epidural was placed in the preoperative holding area for postoperative analgesia. Upon arrival to the main operating room, standard monitors were placed and the patient was pre-oxygenated for five minutes prior to induction. A standard induction was accomplished with 100 micrograms of fentanyl, 70 milligrams of lidocaine, 150 milligrams of propofol and 50 milligrams of rocuronium, followed by an endotracheal intubation using a 35 French double lumen tube. Proper placement was confirmed with auscultation of breath sounds to each lung while the opposite side was clamped, and by direct visualization of the bronchial cuff by fiberoptic technique. The patient was maintained on sevoflurane with 1 L/min of air and 1 L/min of oxygen with a pulse oximetry of 96 to 100 percent. The left lung was deflated during the operation and reinflated prior to wound closure. At the end of the case, the thoracic epidural was dosed with 100 micrograms of fentanyl and an infusion of 20 microgram per milliliter of dilaudid and 0.06% bupivacaine was started at 5 milliliters per hour. The patient was then extubated fully awake and maintained 98% oxygenation via face mask and transported to the recovery room without incident.

Discussion

When performing one-lung ventilation (OLV), patient positioning is crucial to adequate ventilation during the intraoperative period. The majority of OLV cases require the patient to be in the lateral decubitus position. This position changes the ventilation and blood flow that is normally seen in the upright position.

There are six different anesthetic scenarios that determine how significant the perfusion-oxygenation mismatch which may occur. (1) The awake patient, breathing spontaneously, in the lateral position, with the chest closed is most similar to the upright position which
provides adequate ventilation. (2) The awake patient, breathing spontaneously, with the chest open usually requires controlled positive pressure to provide adequate oxygenation. Two complications that are associated with this position are a mediastinal shift upon inspiration and paradoxical breathing. (3) The third scenario is the anesthetized patient, breathing spontaneously, with the chest closed. In this situation, there is a significant perfusion ventilation mismatch because most of the ventilation goes to the nondependent lung, while the majority of the blood flow goes to the dependent lung. (4) The anesthetized patient, breathing spontaneously, with the chest open creates more of a perfusion ventilation mismatch because the nondependent lung has even more room to expand, thereby increasing its ventilation. (5-6) The last two positions, anesthetized patients that are paralyzed, one lung or two lung ventilation, even further increases the perfusion ventilation mismatch. (1)

The ventilation-perfusion mismatch associated with one-lung anesthesia may lead to hypoxemia due to the decrease in oxygenation related to the deflation of the nondependent lung. This may activate a reflex better known as hypoxic pulmonary vasoconstriction (HPV). HPV is an autoregulatory mechanism that diverts blood away from the atelectatic lung, and shifts it to the well-ventilated lung. (1,8-9) This reflex is essential for OLV because it prevents the arterial oxygenation from decreasing, thereby keeping the patient well oxygenated. There are certain factors however, that may decrease HPV leading to an increase in hypoxemia. Direct inhibitors of HPV include infection, vasodilators, hypocarbia and metabolic alkalemia. (1) Another factor that may decrease HPV which may be overlooked is the use of a thoracic epidural. The sympathectomy associated with thoracic epidural anesthesia may attenuate the effects of HPV when it is used for intraoperative management. (9) This may be alleviated with incremental dosing of the epidural intraoperatively or by dosing it at the end of surgery for postoperative pain control only.

One-lung ventilation continues to be an important asset to thoracic surgery. Due to patient positioning and the potential for hypoxemia, it is essential that the anesthesia professional remains vigilant in the assessment of any signs of respiratory compromise. The first signs of hypoxia should be assessed by confirming proper positioning of the DLT by fiberoptic visualization. Once position has been confirmed, the use of continuous positive airway pressure (CPAP) to the nondependent lung should be initiated if hypoxia persists. CPAP is the single most effective method to increase oxygenation during OLV. (1) Other methods to improve oxygenation in these patients include 100 % oxygenation, increasing the tidal volume, increasing respiratory rate and the use of positive end expiratory pressure (PEEP) to the dependent lung. Regardless of the technique used, continuous assessment of adequate ventilation remains paramount.

References


Mentor: Lisa Osborne, CDR, NC, USN, CRNA, PhD

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**Negative Pressure Pulmonary Edema After Laryngospasm**

**Alicia J. Weissgerber, LT, NC, USN, BSN**

Navy Nurse Corps Anesthesia Program

**Key words:** laryngospasm, negative pressure pulmonary edema, non-cardiogenic pulmonary edema, continuous positive airway pressure, positive pressure ventilation

Negative pressure pulmonary edema (NPPE) is an uncommon diagnosis in anesthesia. The etiology of this non-cardiogenic pulmonary edema is unknown. Laryngospasm is associated as a preceding event because the inspiration against a closed glottis creates a change
in the osmotic pressures and capillary membrane permeability. The following case report discusses the anesthetic management and treatment modalities of a patient who is diagnosed with negative pressure pulmonary edema following a possible laryngospasm post-extubation for a tonsillectomy and uvulopalatopharyngoplasty.

**Case Report**

A 25 year-old male, 93 kilogram, ASA physical status II patient presented for a tonsillectomy and uvulopalatopharyngoplasty for hypertrophic tonsils with redundant soft palate and uvula as evidenced by a severe snoring history. His medical history was significant for hypercholesteremia and tobacco history. He had no known drug allergies and did not take any medications. His vital signs were a blood pressure of 110/73 mm Hg, and heart rate of 68 beats per minute. In the patient holding area, midazolam 2 mg was administered intravenously to relieve patient anxiety. Additionally, clindamycin 600 mg and dexamethasone 10 mg were administered in the preoperative holding area. After arrival in the operating room, standard monitors were applied, the patient was preoxyg enated, and a smooth induction was performed with 150 mcg fentanyl, 200 mg of propofol and 100 mg of succinylcholine. A 7.5 mm endotracheal tube was placed under direct laryngoscopy and was secured at a depth of 23 cm measured at the lip. General anesthesia was maintained with desflurane at 4.1% with 50% nitrous oxide and 50% oxygen. The patient remained supine for the procedure. The surgeon completed the surgery and achieved homeostasis with minimal blood loss. An additional 50 mcg of fentanyl was given intra-operatively as well as 4 mg ondansetron toward the end of the surgery. The patient’s total fluid intake was 900 ml. The patient was thoroughly suctioned. He was extubated after he met extubation criteria which included eye opening to commands, and spontaneous ventilation of 16 breaths per minute with adequate tidal volumes. Copious amounts of clear secretions were observed on the pilot balloon when the endotracheal tube was removed. A strong paradoxical breath was witnessed with posteriorly retracting chest movement and an anteriorly protracting abdomen. No mist or fogging was present on the face mask. The oxygen saturation decreased to 90-93%. Positive pressure via the mask was maintained with 100% oxygen. Soon the patient began coughing effectively, and pink frothy sputum was evident. After further oral suctioning, the patient stopped cough, had regular respirations and was in no apparent distress. The patient was transported with oxygen via face mask to the post anesthesia care unit (PACU). A portable chest x-ray was taken in PACU. The patient maintained an oxygen saturation of 92-93% on humidified face mask with 12-16 breaths per minute. The radiology exam revealed diffuse pulmonary infiltrates. Continuous positive airway pressure (CPAP) was initiated with 60% inspired oxygen with 5 cm of water pressure. The patient maintained the same respiratory rate with oxygen saturations greater than 95% on CPAP. His vital signs were normal and he reported a zero pain level on a pain scale of 0-10. He was alert and oriented but stated that he felt short of breath. The patient remained on CPAP for 3 hours before it was replaced with a nasal cannula at 2 liters per minute and he maintained oxygenation at 97%. The patient was transported to the radiology department for a follow-up chest x-ray that showed improvement.
This patient was admitted for an overnight stay for observation and subsequently discharged the following morning without any further problems.

**Discussion**

Negative pressure pulmonary edema was first described in 1977 by Oswalt, et al. who related it to laryngospasm.\(^1\) The reflexive action of the vocal cords is strong and negative inspiratory pressures have been measured as low as -50 cm to -100 cm of water.\(^2\) The low intra-thoracic pressures that are generated cause changes in the pulmonary Starling forces, with a resultant increase in preload, stimulation of the adrenergic system and promotion of hypoxia. All these factors favor pulmonary edema. The prevalence of acute negative pressure pulmonary edema is 0.09% and it tends to occur predominantly in young, athletic, males who are able to create this forceful inspiratory pressure.\(^3\)-\(^5\)

It is speculated that the large negative pressure gradient generated against an airway obstruction such as a laryngospasm produces a change in the equilibrium of Starling forces on the alveolar surface membrane. The normal hydrostatic pressures of the pulmonary vascular structures are increased while more negative hydrostatic pressures in the pulmonary interstitium occur. Concomitant increases in colloid pressures of the pulmonary interstitium also promote pulmonary edema.\(^6\) Thus the normal balance of hydrostatic and colloid pressures that normally maintain the permeable membrane are changed, promoting fluid accumulation in the alveolar space. Furthermore, an increase in venous return contributes to increased fluid volume, pressure and pulmonary capillary permeability, as is demonstrated in the dependent lung from lateral decubitus positioning showing unilateral NPPE.\(^6\)-\(^7\)

Hypoxia related to a ventilation and perfusion mismatch may cause an increase in sympathetic discharge, which leads to increased vascular tone and preload. However, recent studies show that a brief obstruction does not increase blood pressure, but does decrease the hypoxic pulmonary vasoconstriction adaptation promoting the formation of pulmonary edema through the lack of homogenous pulmonary blood flow.\(^8\)-\(^10\) The accumulation of pulmonary fluid occurs after the obstruction is relieved.

Negative pressure pulmonary edema is generally self-limiting and resolves within 12 to 24 hours with supportive care such as supplemental oxygen.\(^2\)-\(^3\),\(^6\) However, if the patient is unable to maintain adequate oxygenation, further interventions are needed. A conservative approach is mask or nasal continuous positive airway pressure (CPAP) for up to 4 hours to reverse the previous negative interstitial pressure mechanism that caused the pulmonary edema. If the patient is unable to tolerate or maintain the mask seal, then intubation with mechanical ventilation is performed with positive pressure. Other traditional treatments include use of diuretics, steroids, theophylline, and digoxin, but have been shown to have little benefit and remain controversial for the treatment of negative pressure edema.

This brief airway obstruction event led to a complicated postoperative course for a normal healthy male. The lesson learned is that prevention of obstruction is the best course of action. Intravenous or laryngotracheal topical lidocaine use may be beneficial prior to intubation. In
addition, adequate suctioning prior to extubation after the patient is awake and appropriately following commands may also be beneficial. Moreover, prompt recognition of pulmonary edema, proper airway management and oxygenation are the keys to a successful outcome. It is difficult to blame the anesthetic technique, but prevention through planning may be appropriate in the future especially for procedures involving supra- and infra-glottic structures.11

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Mentor: Lisa Osborne, CDR, NC, USN, CRNA, PhD
Dexmedetomidine for Conscious Sedation
Kelly A. Tonkin, BSN
Wake Forest University Baptist Medical Center Nurse Anesthesia Program
University of North Carolina at Greensboro

Key words: Precedex; dexmedetomidine; sedation; vascular; revascularization

With the advent of minimally invasive vascular procedures, the practice of vascular anesthesia is constantly changing to address the needs of this specific surgical population. Percutaneous renal revascularization by angioplasty allows for the surgical intervention for renal artery stenosis to be performed without a general anesthetic. This minimally invasive treatment option permits surgical management of patients with renal artery stenosis who would previously be considered high-risk for general anesthesia.1, 2 The following case report discusses dexmedetomidine for conscious sedation during renal angioplasty.

Case Report

A physically active 60-year-old, 78 kilogram, 69 inches tall male presented for a right renal artery arteriogram with possible renal artery angioplasty. His past medical history was significant for uncontrolled systemic hypertension and renal artery stenosis. His medications included amlodipine, aspirin, atenolol, and benazepril. The patient did not report a prior surgical history or family history of anesthetic complications. He had no known drug allergies. Preoperative vital signs were blood pressure of 165/92 mmHg, heart rate of 51 beats per minute, and an oxygen saturation of 97% on room air. Laboratory values were significant only for a creatinine of 1.1 mg/dl. The patient was type- and cross-matched. His airway exam was a Mallampati class III with a mouth opening of 3 finger-breaths, a thyromental distance of 3 finger-breaths, full neck range of motion, and intact dentition. The physical exam was unremarkable, and an ASA classification of III was assigned.

On arrival to the operating room, monitors were placed and the patient was positioned in the supine position with pressure points padded. Both arms were tucked, and the patient was preoxygenated with 8 liters oxygen by face mask with capnography monitoring. Midazolam 2 mg and propofol 50 mg was administered intravenously for sedation during placement of a Foley catheter. A dexmedetomidine infusion was started at 0.5 mcg/kg/hour intravenously. No bolus was given. The patient was prepared in a sterile fashion for a left femoral approach for the renal arteriogram. A local anesthetic of 2 ml of 1% lidocaine was injected subcutaneously by the surgeon. The procedure began with no complaints of pain or discomfort reported by the patient. The procedure time was 60 minutes, and the dexmedetomidine infusion was titrated accordingly to maintain an easily arousable, cooperative patient. The dexmedetomidine infusion ranged from 0.1 mcg/kg/hour to 0.5 mcg/kg/hour with 0.4 mcg/kg/hour providing the most therapeutic level of anesthesia. The patient remained sedate and breathed spontaneously in the supine position for the duration of the case. At appropriate times, he followed commands by the surgeon with minimal encouragement.
Postoperatively, the patient was taken to the post anesthesia care unit (PACU). His vital signs remained within normal limits, and his physical assessment was unremarkable. Thirty minutes after arrival to the PACU, the patient was transferred to the short-term surgical unit. His postoperative hospital course was uneventful, and in the morning, he was discharged home.

**Discussion**

With minimally invasive vascular procedures, the surgeon frequently relies on the cooperation of the patient to successfully complete a procedure. The goal for the anesthetist is to have the patient remain comfortable in the supine position for an extended amount of time while simultaneously preserving the patient’s ability to adequately maintain spontaneous respiration and obey verbal commands. Thus, the focus of this case centers on the advantages and disadvantages of dexmedetomidine for patients undergoing minimally invasive vascular procedures.

The percutaneous renal revascularization procedure requires a brief discussion of the surgical plan with the patient in order for them to better understand the anesthetic implications. Patients need to remain still in the supine position for the duration of the case. Both groin areas will be shaved, sterilized, and draped for surgical exposure. The surgeon will instill local anesthetic to the surgical field prior to incision. A large gauged angiocatheter with or without a guide wire will be placed into the femoral artery which acts as the access point for both the contrast medium and the placement of the stent. The surgeon will use x-ray fluoroscopy, computed tomography imaging, magnetic resonance imaging or a combination of these tools to visualize the stenotic area of the renal artery and to facilitate placement of the stent. The patient will be asked to hold their breath while the contrast medium is being injected so that the surgeon may have a better image taken of the affected area. Also, the surgeon will ask that the patient take a large breath and bare down after the stent is placed to insure its positioning. Procedure time varies with the expertise of the surgeon and the location of the stenotic lesion. A minimum time of 60 minutes has been reported.

The anesthetic plan for a percutaneous renal revascularization begins with patient education. The patient must understand that they will need to remain still for the duration of the procedure. They also need to know that they will be given medication in their peripheral intravenous catheter to help them remain comfortable and calm. Additionally, the medication may not cause amnesia for the surgical event. Last, the patient must understand that there is the chance the monitored anesthesia case will be changed to a general anesthetic. Patient cooperation is the most important factor for determining the success of a monitored anesthesia case.

The administration of local anesthetic and intravenous sedation for percutaneous renal revascularization leaves several medication choices for the anesthetist. The spotlight of this discussion will be on the use of dexmedetomidine. Dexmedetomidine, or Precedex®, is a potent alpha-2 adrenergic receptor agonist that acts on both peripheral and central alpha-2 receptors of the central nervous system. It also affects the sympathetic nervous system with influences on the
cardiovascular system. Dexmedetomidine is considered to be 7-10 times more specific than other alpha-2 adrenergic agonists, making it potent and highly selective. Clinical effects caused by dexmedetomidine include sedation, analgesia, inhibition of sympathetic nervous system activity, and decreased blood pressure and heart rate.³,⁴,⁶

The sedation caused by dexmedetomidine is characteristically different from that caused by other intravenous sedatives and hypnotics.⁶ Patients are consistently reported to be calm, cooperative, and easy to arouse from sleep with minimal stimulation. Also, unlike opioids, sedatives, and hypnotics, dexmedetomidine does not cause respiratory depression or hemodynamic instability. The current literature demonstrates that the sedative effect of dexmedetomidine is related to the predominance of the alpha-2A adrenergic receptor subunits found in the brain which are involved in sedative, behavioral, and sympatholytic actions.³,⁴ When coadministered with opioids or inhaled anesthetics, dexmedetomidine is synergistic in action causing marked decreases in intraoperative requirements for these agents.⁶

Often, the patient population undergoing a minimally invasive revascularization includes patients who would not typically tolerate a general anesthetic because of coexisting morbidities. These patients may present with severe coronary artery disease, congestive heart failure, spinal stenosis, or severe pulmonary disease. Dexmedetomidine presents an excellent anesthetic option for these patients because of its limited respiratory depression and its ability to limit sympathetic nervous system activity. It’s effect on the alpha-2B adrenergic receptor subunits of vascular smooth muscle shows an attenuation of hypotension often found with the induction of anesthetic agents.⁴ Dexmedetomidine can cause peripheral vasoconstriction with an initial bolus of 1 mcg/kg followed by a high-dose infusion of 5 to 10 mcg/kg/hour.⁶ Likewise, reflex bradycardia may occur in a dose dependent fashion with a dexmedetomidine bolus because of decreased sympathetic tone and the baroreceptor reflex associated with the subsequent increase in vagal tone. Together, these hemodynamic effects prohibit the rapid intravenous injection of dexmedetomidine, and the manufacturer recommends boluses be given over 10 minutes.⁴,⁷ A continuous infusion of dexmedetomidine has also been found to block the vascular and cardiac effects of the sympathetic nervous system’s release of norepinephrine and epinephrine by decreasing plasma levels of endogenous catecholamines.³ These predictable cardiac effects make dexmedetomidine an excellent choice for patients at risk for intraoperative cardiac events.

The ability of dexmedetomidine to provide effective anesthesia with minimal respiratory and cardiac side effects makes it an important anesthetic agent for consideration with vascular procedures. Addition research may be needed in the future to comprehensively determine the risk and benefits of using dexmedetomidine as part of an anesthetic plan for either general anesthesia or monitored anesthesia care.

References


Mentor: Joe Joyce, BSN, CRNA

Parent Present for Induction of Pediatric Anesthesia
Mercie Payne, BSN
Wake Forest University Baptist Medical Center Nurse Anesthesia Program
University of North Carolina at Greensboro

Key words: pediatrics, parental presence, anesthesia, pediatric induction, surgery

The most stressful period a child experiences perioperatively is the induction of anesthesia. A parent present during induction of anesthesia is a tool used by some anesthesia professionals to help alleviate some stress for the child and parent. Typically, parents demonstrate a high degree of anxiety prior to their child’s surgery. Both children and parents are fearful of the unknown. A parent present induction (PPI) is when a parent is allowed in the operating room with their child during induction when the anesthesia professional deems it appropriate and beneficial.

Case Report

A seven year-old 21 kg African-American male presented for a direct laryngoscopy and bronchoscopic microdebridement of laryngeal papillomas. His past medical history included premature birth at 26 weeks gestation, prolonged intubation due to prematurity, and multiple procedures for management of laryngeal papillomas. He was classified ASA I and presented for the procedure in no apparent distress. Preoperative vital signs were stable and unremarkable. The family and patient expressed an interest in having a parent present during induction. The plan was discussed by the anesthesia and surgical teams and the patient’s family, and it was agreed that the situation was appropriate for PPI. The father had been present during induction for previous surgeries, and the patient found comfort in having his father present during induction.

The patient was taken to the operating room on a stretcher with his father walking beside him. No pre-operative seda-
tion was given to the patient. Once in the operating room the father and anesthesia team assisted the patient to the operating table. A pulse oximeter was placed on his right hand and his father held his left hand while discussing how many breathes it would take before the patient went to sleep. The patient breathed 100% oxygen through his face mask and was told when induction with sevoflurane was started; this allowed the patient to count how many breaths it took before he went to sleep. Induction of anesthesia was achieved by using an inhalation technique through the face mask with four liters per minute of oxygen, six liters per minute of nitrous oxide, and 8% sevoflurane. Once the patient was anesthetized, the father left the operating room and was escorted back to the holding area. After the father left the room, a 22 gauge peripheral intravenous catheter was placed in his left hand, the patient’s arms were padded and tucked by his sides, direct visual laryngoscopy was performed with a Miller 2 laryngoscope to visualize the vocal cords. Lidocaine, 4% was sprayed over the supraglottic area. The surgical team completed the procedure without event. Once the procedure was complete, sevoflurane and nitrous oxide were discontinued, 100% oxygen was administered through the face mask, the patient was taken to the post anesthesia care unit for recovery where he maintained stable vital signs and he was discharged to home in the care of his parents.

Discussion

A parent present induction (PPI) is when a parent is allowed in the operating room with their child during induction when the anesthesia professional deems it appropriate and beneficial. The impact of parental presence on a child’s anxiety during induction remains controversial. Many clinicians who implement this practice believe there is a subgroup of children who benefit from parental presence in the operating room. Some facilities regularly implement this practice when appropriate. The groups of children found to benefit more from PPI are children older than four years, who had a parent that exhibited lower anxiety, children with a low baseline level of activity as assessed by temperament, and children who underwent surgery previously. A study conducted to predict which child-parent pair would benefit from PPI concluded that the presence of a calm parent does benefit an anxious child during induction of anesthesia, while the presence of an overly-anxious parent has no benefit. Additional benefits to PPI are that premedication is generally not required, which may shorten recovery time after anesthesia.

A clinical case study reports most parents who have been present during their child’s induction felt it was helpful to their child. Parents also commented that it was reassuring to accompany their child during anesthesia induction, and they felt more comfortable observing their child’s experience. Some factors should be considered before PPI: developmental stage, willingness to cooperate, past hospital experiences, and coping patterns. Parents should appear able to cope with their prospective role in the operating room and play a supportive role to the child. In preparation of their role, they need proper education and support by nursing and anesthesia staff. The final decision regarding PPI rests with the anesthesia team.

One study concluded that oral midazolam before surgery is a more effective
intervention than either parental presence or control (which is no premedication or parent presence) for managing a child’s and parent’s perioperative anxiety. 5 This study reported that parents in the midazolam group were the least anxious after separation and parents in the parental-presence group were the most anxious. Some of the most upsetting factors for parents were separation from the child after induction, watching the child go limp during induction, and seeing the child upset before induction. They also found that premedicated children were more compliant during induction. They suggest that parental presence is not an effective intervention for all children and the individual child, parent, and anesthesia professional must be considered. 5

Reflecting on the described case, this was a child who is older, had a calm temperament, had been through this procedure before, and had a calm parent willing to participate in the induction of anesthesia and allay the anxieties if the child. The parent in this case understood his role in the operative and induction setting, and was truly an asset for the child and anesthesia professionals. As a student nurse anesthetist, it was reassuring to watch the interaction between the parent and child, and the calming influence the parent provided. This experience demonstrated how PPI can be a useful adjunct during the anesthesia experience for the patient, parent and anesthesia professional.

References


Mentor: Joe Joyce, BSN, CRNA
Key words: Lung Lavage, proteinosis, Pulmonary Alveolar Proteinosis (PAP)

Pulmonary Alveolar Proteinosis (PAP) is a rare disease characterized by the accumulation of phospholipoproteinaceous material in the alveoli resulting in the progressive impairment of gas exchange.\(^1\) Estimates of the prevalence of PAP range from 0.2-40 cases per million people.\(^2,3\) The etiology is unknown but it is believed to be an acquired clinical syndrome with both genetic and environmental components.\(^2\) Presenting symptoms include dyspnea on exertion and dry cough and can progress to respiratory failure.\(^4\) The most effective treatment for PAP is whole lung lavage (WLL). This case report demonstrates anesthetic management of ventilation and oxygenation during WLL for PAP.

Case Report

A 17 year-old, 64-kilogram male, classified ASA II presented for bronchoscopy with WLL for PAP. His medical history was significant for premature birth at 26 weeks requiring eight weeks of mechanical ventilation, previous hydrocephalus, and asthma. Surgical history included placement and two revisions of a ventriculoperitoneal shunt. Current medication included an albuterol inhaler. Lung sounds were diminished with rales in the bases bilaterally. The patient denied current dyspnea, with a respiratory rate of 18 and oxygen saturation of 100% on room air. Chest CT showed the typical crazy paving pattern. The remainder of the physical exam and vital signs were within normal limits. Pulmonary function tests had not been performed. Air-way evaluation revealed no limitation of cervical range of motion, a Mallampati class I view, and a thyromental distance of three finger breadths.

Midazolam 2.0 mg IV was administered preoperatively. In the operating room the patient was positioned supine and standard monitors were placed. Preoxygenation for five minutes was initiated before induction of general anesthesia using fentanyl 100 mcg, lidocaine 100 mg, propofol 150 mg, and rocuronium 50 mg IV. Direct laryngoscopy was performed and a size 8.5 mmID single lumen endotracheal (ET) tube was placed. Placement was confirmed and mechanical ventilation was initiated with a tidal volume of 10 ml/kg, rate of 10 breaths per minute, and oxygen at 2.0 L/min flow. Anesthesia was maintained with desflurane 5-6% and intermittent boluses of fentanyl. Neuromuscular blockade was continued with subsequent doses of rocuronium. A forced-air warming blanket and a nasal temperature probe were placed.

The bronchoscope was advanced down the ET tube and placement was confirmed at 3.0 cm above the carina. 2.0 ml of 2% lidocaine was instilled. Bronchoalveolar lavage of all lobar sub-segments was performed sequentially on the left then right lung using 37 °C normal saline. The fluid suctioned from each lung was milky in appearance, and lavage continued until the returned fluid was clear.

Bilateral lung ventilation was maintained throughout the procedure. The patient
had intermittent episodes of hypoxemia, with a maximal decrease in saturation to 87%. The lavage was paused and manual ventilation initiated with a rapid return to 98-100% saturation each time. Peak airway pressures ranged from 30 to 46 mmHg. The patient’s temperature dropped to 34.8 °C over the course of the procedure. All other vital signs remained stable.

The patient remained intubated after the procedure and was transferred to the ICU. Arterial blood gases were normal. The patient was extubated the following day and discharged on postoperative day two.

**Discussion**

The main anesthetic challenges during whole lung lavage include airway management, maintenance of adequate ventilation and oxygenation, and prevention of hypothermia. Varying techniques of anesthetic management have been reported in the literature. Local anesthesia with sedation is sometimes used but has mostly been replaced by general anesthesia with endotracheal intubation.

Most anesthesia practitioners report using double lumen ET tubes (DLT) to isolate the ventilated lung from the lavaged lung, thus preventing spillage of lavage fluid. In this case, a single lumen tube (SLT) and bilateral lung ventilation was used throughout the procedure. To minimize spillage of lavage fluid, the bronchoscope was advanced into the main bronchus of the lung to be lavaged, normal saline was instilled directly into each lobar segment and actively suctioned out via the bronchoscope. This technique is in contrast to the use of gravitational drainage reported in most of the literature. Maintenance of the patient’s oxygen saturation throughout the case and no postoperative complications suggest this technique was effective. Some technical difficulties did arise from the use of a single lumen ET tube, however. Manipulation of the bronchoscope through the ET tube caused intermittent loss of ET tube cuff seal and leak of airway gases around the tube, resulting in loss of tidal volume and pressure in the ventilator bellows. In addition, the presence of the bronchoscope in the ET tube caused peak airway pressures to become elevated above desired values. While use of the SLT effectively addressed our anesthetic goals, a DLT may minimize intraoperative complications and increase ease of airway management.

The majority of anesthesia professionals recommend a period of postoperative intubation until the patient’s pulmonary function returns to baseline. This patient remained intubated to maximize pulmonary function and to allow time for any remaining lavage fluid to be absorbed from the lungs. If a DLT is used, it must be replaced postoperatively with a SLT to prevent airway trauma.

In the literature, many anesthesia practitioners report positioning patients in the lateral decubitus position as an additional measure to keep lavage fluid isolated to the dependent lung. The greater pulmonary blood flow to the dependent lavaged lung creates an increased V/Q mismatch due to shunting, however. For this reason some anesthesia professionals choose the supine position. Some case reports describe turning the patient prone toward the end of the case to maximize removal of proteinaceous material from the posterior portions of the lungs. During this case, the supine position was
maintained throughout to good effect, although the lateral decubitus position may be more appropriate when a SLT is chosen. Anesthesia practitioners must be aware of the potential for rapid body temperature loss with large volume lavage. The normal saline lavage fluid should be warmed to 37 °C prior to instillation. Devices such as forced air warming blankets, fluid warmers, and heat and moisture breathing circuit exchangers should be utilized, and room temperature should be maintained above normal operating room levels. As in this case, despite these efforts the patient’s body temperature decreased over the course of the procedure. If this occurs the patient should be returned to normothermia before extubation is considered.

Manual chest physical therapy (PT) during the procedure has been found to increase the volume of proteinaceous material removed during WLL. This intervention was utilized during the postoperative intubation period for this patient but not intraoperatively. While this technique resulted in a positive outcome for the patient, intraoperative use of chest PT potentially could have increased the benefits obtained from this procedure.

Because PAP is a rare disorder, anesthesia professionals may be unfamiliar with recommended management of WLL for these patients. This case report presents a plan of care that proved to be effective in meeting the anesthetic goals of airway, ventilation, and oxygenation management. This discussion shows that SLTs can be used safely when combined with careful lavage technique. However, despite the initial challenges of DLT placement and one lung isolation, DLTs may provide a more secure and easier to manage airway. With either option, close communication and cooperation with the pulmonary team is essential.

References


Mentor: Carrie Bowman, CRNA, MS
**Key words:** fluid resuscitation/methods, hemorrhagic shock, hemorrhagic pathophysiology, trauma therapy, blood transfusion

Traumatic injuries are the leading cause of death in the United States for people between the ages of 1 and 34 years; most fatalities involving alcohol related motor vehicle crashes, followed by gunshot wounds.¹ Victims of violence often lose large amounts of blood and require fluid resuscitation and surgical repair. There is controversy among practitioners as to what types of fluids to use, how much to administer, and what the endpoints of resuscitation should be. This case study explores these issues.

**Case Report**

The trauma team was activated at 0052 to receive a 26-year-old, 80 kg, male transported by ambulance to the hospital with multiple gunshot wounds. Upon arrival the patient was alert and oriented with a Glasgow coma score of 15. He was verbalizing and in no apparent respiratory distress. The pre-hospital blood loss was estimated at one liter. Two sixteen gauge intravenous catheters were placed in the upper extremities and a liter of normal saline was started per side. Physical examination revealed wounds of both the upper extremities, the right lower extremity, abdomen, and back. He was unable to move his lower extremities and had no sensation below the knees. He had no significant medical or surgical history, but did report daily tobacco and alcohol use. After assessment he was given an American Society of Anesthesiologist (ASA) physical status of Five (E). A series of X-rays were taken that revealed no chest injury, a right forearm fracture, blood in the pelvis, and three bullet fragments in right pelvis at L₄-L₅, and L₂. The patient was then taken to the operating room for an exploratory laparotomy. He had a normal airway examination, and induction of anesthesia and intubation were uneventful. His systolic blood pressure was in the middle 140s throughout the procedure with a heart rate ranging from 100-109 for the first hour of the procedure and ending in the low 80s.

His hemoglobin was 10.8, hematocrit 30.6 and platelets 130. Coagulation and chemistry studies were normal with the exception of bicarbonate, which was slightly low (21 mmols/L). A right radial arterial line was placed. An arterial blood gas was drawn and the values were pH 7.29, PCO₂ 40, PaO₂ 201, HCO₃ 19, BE -8, SAO₂ 99.2, LAC 2.1. Five and a half liters of normal saline and two units of packed red blood cells were administered during the procedure. His urine output was 1550 mls and the estimated blood loss was 200 mls. After the procedure was completed the patient was taken intubated to the post anesthesia recovery unit.

**Discussion**

The American College of Surgeons delineates four classes of hemorrhagic shock in the Advanced Trauma Life Support
The shock classifications are defined by vital signs and the amount of blood loss. In Class I the vital signs are normal and the blood loss is less than 750 ml, therefore additional fluids are generally not necessary. However, in Class II shock the heart rate is greater than 100, the blood pressure is normal, the blood loss is estimated to be 750-1500 ml, and two liters of crystalloids are recommended to be administered.

With Class III shock the heart rate is greater than 120, the blood pressure is decreased, and blood loss is 1500-2000 ml. In Class IV the heart rate is greater than 140 beats per minute, the blood pressure is decreased, and blood loss is estimated to exceed 2000 ml. Blood products are indicated for Class III and IV hemorrhagic shock. Of note, no synthetic colloids are prescribed in the ATLS model.

The most commonly used crystalloid solutions are lactated ringers and normal saline. Lactated Ringers is a more desirable solution than normal saline because it is metabolized by the liver and kidneys to generate bicarbonate, which provides a buffer against lactic acid that results from anaerobic metabolism. Metabolic hyperchloremic acidosis has been reported when infusing large volumes of normal saline (> 10 liters). The general guideline for replacement is a 3:1 ratio (3 ml of crystalloid for each 1 ml of blood loss), and there are some sources that advocate as high as a 10:1 ratio because of the ongoing bleeding and capillary leak.

Colloids such as hetastarch solutions and albumin increase intravascular volume by drawing free water back into the vascular space, and require less volume when compared with crystalloids. The general guideline for colloid administration is a 1:1 ratio (1 ml of a colloid for each 1 ml of blood loss) up to one liter. These solutions have no oxygen carrying capacities and have not shown an advantage over crystalloid solutions. Additionally, dextran and some preparations of hetastarch have negative effects on hemostasis by causing a dilutional decrease in coagulation factor concentration. Again, the American College of Surgeons do not advocate the use of colloids in the ATLS course.

Packed red blood cells increase the oxygen delivery to tissue and intravascular volume, and should be used aggressively any time blood loss exceeds 30% of total estimated blood volume. A hypotensive patient with ongoing bleeding who fails to respond to two liters of crystalloids should be resuscitated with blood or blood products until the hemorrhage is surgically controlled.

A hemoglobin level of 6-8 g/dl is a blood transfusion threshold, and it is also reasonable to give blood or blood products to an actively bleeding patient with a hemoglobin of 10 g/dl. Blood administration has risks that include allergic/transfusion reactions, transmission of infectious diseases, coagulopathy, citrate toxicity, acidosis, hyperkalemia, decreased 2,3DPG, and hypothermia.

When blood pressure and urine output are used as end points to fluid resuscitation, up to 85% of people are under resuscitated. Vital signs do not indicate occult hypoperfusion, and diuretic therapy makes urine output a less than valid indicator of volume status. More sensi-
tive variables of resuscitation are oxygen delivery (DO₂), cardiac output, oxygen consumption (VO₂), lactate, and base deficit. Each of these indicators has shortcomings. For example, a lactate level requires considerable time to obtain results and cardiac output necessitates placement of a pulmonary artery catheter. However, these measurements can be excellent indicators of the effectiveness of fluid resuscitation.

A life threatening complication of trauma is hemorrhage. The choice and timing of fluid for resuscitation remains controversial. There are advantages and disadvantages to each replacement fluid that practitioners must consider. On the other hand, the American College of Surgeons does not advocate colloid administration, which places doubt on the value of colloids for trauma resuscitation. Additionally, there are no consensus guidelines for endpoints to fluid resuscitation. These topics require more in-depth exploration and investigation.

References


Mentor: Lisa Osborne, CDR, NC, USN, CRNA, PhD

Abstract

Beta-Blocker Use and Hemodynamic Stability
Heather N. Hamilton, BSN
Kirsten A. Hurd, BSN
Sarah B. Wilson, BSN
University of Michigan-Flint/Hurley Medical Center Anesthesia Program

Introduction: Cardiovascular disease is the leading cause of death, consuming more healthcare costs than any other disease. The Agency for Healthcare Research and Quality encourages the use of beta-blockers in an effort to decrease the risk of postoperative mortality. These researchers hypothesized that patients receiving a first time dose of a beta-blocker on the day of surgery would have a statistically significant decrease in blood pressure after induction, as compared to patients who were chronic users. The secondary aim was to com-
pare the treatment regimens for hypotension between the two groups.

Methods: Data was recorded on a standard form developed by the researchers. All patients greater than 18 years of age who presented for surgery under general anesthesia were eligible for inclusion. Patients who took a beta-blocker prior to the day of surgery were placed in the chronic use group. Patients administered a beta-blocker for the first time on the day of surgery were considered acute users. Induction agents were limited to propofol and fentanyl. Blood pressure was recorded at 1, 5, 10, and 30 minute intervals following induction. The total amount of intravenous fluid administered, ephedrine dose, and MAC less than 0.8 in response to hypotension at any point within the first 30 minutes were also recorded.

Results: Upon initiation of the data collection process, it was discovered that the Genesys protocol had been altered to exclude outpatients. As inpatient status was criteria for exclusion, difficulty obtaining a sufficient number of participants was encountered. Statistical analyses were limited with respect to comparison between the groups. Only generalizations were made. Utilizing the correlation of repeated measures within the chronic group, marginal evidence of a negative linear trend (p = 0.088) existed. A test for trend in the acute group could not be computed. The data, however, suggested a strong negative correlation of time with the MAP score, and a stronger decline over time than is evident in the chronic group.

Conclusion: Due to low recruitment numbers, statistical analyses were limited. The only definitive result obtained from analysis was that for each passing minute, the MAP of the chronic group would decrease by approximately 0.245mm Hg. The acute use group did not consist of enough participants to accurately compare information between the groups. As several limitations were evident, further study is recommended in a setting where this type of protocol is in use on a significant basis.

Mentor: Lynn L. Lebeck, CRNA, PhD.

Abstract

Follow-up Study: Clinical Experiences of Student Registered Nurse Anesthetists
Daniel Padgett, BSN
Medical College of Georgia

Introduction: Clinical experiences of Student Registered Nurse Anesthetists (SRNAs) were surveyed in 1990 and 1992. Since that time there have been significant changes in the number of clinical sites and in the type and number of cases done at those sites. This study repeated the previous surveys with modifications to examine the quality and quantity of clinical experiences that SRNAs received and described differences found between current and past surveys.

Purpose: The purpose of the study was to examine the clinical experiences of
SRNAs and how they have changed over the past 15 years. It is a follow-up study to a previous study that was conducted in 1990 and repeated in 1992.

**Hypotheses:** It was hypothesized that today’s students would have more experiences with invasive line placements and with higher acuity cases such as cardiothoracic and organ transplant due to the increased number of hospitals performing these procedures.

**Methodology:** Inclusion criteria from the previous surveys were used, and 1 senior student and 1 junior student were chosen at random from each of the current 106 nurse anesthesia programs by the program’s director. Surveys were distributed via the internet. Results were reported on a 0 to 4 Likert scale (“poor” to “excellent”).

**Results:** The response rate for the survey was 58%. The respondents of the 2007 survey consisted of 13 first year students (35 responses were excluded because of failure to meet inclusion criteria) and 76 second-year students. Similar results were seen from previous surveys in the areas of invasive line placement, alternative intubation techniques, and perception of clinical experiences. Small increases in the perceptions of clinical experiences were seen with organ transplant and central line placement. A decrease was seen in the area of placement of peripheral nerve blocks (PNB) (nearly a 20% decrease with second-year students). Finally, almost 46.3% of the respondents stated that their program does not include pain management.

**Conclusion:** Results were very similar to previous surveys. There was a slight increase in the amount of organ transplant experience, but there was an unexpected decrease in the perceived experiences in PNBs among second-year students. However, other regional techniques have remained similar over the past 15 years. With 46.3% of respondents stating that their programs do not include pain management, there may be an association between pain management and lack of PNB experience. Thus, this may also be an area in which the SRNA needs more clinical experience.

**Mentor:** Corey Peterson, CRNA, MSN, PhD