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Thank You

A special Thank You to Kaiser Permanente School of Anesthesia/California State University, Fullerton for its financial support. The program made a generous donation to the AANA Foundation that is particularly allocated to encouraging and assisting nurse anesthesia student writing and publication.

Revising Your Articles

As a policy we rarely reject an article, however, we have sent a number of articles back to the author for repair to clarify some ambiguity or to respond to questions raised by the reviewers. Of those we have sent back, most are not returned for publication. This is unfortunate for many reasons. First, the authors have put a lot of time in writing the article in the first place. Secondly, program mentors have also devoted a considerable amount of time and effort in guiding the author in the process. Thirdly, the reviewers have put a lot of time and effort into reviewing the articles.

Our biggest concern as editors is the time spent and wasted by reviewers. Your reviewers are program directors and faculty from other programs who are giving up their time to help you, the author, not only to get published, but to publish a quality article. If the article is not repaired and resubmitted a sad waste has taken place.

We ask all authors to do your best to submit a publishable quality paper. We ask the mentors to wear two hats before authorizing the submission – one as advocate for your student author and then the hat of a reviewer reading it on behalf of the Journal, answering the question – is this publication quality? Both persons can improve that performance by checking the work against the check off sheet found in the Guide for Authors (found on the AANA web site in the student section).

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Keywords: anesthesia, tracheal esophageal fistula, difficult airway, pediatric airway, esophageal atresia

Tracheal esophageal fistula (TEF) occurs in approximately 1 out of every 3000 births. TEF exists in 5 different forms with 87% of the cases presenting in the form of esophageal atresia with a distal tracheal esophageal fistula. Corrective repair is typically done within the first few days of life. Tracheal intubation prior to repair can be difficult due to the need to place the endotracheal tube distal to the tracheoesophageal fistula to avoid ventilating the stomach and to adequately ventilate the lungs. The neonate with TEF is at a greater risk for aspiration due to the direct connection of the esophagus to the trachea.

Case Report

A 7 year old, 23.3 kg, ventilator dependent male with a long standing tracheotomy, a history of spinal muscle atrophy type I (SMA I), and repaired TEF presented for a posterior spinal fusion with unit rod placement. The patient presented with an uncuffed 5.5 mmID bovine tracheostomy tube and an audible leak.

It was decided that the anesthesia team would utilize a cuffed 5.5 mmID endotracheal tube during the surgery and stitch it into place prior to turning the patient prone. The patient was taken to the operating room and an inhalational induction with sevoflurane 4% was performed through the uncuffed 5.5 mmID tracheostomy tube. Tracheal intubation through the tracheostomy stoma was performed without difficulty with a cuffed 5.5 mmID endotracheal tube. The ability to ventilate was easily established. Adequate ventilation was confirmed with a sustained ETCO₂ and bilateral breath sounds. The endotracheal tube was sutured into place, the sevoflurane was turned off, and an infusion of propofol was started at a rate of 200 µg/kg/min along with an infusion of sufentanil at 0.2 µg/kg/min.

During the preparation for the placement of a right subclavian central line, the patient’s tidal volumes decreased from approximately 180 mL to approximately 30 mL. We disconnected the ventilator and began manual ventilation. Manual ventilation allowed for 40-60 mL tidal volumes with peak inspiratory pressures of 30-40 mmHg. The endotracheal tube sutures were cut and the endotracheal tube was repositioned several times before ventilation became adequate. After completion of re-suturing to secure the endotracheal tube, manual ventilation again became difficult as evidenced by peak inspiratory pressures of greater than 30 mmHg and tidal volumes ranging from 20-60 mL. The cuffed endotracheal tube was removed, a cuffed 5.5 mmID bovine tracheostomy tube was placed. There was no audible leak and adequate ventilation was established.

Preparation for surgery continued without any further problems. A right subclavian central line, left radial arterial line, and Foley catheter were placed. The patient was turned prone onto the operating room table. At this point ventilation became difficult again and an audible leak around the...
tracheostomy tube was noted. Tidal volumes were maintained with high oxygen flows and oxygen saturations remained greater than 95%. After discovering that the leak became significantly better if posterior pressure was applied to the tracheostomy tube, the patient’s tracheostomy ties were replaced to facilitate the maintenance of this position. Although the leak was improved, a small audible leak still existed. The air was removed from the cuff of the tracheostomy tube and replaced with 2.5 mL of sterile water. The leak completely resolved.

**Discussion**

Scoliosis can lead to respiratory problems that are directly associated with the degree of spinal curvature. As the curvature of the spine increases, functional residual capacity (FRC), diffusion capacity, chest wall compliance, and $\text{PaO}_2$ decrease. An angle of curvature greater than 45 degrees is typically treated with surgical intervention due to respiratory compromise. The patient presented in this case study had a curvature of 73 degrees. An inability to ventilate a patient with this degree of curvature will result in a rapid decrease in oxygen saturation due to a decrease in FRC.

This patient’s pre-operative assessment alerted us to the possibility of a difficult airway. Difficulty with ventilation did not arise until after the placement of the cuffed 5.5 mmID endotracheal tube. It was noted that the cuffed 5.5 endotracheal tube had less of a curve than either the uncuffed or cuffed 5.5 mmID bovines. It was postulated that, due to the patient’s history of TEF, this difference in curvature may have caused the cuffed 5.5 mmID endotracheal tube to fall into a blind esophageal pouch. A rigid fiberoptic scope may have been helpful in positively identifying the problem with the cuffed endotracheal tube.

Difficulty with airway management is the most common cause of adverse outcomes during anesthesia. The inability to ventilate coupled with the inability to intubate occurs in as many as 1 in 5000 anesthetics. Although the difficult airway algorithm does not encompass the difficult airway as it occurred in this case study, a plan of action should always be established preoperatively in order to avoid adverse outcomes.

**References**


Minimally Invasive Video-Assisted Thoracoscopic Approach to Ablation of Atrial Fibrillation

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Keywords: Atrial fibrillation, ablation, thoracoscopic, 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.\(^1\) It is predicted that by the year 2050, 5.6 million patients will be diagnosed with AF.\(^1\) AF is associated with increased mortality, exacerbation of heart failure, and a seven-fold increased risk of stroke.\(^1\) Optimal therapy for AF has been a challenge. Standard medical management of AF involves heart rate control plus blood thinners. This approach utilizes antiarrhythmic medications to treat the symptoms of AF and anticoagulants to minimize the risk of stroke.\(^3\) However, antiarrhythmic medications have limited efficacy in maintaining sinus rhythm and might have serious adverse effects,\(^2\) 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 lower mortality.\(^2\) 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 cardiopulmonary bypass. A new, minimally invasive, video-assisted thoracoscopic (VATS) surgical technique has been demonstrated to be safe and effective in the treatment of AF.\(^2\) 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 treatment 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 throughout 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, transcutaneous 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 were 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 was incorporated into this procedure because it was 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 Marcaine 0.25% were placed in
bilateral chest walls for postoperative pain management. The DLT was changed without difficulty to a 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. He was 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 localized 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.
Transderm Scop

For postoperative nausea and vomiting (PONV)

The patch that delivers

PONV prevention for 24 hours

In two pivotal clinical trials with OB/GYN patients

- 2 out of 3 patients had no retching or vomiting for 24 hours following recovery from anesthesia and surgery
- 3 out of 4 patients had no need for additional antiemetics

Indications
Transderm Scop is indicated in adults for prevention of nausea and vomiting associated with recovery from anesthesia and surgery.

Safety Information
Transderm Scop is contraindicated in:
- Pediatric patients
- Persons who are hypersensitive to the drug scopolamine or to other belladonna alkaloids or to any ingredient or component in the formulation or delivery system
- Patients with angle-closure (narrow-angle) glaucoma

Transderm Scop should be used with caution in the elderly or in individuals with impaired liver or kidney function.

In clinical studies, the most commonly reported adverse events were dry mouth (29%) and dizziness (12%).

While using this product one should not drive, operate dangerous machinery, or do other things that require alertness. One should not use alcohol.

**DESCRIPTION**

The Transderm Scop (transdermal scopemyrtine) system is a circular, transdermal system designed for continuous release of scopemyrtine following application to an area of intact skin on the head, behind the ear. Each system contains 1.0 mg of scopemyrtine (25% of the active ingredient, scopemyrtine). The empirical formula is C_{20}H_{38}O_{5} and its structural formula is 

\[
\text{C}_{20}\text{H}_{38}\text{O}_{5}
\]

**CONTRAINDICATIONS**

Transderm Scop is contraindicated in patients who are hypersensitive to scopemyrtine or to any of the ingredients in the formulation or delivery system, or in patients with angle-closure narrow angle glaucoma.

**SIDE EFFECTS**

Red, dusky or area reaction with cutaneous vasodilation due to systemic circulation increase occurs more frequently in women than in men. Transdermal Scop can be discontinued, it is not known whether this system will release an amount of scopemyrtine that could produce serious adverse effects in children.

**ADVERSE DRUG REACTIONS**

The side effects of Transderm Scop can be divided into two major categories: the most frequent reactions and less frequent reactions. The most frequent reactions are:

1. **Nausea and Vomiting**
2. **Blurred Vision**
3. **Drowsiness**
4. **Dry Mouth**
5. **Dizziness**
6. **Strong味**

**PHARMACOKINETICS**

Scopemyrtine is absorbed from the skin and is distributed throughout the body. It is metabolized in the liver and excreted in the urine. The half-life of scopemyrtine is about 4 hours.

**DOSAGE AND ADMINISTRATION**

Transderm Scop is a transdermal patch system that is used to deliver a constant amount of scopemyrtine. The patch is applied to the back of the ear, behind the earlobe. The patch should be applied to the intact skin of the head and should be replaced every 3 days.

**NATURAL HISTORY**

Transderm Scop is indicated in adults for prevention of nausea and vomiting associated with motion sickness. The patch should be applied to the intact skin of the head and should be replaced every 3 days.

**CLINICAL PHARMACOLOGY**

**Pharmacology**

The main active ingredient of Transderm Scop is scopemyrtine, which is a synthetic pyrrolizidine alkaloid. It is a centrally acting antiemetic that works by blocking the central action of the neurotransmitter dopamine. Transderm Scop is a transdermal delivery system that uses a controlled release mechanism to deliver scopemyrtine at a constant rate.

**Pharmacokinetics**

Scopemyrtine is absorbed from the skin and is distributed throughout the body. It is metabolized in the liver and excreted in the urine. The half-life of scopemyrtine is about 4 hours.
Anesthetic Management of a Jehovah’s Witness Patient
Possessing Many Co-Morbidities

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Keywords: Jehovah’s Witness, Autologous blood, Aortic stenosis, Heart failure, Anesthesia

Providing anesthesia for a patient who is a Jehovah’s Witness is challenging, especially in the event that large amounts of blood are lost. Jehovah’s Witnesses believe that when blood has left the body, it is considered impure and it should be disposed. Most Jehovah’s Witnesses refuse transfusion of primary blood components which includes red blood cells, white blood cells, platelets and plasma. Some however, accept albumin and other fractionated blood components. Still others agree with receiving cell saver autologous blood as long as the blood has not left the closed system. Therefore each Jehovah’s Witness patient must be approached as an individual and not as a member of a group. A thorough preoperative assessment by the nurse anesthetist which takes into account the individual patient’s beliefs is essential in providing the most considerate care.

Case Report

A 58 year old, 150 kg female gravida 3 para 3 presented with abdominal pain and with a large pelvic mass. She was scheduled for an exploratory laparotomy. The patient had documented allergies to penicillin and egg yolk which caused itching, and shellfish which caused nausea and vomiting. The only significant past surgical history was an appendectomy which had no anesthetic complications documented. Some of the patient’s comorbidities included a history of restrictive pulmonary disease, severe aortic stenosis, depression, morbid obesity, chronic anemia, and congestive heart failure. Also there was a 10 pack-year smoking history. The patient denied alcohol and illicit drug use. The patient was also a practicing Jehovah’s Witness. The increased risk of potential blood loss was discussed in detail with the patient. The patient refused to receive allogenic packed red blood cells but did consent to intraoperative salvage of autologous blood by cell saver protocol and albumin colloid solutions.
The patient was classified as an American Society of Anesthesiologist (ASA) 4 with an airway evaluation which revealed a Mallampati class II, three fingerbreadth thyromental distance, and a full range of motion of the neck. Preoperative blood pressure was 142/81 mmHg with a heart rate of 110 beats per minute. Oxygen saturation with two liters of O2 via nasal cannula was 96%. Hemoglobin was 11.7 grams/deciliter and hematocrit was 39%. Physical examination revealed S1S2 with a III/VI systolic ejection murmur. Lungs were clear to auscultation bilaterally. No pulmonary function tests or arterial blood gases were obtained preoperatively. The patient reported being able to ambulate with a walker but tired easily and was mostly confined to bed. The head of the bed was elevated and the patient was further positioned by the use of folded blankets to facilitate intubation. A slow, smooth intravenous induction with fentanyl 150 mcg, esmolol 100 mg, and etomidate 20 mg was administered.

Anesthesia was maintained with 1.2-1.5% isoflurane and 50% oxygen and 50% air. Fentanyl 100 mcg was given after the first hour of surgery, for a total of 250 mcg to maintain arterial blood pressure and heart rate within 20% of baseline. A sufentanil drip at 0.3 mcg/kg was maintained throughout the procedure for a total dose of 150 mcg. 12 Liters of lactated Ringer’s, 3250 ml of Albumin 5% and 200 ml Albumin 25% were also given. Urine output was 1775 ml, the total estimated blood loss (EBL) was 1800 ml, and 500 ml of autologous red blood cell concentrate collected by cell saver was provided. End tidal CO2 was maintained between 30-32 mm Hg by adjusting the tidal volume between 450-500 ml and respiratory rate between 14-16 breaths per minute. Neuromuscular blockade was maintained for the 6.5 hour surgery with vecuronium every 1-1.5 hours in 2-3 mg boluses titrated to 2 twitches using the train of four measurement for a total dose of 45 mg. An arterial blood gas was reported within normal limits and the HCT of 34% was noted approximately 30 minutes after surgical incision.

About 30 minutes before the end of surgery, an ABG was reported within normal limits and the HCT was 25%. The patient was transferred to the surgical ICU while intubated. Neuromuscular blockade was maintained with another 10 mg of vecuronium. The patient was transferred with standard monitors and was hand ventilated enroute. The patient's ventilation was then controlled by mechanical ventilation with the following settings: SIMV/PS 14, TV 500, PS 10, PEEP 5, and 100% FIO2. Vital signs upon arrival to the ICU were as follows: BP-156/67 mmHg, HR-111, SPO2 96%. The patient's airway was extubated the next day and she was discharged from the hospital four days later without any complications reported.

Discussion

It is well known and documented that Jehovah’s Witnesses do not normally accept whole blood transfusions. They believe that once blood has left the body, it is considered unhealthy. A written waiver is often signed relieving the anesthetist of any responsibility or consequences of blood refusal. The patient did consent for albumin and the use of cell saver autologous blood products as long as it was maintained in a closed sterile system. The decision to accept blood derivatives was made by the patient. Other known co-morbidities such as aortic stenosis, congestive heart failure, and morbid obesity existed and were
considered as potential factors in establishing the anesthetic plan.

Autologous blood donation could be an alternative if the patient needed blood during surgery. This option was not presented to the patient because of the emergent situation. There are several ways to collect autologous blood. Autologous blood donation usually is collected three to five weeks prior to elective surgery. Intraoperative hemodilution is usually collected at the beginning of surgery and the fluid lost is replaced with intravenous solution. Then the blood is stored and reinfused during or at the end of surgery. Intraoperative blood salvage is collected from the surgical area during the surgery and re-infused during or after surgery. Post-operative blood salvage is collected after the surgery and re-infused at the completion of surgery.

The only method that was used in this case was intraoperative blood salvage by cell saver. Aortic stenosis presents another challenge to the anesthesia provider. This patient had severe aortic stenosis with an area of 0.9 cm². The normal aortic valve area is 3.0-4.0 cm². The stenosis and the build up of pressure is gradual which allows the ventricle to initially compensate and maintain stroke volume. Concentric hypertrophy enables the left ventricle to maintain stroke volume by generating a valvular gradient and reduce ventricular wall tension.

Documented congestive heart failure can cause eccentric or concentric hypertrophy. Eccentric hypertrophy is a result of the left ventricle’s inability to pump or contract effectively. The patient’s concentric hypertrophy may have been the result of aortic stenosis. Usually there is a build up of pressure in the left ventricle because the aortic valvular opening narrows. The left ventricle then becomes thickened and muscular in order to maintain the normal blood pressure.

Morbid obesity is usually considered to be a body mass index (BMI) greater than 40. Obese patients present major pulmonary and ventilatory challenges during the intraoperative period. Our patient had a BMI calculated to be > 40. In the obese patient, excessive adipose tissue over the chest decreases lung compliance leading to a decrease in functional residual capacity (FRC). The decrease in FRC can rapidly lead to hypoxia. The increase in abdominal mass pushes the diaphragm cephalad further decreasing FRC and is suggestive of restrictive pulmonary disease. Even though pre-oxygenation with 100% FIO₂ prior to induction is the usual standard, it is of the utmost importance in the obese patient.

Anesthesia care for the Jehovah’s Witness patient involves the preoperative discussion with the individual patient to determine the level of knowledge of options available and the desire to accept transfusion of blood or fractionations of blood. Providing adequate amounts of intraoperative crystalloids and colloids is essential for the maintenance of tissue perfusion. An understanding of the preoperative alternatives to increase red cell production is essential in providing the best anesthesia possible. Co-morbidities such as aortic stenosis, congestive heart failure, and morbid obesity further complicate surgery and increase the anesthetic risk. All of these co-morbidities may contribute to clinical complications and increase the potential blood loss. The overall status of the patient who is a Jehovah’s Witness including all co-morbidities must be fully analyzed in order to minimize this blood loss and assure a successful outcome.
References


Mentor: W. Patrick Monaghan, CLS, SBB, Ph.D.
Keywords: Craniotomy, Tumor, Awake fiberoptic intubation, Difficult airway, Limited mouth opening, Anesthesia

Some patients have severely limited mouth opening secondary to injury, surgery or simply due to abnormal anatomy. Occasionally these patients require elective, but necessary procedures. In the event that one of these patients presents for a surgical procedure requiring a secure airway and general anesthesia, a carefully prepared airway management plan must be in place to protect the airway and patient safety. The difficult airway algorithm is quickly exhausted of options that are useful in this population.¹ The impossibility of direct vision laryngoscopy or laryngeal mask airway (LMA) placement requires anesthesia professionals to be prepared for an awake fiberoptic nasal intubation, cricothyrotomy or tracheostomy.

Case Report

A 49 year old, 82 kilogram male diagnosed with right temporal meningioma was scheduled for a craniotomy and right temporal tumor excision. The tumor was diagnosed after the patient developed frequent headache and left sided weakness.

The patient history included tonsillectomy, right knee surgery, left modified radical neck dissection with forearm flap for glottic neoplasm six months prior, a history of smoking 2 packs of cigarettes a day for 25 years, as well as insulin dependent diabetes. Medications included fentanyl patch 75 mcg, acetaminophen 500 mg, hydrocodone bitartrate 5 mg, and intermediate acting insulin. The patient reported no known allergies.

Physical examination revealed no current neurological symptoms. Assessment of the airway showed extremely limited mobility of the neck and mouth opening limited to 2 centimeters secondary to previous modified radical neck dissection. The patient was edentulous. The mouth opening was so limited that a Mallampati classification could not be assigned and direct vision laryngoscopy was not deemed possible. An awake fiberoptic nasal intubation was planned. An ear, nose and throat (ENT) surgeon was available in the event that emergent tracheostomy was needed. A right radial arterial line was placed in the pre-operative holding area after midazolam 2 mg was administered intravenously (IV). At this time, neosynephrine spray was administered into the patient’s nasal passages through each nare. A swab soaked with 4% lidocaine was then inserted into each nare and the patient was asked to hold them in place for approximately five minutes.

The patient was transported to the operating room where standard monitors were placed and oxygen was applied. Fentanyl 100 mcg IV was slowly administered to achieve patient comfort while maintaining spontaneous ventilation. The patient was placed in slight reverse Trendelenburg position. The trachea was intubated using a nasal fiberoptic approach. Upon confirmation of nasotracheal tube placement with the presence of end-tidal CO2 s and equal bilateral breath sounds, anesthesia was induced with
sodium thiopental 500 mg IV. Neuromuscular relaxation was provided with rocuronium 50 mg IV. Anesthesia was maintained with desflurane at an end tidal concentration of 4.2–6.5% and 1 liter flow each of air and oxygen. Fentanyl was administered incrementally throughout the case for a total of 350 mcg. An additional dose of rocuronium 20 mg was given upon the return of four twitches to train-of-four stimulation shortly after surgical incision. The intraoperative course was uneventful.

At the conclusion of the surgical procedure, neuromuscular blockade was antagonized with neostigmine and glycopyrrolate. Lidocaine 50 mg IV was administered 30 minutes prior to the end of surgery to reduce airway irritability upon emergence from anesthesia. After the return of spontaneous ventilation at a rate of 12 breaths per minute, a tidal volume of 550 mL, and a demonstrated ability to sustain head lift for five seconds, the trachea was extubated. Neurological examination was without deficit post operatively. The patient was transported to the post-anesthesia care unit with nasal oxygen at 4 liters per minute. The patient had no complaints of nausea or pain.

**Discussion**

The responsibility of anesthesia professionals to safely manage the airway is of primary importance. This requires that a variety of skills and knowledge of the difficult airway algorithm be developed to meet the many challenges that can be presented by difficult airways. In the case of a patient with limited or absent mouth opening due to deformities, surgical changes, trismus, or any other reason it is necessary to establish a secure airway either nasally or percutaneously.

In order to insert an endotracheal tube using nasal fiberoptic technique, the anesthesia professional must pass the endoscope into the nasal passage, past the epiglottis, through the larynx, and into the trachea until tracheal rings and the carina are visualized. To accomplish this passage in a patient who is awake and spontaneously breathing requires proper preparation of the patient prior to the start of the procedure.

Preparation of the nasal airway passage starts with application of a topical vasoconstrictor to the nasal mucosa in order to prevent epistaxis which can lead to aspiration and/or obscure the endoscopic view. Once the bronchoscope is in the trachea, the endotracheal tube is advanced into the trachea over the bronchoscope. It is also important to anesthetize the airway topically with a local anesthetic in order to minimize airway reactivity. This can be accomplished with transtracheal injection of local anesthetic, local anesthetic spray, or with the use of viscous lidocaine.

It is almost always necessary for patients to be sedated in order to tolerate this preparation as well as the intubation procedure itself. The most common method selected for sedation for this procedure, and the one used in the case study described, is a combination of IV midazolam and fentanyl. Several other pharmacological regimens have been suggested as potentially better methods of controlling the hemodynamic response to awake tracheal intubation. In one study of 74 patients where remifentanil was used as the sole sedative drug for awake fiberoptic intubation there was a reduction in pain and coughing as well as better attenuation of the hemodynamic response in the patients receiving remifentanil versus those in the control group who received midazolam and fentanyl. It is
worth noting that a higher incidence of recall was present in the remifentanil group. The addition of midazolam to a remifentanil infusion can help to eliminate this problem. Case reports have shown that another option for sedation with less potential for respiratory depression and a greater attenuation of the hemodynamic response to intubation is the use of a dexmedetomidine infusion as the sole agent.

In the event that nasal intubation of the trachea proves impossible it may be necessary to perform a cricothyrotomy or tracheostomy. A cricothyrotomy becomes an option in the event that spontaneous ventilation is lost during an unsuccessful nasal intubation attempt and mask ventilation attempts are unsuccessful. For this reason, anesthesia professionals should consider taking the time to place a mark on the patients’ skin at the level of the cricothyroid membrane prior to any attempt to intubate the trachea. In the case study described above care was taken to secure the presence of an ENT surgeon in the operating theatre so that a tracheostomy could be performed in the event that tracheal intubation was unsuccessful. It is also important to verify that the operating room nursing staff is aware of the possible need for an emergency tracheostomy and that the appropriate equipment is immediately available.

There are difficulties associated with attempting tracheal intubation in a patient population requiring a nasal approach. The limitations placed on the anesthesia professional’s airway management options require skill and preparation when confronted with these difficulties. However, with teamwork, planning, and care these cases can be managed safely and successfully.

References


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Genitourinary Surgery in a Patient with Angelman’s Syndrome
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Keywords: Angelman’s Syndrome, pediatric airway, prognathia, macroglossia, anticonvulsants, neuromuscular blockade, anesthesia

Angelman’s Syndrome was first diagnosed in 1965 by Dr. Harold Angelman. It is a disease that causes neurological problems as a result of a deletion or inactivation of specific genes on chromosome 15q11-13. Most cases of Angelman’s can be linked to the maternal inheritance of an abnormal chromosome and the remaining cases are due to a genetic mutation of unknown origin.¹ The incidence of Angelman’s syndrome is small, 1:15,000-1:20,000.² However, these patients often suffer from strabismus, seizure disorders and hyperactive lower limb deep tendon reflexes and frequently present for surgery and anesthesia care.³ This potential need for anesthesia warrants further research by anesthesia professionals on how to best prepare and care for this unique pediatric population.

Case Report

A 12 year old male presented for right orchiopexy and cystoscopy. He weighed 35 kilograms and his past medical history consisted of aspiration pneumonia, horseshoe kidney, seizure disorder, microcephaly, hypothyroidism and developmental delay which rendered him nonverbal. ASA physical status at the time of the surgery was II and his past surgical history consisted of myringotomy, left orchiopexy and eyelid surgery, all of which were uneventful. The patient lived in a household where one parent smoked tobacco and he had a sibling who also suffered from Angelman’s syndrome. He had no known drug allergies and his daily medication regimen included levothyroxine, phenytoin and valproic acid.

The anesthesia care team met the patient for the first time on the day of surgery. He was lying on a stretcher with his legs bent at the knees and crossed, and with his arms flapping and waving in the air. He was laughing loudly and smiling while he crumpled pieces of paper. He was nonverbal and made incomprehensible sounds. The anesthesia providers introduced themselves to the patient and the patient’s mother. A brief physical exam was performed. The child’s jaw was large for his body size and he had prognathia and macroglossia. He made constant chewing motions with his mouth and tongue. He could not cooperate for an open mouth airway exam but his mother stated that all teeth were intact. His airway mobility appeared normal. The patient entered the operating room and a pulse oximeter and precordial stethoscope were applied. An inhalation induction using nitrous oxide five liters, oxygen two liters and sevoflurane 1% were administered. The sevoflurane was increased incrementally. Standard monitors were applied after the patient became unresponsive to stimulation and the eyelid reflex was lost. An intravenous catheter was placed in the left hand and an 80 millimeter oral airway was placed in the patient’s mouth. Breaths were provided to the patient at a rate of 18 breaths per minute. Once the intravenous catheter access was established, the oral airway was removed and a #3 Laryngeal Mask Airway (LMA) was placed without
difficulty. Ventilation was confirmed by auscultation of clear bilateral breath sounds and a positive end tidal carbon dioxide tracing was noted on the capnograph. At this point, the volatile anesthetic was changed to isoflurane 0.6% and the nitrous oxide and oxygen flows were decreased to 1 liter and 0.6 liters, respectively. The patient’s ventilation was manually assisted until adequate spontaneous effort returned. The patient was placed in the lithotomy position and the procedure began. During the case, dexamethasone four milligrams, cefazolin 850 milligrams, Ketorolac 15 milligrams and ondansetron two milligrams were given intravenously. Fentanyl (total 62.5 micrograms) IV and propofol (10 milligrams) IV were titrated according to patient condition and comfort level. The patient received 500 milliliters of intravenous lactated ringer’s solution. After the procedure was complete the LMA was removed, the patient was spontaneously breathing but was still unresponsive to verbal stimulation. An 80 millimeter oral airway was placed. The oral airway and a jaw lift were required for approximately five minutes to maintain clear bilateral breath sounds. Once the patient was awake and able to protect his airway without a jaw lift he was transferred to the recovery room and was discharged to home later that day.

**Discussion**

This case study brings up three areas for consideration by the anesthesia professional. First, chronic use of the anticonvulsants phenytoin and valproic acid cause interactions with anesthetic medications. These medications cause drug induced enzyme induction and therefore, alter the metabolism of some drugs such as midazolam and neuromuscular blockers (NMB). The concurrent use of atracurium and these anticonvulsants can cause atracurium resistance. Larger doses of some medications such as atracurium and other NMB as well as midazolam may be needed. On the other hand, the sedation that occurs with anticonvulsants is additive to the sedative effects of anesthesia medications like opioids and barbiturates. Therefore, smaller doses of these sedatives may be required. Angelman’s patients who present with seizure disorders requiring chronic use of phenytoin and valproic acid are also at a higher risk for organ toxicity due to altered drug metabolism. Liver failure, anemia and pancreatitis can be assessed through lab work and a thorough physical exam can detect depression of cerebral function, ataxia and dyskinesis of the tongue, face and limbs all of which are signs of antiepileptic medication organ toxicity. In this patient population it is crucial to titrate all medications to patient effect. We avoided NMB and because spontaneous respiration was maintained it was possible to titrate sedation to the patient’s respiratory rate. Valproic acid can also cause thrombocytopenia and this could lead to bleeding problems and potential hematoma formation if bleeding during surgery were to occur.

The second area for concern in Angelman’s patients is positioning. As previously stated, a symptom of Angelman’s syndrome is hyperactive lower extremity deep tendon reflexes. Cystoscopy required the patient to be in the lithotomy position and a potential complication of this position is compartment syndrome of one or both legs. Care was taken to avoid over stretching the ligaments of the lower extremities. The support devices for each leg were carefully measured to fit the patient’s height and the edges were padded to avoid pressure to any bony prominences. Proper positioning and
padding is extremely important to protect these nonverbal highly contracted patients from avoidable harm. Positioning was carefully accomplished with our patient and involved the entire operating room team.

Finally, prognathia and macroglossia increase the risk of encountering a difficult airway. These congenital malformations can cause upper and lower airway obstruction. Fortunately, the prognathia and macroglossia in our patient were offset by a wide jaw and mouth also characteristic of patients with Angelman’s syndrome. We chose to use a #3 LMA for the case and utilized an 80 millimeter oral airway for ventilation before placement of the LMA and also after the LMA was removed to ensure adequate oxygenation and ventilation for the patient. We were prepared to place an endotracheal tube if the LMA was not adequate to support ventilation. After assessing the patient we did not anticipate a difficult intubation but a bougie and rocuronium were available. If a difficult intubation was anticipated a fiberoptic bronchoscopy could have been in the operating room as well.

Like many patients with Angelman’s syndrome, our patient’s seizure disorder required him to take daily phenytoin and valproic acid both of which alter the metabolism of anesthetic medications. By using an LMA and allowing the patient to maintain spontaneous respirations, the anesthesia professional could get a better sense of how well anesthetized the patient was. Patient respiratory rate can be a helpful indicator of pain and sedation level. In the future, a bispectral monitor may also have been an informative device in determining anesthetic level. The patient seemed comfortable and appropriately anesthetized during the case but due to his nonverbal communication and developmental delay this is impossible to truly assess.

Angelman’s syndrome is one of the congenital diagnoses found in the pediatric population that holds implications for anesthesia care and planning. With knowledge, planning and individualization of management anesthesia practitioners can optimize outcomes in this unique population.

References


Anesthesia for Carotid Endarterectomy
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Keywords: carotid endarterectomy, desflurane, remifentanil, carotid artery stenosis, opioid, anesthesia

Anesthesia for the surgical treatment of high-grade carotid artery stenosis presents many challenges. The main goals are to protect cerebral perfusion while guarding against cardiac ischemia.\textsuperscript{1} The most common morbidity in the perioperative period of carotid endarterectomy (CEA) in symptomatic and asymptomatic patients is stroke and is related to many patient characteristics.\textsuperscript{2} In some cases, the post-operative morbidity can be significantly reduced if detected early and treated immediately.\textsuperscript{3} This case describes the management of an asymptomatic patient with high grade carotid artery stenosis.

Case Report

A 76 year old female asymptomatic patient diagnosed by duplex scan with 95\% right carotid stenosis presented for right-sided carotid endarterectomy. The patient’s medical history included hypertension, coronary artery disease without angina, hyperlipidemia, tobacco use, and hypothyroidism. Her past surgical history included a 2-vessel coronary artery bypass graft, a coronary artery stent placement, and bilateral cataract extractions. The patient’s medications consisted of: metoprolol, isorbide, lisinopril, aspirin, hydrochlorothiazide, atorvastatin calcium, and levothyroxine. The patient was instructed to take all medications except aspirin on the day of surgery.

The patient weighed 76 kilograms and was 64 inches tall. Her preoperative heart rate was 60 beats per minute, blood pressure was 136/60 mmHg, oxygen saturation on room air was 98\%, and respiratory rate was 14 breaths per minute. A recent 12-lead electrocardiogram showed left ventricular hypertrophy with old ST segment abnormality. A 3 year old dobutamine stress test was negative for ischemia and showed an ejection fraction of 48\%. Physical exam revealed a pleasant, alert and oriented female in no acute distress. Breath sounds were diminished with mild rales in the right lower lobe. Heart rate and rhythm were regular. Her physical status was classified as ASA III and general anesthesia was planned.

A radial arterial line was placed in the pre-
operative area after midazolam 1 mg and fentanyl 50 mcg sedation. The patient was then taken to the operating room and monitors applied including a bispectral index (BIS) monitor. Her first vital signs in the operating room were as follows: blood pressure 143/62, heart rate 64, ECG normal sinus rhythm, and room air oxygen saturation 95%. After preoxygenation, anesthesia was induced with lidocaine 80 mg, propofol 100 mg, and remifentanil infusion started without bolus at 0.125 mcg/kg/min. Esmolol 40 mg, rocuronium 40 mg, and an additional propofol 40 mg dose were given prior to laryngoscopy. The patient’s vital signs remained stable throughout induction and intubation. After the trachea was intubated, oxygen was decreased to a 2 liter flow, nitrous oxide added at 2 liters, and desflurane introduced at 2%.

Prior to carotid artery cross-clamping, a dose of ephedrine 5 mg was given and a phenylephrine infusion was initiated and titrated to maintain systolic arterial blood pressure above 130 mmHg during shunt placement. BIS values were monitored and remained between 40 and 60. Following closure of the carotid artery with a patch, the surgeon requested that the patients blood pressure be increased to near her preoperative level and the phenylephrine drip was titrated to raise the systolic arterial blood pressure to 140-150. After performance of an arteriogram to evaluate the patency of the vessel, the phenylephrine drip was titrated down and discontinued. When closure reached skin level, the remifentanil drip was discontinued, esmolol 50 mg given (in divided doses), and the neuromuscular blockade antagonized with neostigmine and glycopyrrolate. After wound closure, the desflurane and nitrous oxide were discontinued. The dressing was placed and the patient opened her eyes and calmly followed commands and the trachea was extubated. At this point neurological examination was preformed by the surgeon and found to be intact. The patient transferred herself to a stretcher and was taken to the post-anesthesia care unit.

In the PACU fentanyl 50 mcg was given for moderate surgical site discomfort. Vital signs were stable without pharmacologic support. Total fluid administration was lactated Ringer’s 600 cc and estimated blood loss was 50 cc. Operative time was 1 hour. The patient was alert and oriented and no neurological deficits appreciated. She was transferred to the intensive care unit and discharged the next afternoon after an uneventful postoperative course.

**Discussion**

CEA is being performed increasingly in patients with carotid artery stenosis who are asymptomatic and studies have shown that strokes can be reduced by surgical treat-ment in these patients. The operative risk of stroke and death in symptomatic patients is 5.1% versus 2.8% in asymptomatic patients. Ischemic events are usually the cause of intraoperative stroke and embolic events are most common in the postoperative period. Therefore, rapid recovery and early perioperative neurological assessment are practical goals in the management of patients undergoing CEA. Many methods of anesthesia for CEA are used according to patient characteristics, surgeon’s skill and comfort level, and institutional convention. Regional anesthesia has been increasingly advocated to allow for rapid detection of intraoperative neurological symptoms, stable hemodynamics, and adequate operating conditions. This technique has disadvantages including lack of airway control and need for a
cooperative patient. The literature does not yet support a clear advantage of one anesthetic technique over another for CEA. In this case, regional anesthesia for CEA is not a method customarily used at this institution.

To facilitate the rapid emergence required for these cases Wilhelm, et. al. proposed remifentanil-desflurane or fentanyl-desflurane anesthesia. In a small randomized trial these methods were evaluated for times to early recovery and response to simple neurological tests at 30, 60, and 90 minutes after operation. Patients in the remifentanil-desflurane group had faster times to extubation, stated their names faster, and preformed neurological tests significantly earlier than those in the fentanyl-desflurane group. The remifentanil group maintained hemodynamic stability better during intubation. Hemodynamic characteristics were similar during maintenance of anesthesia in both groups. They concluded that this anesthetic method is a suitable alternative to standard fentanyl-based general anesthetic technique in patients undergoing CEA. A limitation of this study was the inability to compare depth of anesthesia in the two groups. We addressed the issue of depth of anesthesia by using a BIS monitor as an additional assessment tool.

Remifentanil is an opioid agonist with analgesic potency similar to fentanyl. It is metabolized by hydrolysis by nonspecific esterases to inactive metabolites. Because of this remifentanil has a short duration of action, rapid onset, noncumulative effects, and rapid recovery. Remifentanil is able to be precisely and rapidly titrated, has low interindividual variability, and has similar pharmacokinetics in obese and lean patients. High dose remifentanil decreases cerebral blood flow and cerebral metabolic oxygen requirements without impairing carbon dioxide reactivity and is not associated with histamine release. In addition to these properties, better hemodynamic control during laryngoscopy and maintenance with remifentanil versus fentanyl has been shown. The use of remifentanil titrated to patient need has been shown to decrease intraoperative bradycardia and hypotension episodes that may be side effects of higher than required dosing. In this case the dose was not titrated and vasopressors used as needed for hemodynamic control. Titration may have decreased the requirement of phenylephrine.

Desflurane is a fluorinated methyl ethyl ether with a blood:gas partition coefficient of 0.45 and MAC of 6%. These properties allow for rapid achievement of anesthetic levels and timely awakening. When opioids and nitrous oxide are given with desflurane there is a dose dependant decrease in the MAC. Midazolam premedication also decreases the MAC of desflurane.

Early detection and intervention is vital should complications arise after CEA. Patients require careful monitoring in the post operative period. A new major neurologic deficit in the immediate postoperative period represents a surgical emergency and early detection effects outcome. Immediate reexploration may be indicated in these patients. The anesthetic management is similar to the technique used in elective situations. If a hematoma necessitates neck exploration following CEA a difficult intubation should be anticipated and emergency tracheostomy or cricothyroidotomy equipment available.

CEA is a commonly performed surgery that carries the risk of substantial complications. In some cases these may be amelio-
rated if diagnosed early and treated quickly. The use of short acting anesthetic drugs such as remifentanil and desflurane may be superior to other general anesthesia techniques in allowing reliable neurological assessment immediately post operatively. As with any case, a plan should be formulated based on the patient’s individual characteristics along with team experience and comfort levels.

References


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Anesthetic Management of Known Placenta Previa/Accreta
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Keywords: Placenta previa, accreta, abnormal pregnancy, gravid hysterectomy, cesarean hysterectomy, anesthesia

Placenta previa is an abnormal condition of pregnancy in which the placenta implants in the lower segment of the uterus and may cover the internal cervical os.\(^1\)\(^,\)\(^2\) Placenta accreta is an abnormal invasion of the placentental trophoblast through the normally protective decidua basalis of the uterus and adherence of the placenta to the myometrium.\(^3\)\(^,\)\(^4\)\(^,\)\(^5\)\(^,\)\(^6\) Either condition can lead to catastrophic hemorrhage during childbirth. Careful surgical and anesthetic planning and management is required to anticipate intraoperative problems. This case report describes anesthetic management of a patient diagnosed with placenta previa and suspected placenta accreta during cesarean section (CS) and subsequent cesarean hysterectomy (CH).

Case Report

A 25 year-old female gravida/parity 3-2-0-0-2, 69.5 kg, 62 in. presented for CS and likely CH. The patient had two prior CS without complications. Estimated gestational age was 36 weeks and one day. The pregnancy had been relatively benign with minimal uterine activity, good fetal movements, and normal fetal growth noted on twice weekly antepartum testing. Complete placenta previa had been diagnosed by ultrasonography (US), and magnetic resonance imaging (MRI) studies revealed likely accreta. The medical history included a 10 pack-year history of cigarette smoking. The patient reported no known drug allergies and denied any current medications. Her most recent hemoglobin measurement was 11.0 gm/dL.

On the morning of surgery an epidural catheter was placed successfully, and advanced approximately 3 cm into the epidural space. The patient was then transported to interventional radiology where temporary balloon occlusion catheters were successfully placed in the right and left internal iliac arteries under fluoroscopy for control of intraoperative bleeding. Upon arrival to the preoperative holding area, a second large-bore IV was placed, the patient was preloaded with 1000 cc of LR intravenously (IV), and the epidural was dosed in an incremental manner with 2% lidocaine and 1:200,000 epinephrine to a total volume of 16 cc. In the operating room, routine monitors were placed and four liters of oxygen were administered via nasal cannula.

A six pound male infant was delivered breech by CS uneventfully, with APGAR scores of 8 and 8 at one and five minutes. Following delivery, the definitive diagnoses of accreta was made, and CH ensued. The internal iliac balloons were inflated by the interventional radiologist to control uterine blood loss. Toward the completion of the hysterectomy, the patient began to experience mild nausea, and described discomfort and pressure in the rectal area. She denied any pain, but the discomfort worsened as the surgery proceeded. Fentanyl 100 mcg, ondansetron 4 mg, and metoclopramide 10 mg were given IV. A low-dose propofol drip IV was started as well. The patient’s discomfort persisted, and ketorolac 30 mg and meperidine 25 mg were given IV. The
discomfort became intense the patient began to move her legs on the table weakly, but uncooperatively. An additional 4 cc of 2% lidocaine with epinephrine was placed in the epidural catheter, and general anesthesia was administered with nitrous oxide and sevoflurane. No additional blood loss was noted when the iliac balloons were deflated. Following closure of the surgical wound, the patient was transported to recovery without complications or complaints. Estimated blood loss was 900cc, crystalloid fluid replacement was 3400cc and no blood products were transfused. She was discharged to home four days later with a healthy infant.

Discussion

Placenta previa is described as marginal (low-lying), partial (incomplete) or total (complete or central) depending on the amount of cervical os involvement.\(^1\) The incidence is 0.1-1.0 %.\(^1,2,8\) with a maternal mortality rate of 0.03%.\(^2,8\) While the etiology is unknown, there are several risk factors associated with placenta previa. There is a six-fold increase in risk for placenta previa for women who have had a previous lower segment CS.\(^1\) Multiparity, multigravida, frequent pregnancy (brief non-pregnant states), smoking, advanced maternal age and previous placenta previa are also associated with elevated risk.\(^1,4,8\) Diagnosis is usually by serial US.\(^1,7\)

Placenta accreta is a rare complication of pregnancy now occurring in 0.04% of all deliveries.\(^4\) However, in the last 50 years, the incidence has increased 10-fold, likely from increased CS rates.\(^3,4\) It occurs in nearly 10% of pregnancies where placenta previa is present, compared to 0.005% when it is not present.\(^4\) The incidence increases with the number of CS and may reach as high as 24-67% with concurrent previa and a history of two or more previous CS.\(^4,9\) Serial US, color-flow Doppler, and MRI are the most useful diagnostic tools, however, definitive diagnosis cannot be made until the uterus can be visualized during cesarean section and the placenta cannot be easily separated from the uterus.\(^3,7\)

The greatest risk of placenta previa and placenta accreta is massive uterine hemorrhage with resulting maternal and/or fetal demise, especially if placental separation occurs outside of the hospital setting. If the placenta is tightly adhered to the uterus and cannot be separated easily, immediate and even emergent hysterectomy may be required to prevent catastrophic hemorrhage. Statistically, blood loss exceeds two liters in over half of all surgical cases.\(^4\) It is important to inform the mother of this risk and that hysterectomy may be necessary, as well as the possibility of blood product transfusion. Autologous blood collection and storage may be an option as well.\(^5\)

Anesthetic choice for the patient with placenta previa-placenta accreta is controversial. While many believe that a conservative approach of general anesthesia (GA) for CS should be used for placenta previa, at least two studies have shown that regional anesthesia (RA) can be used safely resulting in more stable intraoperative blood pressures, reduced blood loss, and decreased postoperative transfusion rates when compared to GA.\(^2,10\) Additionally, use of RA allows the mother to be conscious and aware during the birth which is usually desired, and can allow for spousal presence as well. The anesthetic practitioner has the option to cautiously convert to GA after the birth if needed or desired for CH.

Although few studies have been published on the subject, balloon occlusion catheters placed preoperatively in the internal iliac arteries, and inflated to minimize blood flow to the uteroplacenta complex during CH have been found to result in a remarkable decrease in blood loss intraoperatively.\(^5,6,7\) Catheters can remain
deflated during CS, and then inflated and deflated during the CH portion to occlude blood flow and evaluate bleeding. The catheters can be discontinued at a later time with a low risk of complications.

Upon evaluating the patient for anesthesia, we took into consideration the uncomplicated and stable pregnancy course, with no evidence of internal or external bleeding confirmed by physical exam, ultrasonography, and MRI. Additionally, the patient had no contraindications to neuraxial anesthesia, and desired to be aware and conscious during the birth. The patient had an adequate preoperative hemoglobin level, we planned IV hydration with 1-2 liters of crystalloid fluid prior to incision, and the surgical team was thoroughly prepared for substantial blood loss. We felt placement of an epidural catheter and dosing it accordingly for surgical purposes and leaving it in place for postoperative pain control was appropriate.

While regional anesthesia may not be the best choice for every placenta previa/accreta case, after thorough assessment of this patient, we felt it was the best choice in our situation. In retrospect, we are unsure of why there was some sacral sparing during the hysterectomy that obliged us to supplement IV analgesics, sedatives and then general inhalational anesthetics. Due to the risk of aspiration, this must be done with a protected airway in place. Perhaps spinal anesthesia or combined spinal epidural anesthesia would have provided a denser block, and would have covered sacral dermatomes more adequately.

References


Mentor: Sharon Hadenfeldt, CRNA, PhD
Keywords: Dexmedetomidine, alpha-2 agonist, controlled hypotension, neuroprotection, anesthesia

Dexmedetomidine is an alpha-2 agonist. Its selective alpha-2 agonism is 1620:1 alpha-2 to alpha-1, and compared to clonidine has a faster onset and shorter half life. Its numerous uses in anesthesia include: analgesia, sedation and anxiolysis, decreased blood pressure and heart rate, and inhibition of the sympathetic nervous system. Other effects of dexmedetomidine include antisialogogue, suppression of antidiuretic hormone secretion, and neuroprotection. Clinically, dexmedetomidine is useful in the operating room for reasons previously stated and useful in the intensive care unit for sedation. Although it is not available in all operative settings, its use is more widely accepted and gaining popularity in the anesthesia community.

Case Report

A 72 year old female was scheduled for an orbitotomy, sphenoidectomy, and maxillectomy with possible craniotomy. The patient presented to clinic with a recurring adenoid cystic carcinoma of the left maxillary sinus. In 2002 the patient underwent radiation therapy with some shrinkage of the mass. The current CAT scan of paranasal sinuses and the brain revealed a large mass of the left maxillary sinus extending through the maxillary sinus walls invading the orbit, the sphenoid sinus, the sella turcica and left middle cranial fossa, as well as the palate and left nasal fossa. The borders of the tumor were not fully defined on CAT scan. The patient’s past medical history included hypertension, hypercholesterolemia, and recurrent adenoid cystic carcinoma. The past surgical history was significant for tonsillectomy as a child with no complications from anesthesia. The medication profile included diovan, fexofenadine, and pravachol.

The patient weighed 88 kg and was 5 feet 6 inches. Preoperative blood pressure was 145/82 mmHg, heart rate of 73 beats per minute, respiratory rate of 20 breaths per minute, and room air oxygen saturation was 97%. Her physical status was classified as ASA II and the airway assessment revealed Mallampati class II with normal cervical range of motion, atlanto-occipital joint extension, and thyromental distance. The patient could also move all extremities with equal strength, and her mental status was alert and oriented times three. There were no apparent neurological deficits.

The patient’s preoperative medication included midazolam 2 milligrams, dexmedetomidine 20 micrograms, dexamethasone 10 milligrams, and cefazolin 1 gram. The patient was taken to the operating room and preoxygenated with 12 liters of oxygen via the anesthesia machine circuit, and standard monitors were applied. A 14 gauge intravenous catheter and 20g radial arterial line were inserted into the right arm. Intravenous induction was then performed with fentanyl 150 micrograms (mcg), propofol 120 milligrams (mg), and succinylcholine 100 mg. The trachea was intubated with a 7.5 centimeter anode tube and secured on the right side of the face. The arms were tucked and eyes lubed and taped shut. Mechanical ventilation was
initiated and anesthesia was maintained with sevoflurane end tidal concentrations of 0.6-1.1%, and 1.5 liters flow of both oxygen and air. Throughout the case, the patient received a total of dexmedetomidine 240 mcg, fentanyl 250 mcg, hydromorphone 2.8 mg, and vecuronium 30 mg. The patient’s systolic blood pressure was kept between 90-110 mmHg throughout the case.

The patient underwent decompression orbitotomy, left medial maxillectomy, infra temporal fossa excision, and total sphenoidectomy. Total blood loss was 600 milliliters. The surgery lasted 7 hours, and at the end of the case the patient was extubated, placed on 50% oxygen face tent, and transported to the intensive care unit. The patient was able to answer questions appropriately, maintain oxygenation with face tent, and did not complain of any pain. Postoperative blood pressure was 107/62 with heart rate of 69.

**Discussion**

Patients undergoing facial or cranial surgery frequently require large dose narcotics to decrease pain and maintain controlled hypotension to decrease blood loss throughout the case. Anesthetic considerations related to large dose narcotic administration for this patient included: the patient’s age, history of hypertension, and a possible craniotomy with surgery. It is possible that large doses of narcotic would delay wakeup and cause respiratory depression, which are unwanted side effects for the elderly and for patients undergoing craniotomy. The delay in wakeup could lead the surgical team to believe there is a potential neurological deficit. Secondary to the possible effects of large amounts of narcotics, and given the patients history of hypertension, our anesthesia team decided to use dexmedetomidine for analgesia and to facilitate stability of hemodynamics by maintaining controlled hypotension.

Alpha-2 receptor sites are found inside and outside the central nervous system and in the periphery. In the brain, they are found primarily in the pons and medulla which transmit sympathetic activation from higher brain centers to the periphery. This signal transduction acts on presynaptic alpha-2 receptors inhibiting release of norepinephrine and on postsynaptic alpha-2 receptors decreasing sympathetic activity. The overall effect is a decrease in blood pressure and heart rate. In the spinal cord, alpha-2 agonism inhibits nociceptive signal transduction providing analgesia, and in the periphery induces vasoconstriction.

Dexmedetomidine is a potent alpha-2 agonist and provides analgesia via supraspinal and spinal sites without respiratory depression, decreases plasma catecholamine release, produces centrally mediated hypotension and bradycardia, produces dose dependent sedation and anxiolysis, causes diuresis due to inhibition of anti-diuretic(ADH) hormone release and antagonism of ADH tubular effects, and may produce decongestant and antisialogogue effects. Its use as an analgesic may help to reduce narcotic requirement, although the exact mechanism of action is not known. In regards to hemodynamics, the initial response may be a transient hypertension secondary to its effects in the periphery, but the overall effect is a decrease in the sympathetic outflow of the central nervous system with resulting increase in parasympathetic outflow. This results in decreased circulating catecholamines, blood pressure, and heart rate.

Activation of the alpha-2 receptors located in the locus ceruleus in the brain produce
Extra weight shouldn’t mean extra wait

REFERENCES
The most recent data available show that 67% of the adult U.S. population is overweight (BMI ≥25). Extra weight has been associated with difficulty in tracheal intubation, hypoxemia, decreased functional residual capacity, increased airway resistance, sleep apnea and aspiration.

One of the main goals following general anesthesia is to optimize recovery. With Suprane (desflurane, USP), overweight patients experienced faster early recovery from anesthesia compared with isoflurane (see table). In addition, adverse events were comparable for overweight patients compared to normal weight patients.

So if you’re not considering Suprane (desflurane, USP) in your overweight patients, what are you waiting for?

**Indications and Usage:**
Suprane (desflurane, USP) is indicated as an inhalation agent for induction and/or maintenance of general anesthesia for inpatient & outpatient surgery in adults.

Suprane is not recommended for induction of anesthesia in pediatric patients because of a high incidence of moderate to severe upper airway adverse events. After induction of anesthesia with agents other than Suprane, and tracheal intubation, Suprane is indicated for maintenance of anesthesia in infants and children.

Suprane should be administered only by persons trained in the administration of general anesthesia, using a vaporizer specifically designed and designated for use with desflurane. Facilities for maintenance of a patent airway, artificial ventilation, oxygen enrichment, and circulatory resuscitation must be immediately available. Hypotension and respiratory depression increase as anesthesia is deepened.

**Important Safety Information:**
Suprane should not be used in patients with a known or suspected genetic susceptibility to malignant hyperthermia, or known sensitivity to Suprane or to other halogenated agents.

Use of inhaled anesthetic agents has been associated with rare increases in serum potassium levels that have resulted in cardiac arrhythmias and death in pediatric patients during the postoperative period. Patients with latent as well as overt neuromuscular disease, particularly Duchenne muscular dystrophy, appear to be most vulnerable. Concomitant use of succinylcholine has been associated with most, but not all of these cases. Despite the similarity in presentation to malignant hyperthermia, none of these patients exhibited signs or symptoms of muscle rigidity or hypermetabolic state. Suprane is not recommended for induction of general anesthesia via mask in infants or children because of the high incidence of moderate to severe laryngospasm in 50% of patients, coughing 72%, breathholding 68%, increase in secretions 21% and oxyhemoglobin desaturation 26%.

Concentrations of desflurane exceeding 1 MAC may increase heart rate. Thus an increased heart rate may not be a sign of inadequate anesthesia.

Suprane should not be used as the sole agent for anesthetic induction in patients with coronary artery disease or patients where increases in heart rate or blood pressure are undesirable. It should be used with other medications, preferably intravenous opioids and hypnotics. Suprane, like some other inhalational anesthetics, can react with desiccated carbon dioxide (CO₂) absorbents to produce carbon monoxide which may result in elevated levels of carboxyhemoglobin in some patients. Case reports suggest that barium hydroxide lime and soda lime become desiccated when fresh gases are passed through the CO₂ absorber canister at high flow rates over many hours or days.

As with other halogenated anesthetic agents, Suprane (desflurane, USP) may cause sensitivity hepatitis in patients who have been sensitized by previous exposure to halogenated anesthetics. The average MAC for Suprane in a 70 year old patient is two-thirds the MAC for a 20 year old patient.

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### Desflurane vs. Isoflurane in Overweight Subjects: Early Recovery Parameters

<table>
<thead>
<tr>
<th>Early Recovery Parameters</th>
<th>Desflurane</th>
<th>Isoflurane</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=136*†</td>
<td>n=102*†</td>
<td></td>
</tr>
<tr>
<td>Cessation of anesthesia to eye opening</td>
<td>9.0±6.5 n=134</td>
<td>12.0±11.5 n=98</td>
<td>0.0220</td>
</tr>
<tr>
<td>Response to command:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Squeeze my fingers</td>
<td>9.6±6.7 n=135</td>
<td>13.3±10.7 n=98</td>
<td>0.0029</td>
</tr>
<tr>
<td>Tell me your date of birth</td>
<td>12.9±9.9 n=117</td>
<td>16.4±9.3 n=87</td>
<td>0.0129</td>
</tr>
<tr>
<td>Tell me your name</td>
<td>12.2±9.3 n=117</td>
<td>15.7±9.3 n=87</td>
<td>0.0094</td>
</tr>
</tbody>
</table>

* BMI ≥ 25  † Age ≤ 65  ‡ Desflurane significantly faster than isoflurane for all parameters, p<0.05; mean (min.) ± standard deviation

Please see brief summary of Prescribing Information on the next page.
**SUPRANE (desflurane, USP)**

**Volume Liquid for Inhalation**

**Brief Summary.** See Product Insert for Full Prescribing Information.

Deerfield, IL 60015 USA

For Product Inquiry 1 800 ANA DRUG (1-800-262-3784)

MLT-00070/7.0

Revised: July 2006

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**INDICATIONS AND USAGE**

SUPRANE (desflurane, USP) is not recommended for induction of anesthesia in pediatric patients because of a high incidence of moderate to severe upper airway adverse events (see **WARNINGS**). After induction of anesthesia with agents other than SUPRANE, SUPRANE is indicated for maintenance of anesthesia in infants and children.

**CONTRAINDICATIONS**

SUPRANE (desflurane, USP) should not be used in patients with a known or suspected genetic susceptibility to malignant hyperthermia.

**WARNINGS**

Perioperative Hyperkalemia

Use of inhaled anesthetic agents has been associated with rare increases in serum potassium levels that have resulted in cardiac dysrhythmias and death. Postoperative respiratory depression may lead to hypoxia, and in some cases, changes in urine consistent with myoglobinuria. Despite the similarity in presentation to malignant hyperthermia, none of these patients exhibited signs or symptoms of muscular rigidity or respiratory intermyopathy. Early and aggressive intervention to treat the hyperkalemia and resistant arrhythmias is recommended, if tolerable. Treatment of malignant hyperthermia includes discontinuation of trigger agents, administration of intravenous dantrolene sodium, and application of supportive therapy. (Consult prescribing information for dantrolene sodium intravenous for additional information on patient management.) Renal failure may appear later, and urine flow should be monitored and sustained if possible.

**PRECAUTIONS**

During maintenance of anesthesia, increasing concentrations of SUPRANE (desflurane, USP) produce dose-dependent decreases in blood pressure. Excessive decreases in blood pressure may be related to depth of anesthesia and in such instances may be corrected by decreasing the inspired concentration of SUPRANE.

Concentrations of desflurane exceeding 1 MAC may increase heart rate. Thus an increased heart rate may not be a sign of inadequate anesthesia.

In patients with intracranial space occupying lesions, SUPRANE (desflurane, USP) should be used with caution as it may contribute to intracranial hypertension and raised intracranial pressure. Barbiturate induction and hyperventilation (hypocapnia) will reduce intracranial pressure.

**ADVERSE REACTIONS**

The average MAC for SUPRANE (desflurane, USP) in a 70 year old patient is 0.54. In the absence of specific guidelines:

- **1.25 MAC O2**
- **22 123**
- **362**

Dose reduction of neuromuscular blocking agents during induction of anesthesia may result in delayed onset of condition suitable for endotracheal intubation or inadequate muscle relaxation, because potentiation of neuromuscular blocking by desflurane may be prevented by the delivered partial pressure of desflurane.

**THERAPEUTIC EFFECTS**

No teratogenic effect was observed at approximate 10 and 13 cumulative MAC-Hours exposure at 1 MAC-Hour per day during organogenesis in rats or rabbits. At higher doses than those used in organogenesis, desflurane adversely affected the reproductive life of rats. The recovery from general anesthesia should be assessed carefully before patients are discharged from the post anesthesia care unit (PACU).

**ADVERSE REACTIONS**

- **Cardiovascular**
  - Bradycardia, hypertension, tachycardia, tachypnea
- **Dental**
  - Caries
- **Gastrointestinal**
  - Dyspepsia
- **Headache**
  - Headache
- **Hypersensitivity**
  - Anaphylactic reactions
- **Metabolic and Nutrition**
  - Increased creatinine phosphokinase
  - Increased cholesterol, triglycerides
- **Mucosal Skeletal System**
  - Myalgia
- **Neuromuscular**
  - Hypotonia
- **Respiratory**
  - Hypoxia
  - Hypercapnia
- **Skin and Appendages**
  - Pharyngitis

**PROBABLY CAUSALLY RELATED: Incidence greater than 1%.**

- **Cardiovascular**
  - Arrhythmia, hypotension

**CAUSAL RELATIONSHIP UNKNOWN: Incidence less than 1%.**

- **Central Nervous System**
  - Somnolence

**Special Senses**

- **Incidence of events: 3% - 10%**

- **Body as a Whole**
  - Fever

**Adverse reactions reported only from postmarketing experience or in the literature, not seen in clinical trials, are considered rare and are italicized.

**Cardiovascular**

Bradycardia, hypertension, tachycardia, tachypnea

**Digestive**

Nausea 27%, vomiting 16%

**Nervous system**

Increased Salivation

**Respiratory**

Annea*, breathing, coughing

- **Sedation**
  - Laryngospasm

**Special Senses**

Conjunctivitis (conjunctival hyperemia)

* Incidence of events: 3% - 10%

**PROBABLY CAUSALLY RELATED: Incidence less than 1%.**

- **Cardiovascular**
  - Arrhythmia, hypotension
- **Central Nervous System**
  - Somnolence

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**Respiratory**

Annea*, breathing, coughing

- **Sedation**
  - Laryngospasm

**Special Senses**

Conjunctivitis (conjunctival hyperemia)

* Incidence of events: 3% - 10%
anxiolysis and sedation. The locus ceruleus is a key modulator for critical brain functions including arousal, sleep, and anxiety.\textsuperscript{3} Dexmedetomidine effects are not dependent on gamma-aminobutyric acid (GABA) system, and seem to produce a cooperative form of sedation where patients are easily aroused when stimulated and back to sleep when left alone. Cognitive function may also be better preserved when compared with other anxiolytics or hypnotics.\textsuperscript{3}

Dexmedetomidine also offers neuroprotection. It helps to inhibit ischemia induced release of norepinephrine, and reduces glutamate release as well as facilitating glutamate disposal by oxidative metabolism.\textsuperscript{3} Dexmedetomidine seems to have no direct effect on intracranial pressure (ICP) but it reduces cerebral metabolic rate of oxygen, decreases cerebral blood flow thereby decreasing ICP, and has minimal effects on evoked potential latency or amplitude.

Despite all the benefits of dexmedetomidine, it is not without side effects. Common side effects include hypotension, transient hypertension, dry mouth, bradycardia, reduction in the cerebral blood flow/ cerebral metabolic rate of oxygen ratio, and excessive sedation.\textsuperscript{2,3} Some of these side effects may be reduced by using a slow bolus for the initial loading dose, and careful titration of subsequent doses. It is suggested that a loading dose of 1 mcg/kg be given over a period of 10 minutes as the initial dose, and that this dose not be bolused.

In the case presented, dexmedetomidine proved useful by helping to reduce narcotic and inhalational agent requirement, and by maintaining slight hypotension. We were able to maintain the patient’s systolic blood pressure within a tight range without the use of other antihypertensives. The patient did develop transient hypertension in the beginning with our loading dose secondary to rapid infusion. Given the recommendations of administration of dexmedetomidine, this side effect could have been potentially prevented with a slow bolus as the initial dose. Overall, the patient did not require large doses of narcotics or inhalational agents which facilitated rapid emergence at the end of the case. The patient also did not require the use of other antihypertensives to maintain controlled hypotension to help decrease blood loss. Moreover, the patient was comfortable, arousable, and pain free after major surgery.

References


Mentor: Russ Lynn CRNA, MSN
Keywords: brain dead, organ donor, organ procurements, anesthesia

Brain dead organ donor patients present challenging issues in anesthetic management. Brain death is declared when cerebral and brainstem function has irreversibly ceased. This complex process involves hemodynamic instability with endocrine and metabolic regulation disruption if untreated. Salvaging viable organs is possible when homeostasis is closely regulated. Anesthetic management includes administration of vasopressors to maintain a mean arterial pressure (MAP) of 70 mmHg, aggressive fluid resuscitation for hypovolemia, thermoregulation, management of diabetes insipidus, correction of electrolyte abnormalities, maintaining adequate oxygenation, management of cardiac arrhythmias, pulmonary toilet, and > 30% hematocrit (Hct) values. This case report discusses one case of liver and kidney donation from a brain dead donor.

Case Report

A 35 year-old male was admitted to the hospital for an intracranial subarachnoid hemorrhage. He was transferred to the intensive care unit (ICU) and declared brain dead after the completion of an apnea test and confirmation of the absence of brain stem reflexes. He was classified an ASA VI. History and consent for organ donation was received from immediate family members. No prior surgical history was noted. Medical history included hypertension and dextrocardia. The patient’s heart and spleen were on the right side of his body and his liver was on the left side. According to family history and chart review, the patient did not have any noted issues due to his reversed anatomy. He was healthy and functioned normally. After brain death declaration, all medications were discontinued except for a phenylephrine infusion to maintain a MAP between 70-100 mmHg. A vasopressin infusion was administered for diabetes insipidus that developed during the patient’s ICU course. Once serum and urine osmolality were within normal limits, this infusion was discontinued in the ICU. Lab values preoperatively: Na – 152 mEq/L, K – 4.1 mEq/L, Glucose 167 mg/dL, Hct – 34%, PT – 12 sec, PTT – 45 sec, INR 1.0. Ejection fraction of 70%, normal left ventricular and valvular function were reported in the preoperative echocardiogram, and the ECG showed normal sinus rhythm with a heart rate of 92 bpm. The patient’s trachea was intubated upon admission to the emergency room and respirations were mechanically controlled with ventilator settings of assist control, TV 700, and Rate 12, FiO2 100% in the ICU. Preoperative arterial blood gas (ABG) values were normal (ph – 7.39, PaCO2 – 39 mmHg, PaO2 – 200 mmHg) and monitored hourly intraoperatively. Intra-arterial and central venous pressure monitoring were utilized in the ICU and continued intraoperatively. The patient was receiving NS solution intravenously at 100 ml/hr. Heart sounds heard on the right side were normal and lungs sounds were clear, though diminished in the lower lobes.

The United Network for Organ Sharing (UNOS) was perioperatively involved in the management of the patient. A guideline

Multiorgan Procurement Management
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was provided by UNOS to aid with the intraoperative management. The anesthetic plan focused on maintaining hemodynamic stability that supported organ function. The patient was placed on portable monitors, 10 L/min oxygen administered by manual ventilation with ambu bag and transferred to the operating room by anesthesia practitioners and UNOS personnel. Upon entering the operating room, the patient’s respirations were controlled by mechanical ventilation and ICU ventilator settings were maintained. Hemodynamic stability was maintained with a phenylephrine infusion at 25 mcg/min titrated as needed to maintain MAP of 70-100 mmHg, NS at 100 ml/hr was continued. Inhalation or neuromuscular blockade agents were not utilized during the surgical procedure. An esophageal stethoscope and temperature probe was placed. Intra-arterial blood pressure and central venous monitoring were continued. Heparin 30,000 units and Mannitol 25 grams were administered intravenously immediately before cross clamping of the aorta. When the aorta was cross-clamped, NS and phenylephrine solutions and ventilatory support were discontinued. Tissue biopsies of the procured organs were sent to pathology. The endotracheal tube (ETT), all invasive monitoring devices and intravenous catheters were left in place, and the patient was declared expired. Anesthesia management was not required for the post procurement closure. After the organs were removed, the surgeons transported the liver and kidneys to their respective facilities for organ transplantation (after pathology reports received). UNOS remained in the operating room for incision closure and removal of invasive monitoring devices, intravenous catheters, Foley, and ETT. The body was placed in a body bag and taken to the morgue accompanied by transport personnel and an operating room RN.

**Discussion**

Preoperative management and assessment are as important as intraoperative management in this case scenario. Measures utilized preoperatively to maintain hemodynamic stability, optimum oxygenation, and endocrine regulation needed to be continued until organs had been procured. Communication with the ICU team managing the patient was invaluable. Inhalation agents are not necessary during organ procurement after the declaration of brain death, but spinal reflexes and some movement may be present so neuromuscular blockade with a nondepolarizing agent is recommended. Per surgeon request, neuromuscular blockade was avoided in this case. Oxygen 2 l/min was administered via ETT to prevent ischemia and promote maximum oxygenation to all tissues. ICU ventilator settings were continued. Esophageal stethoscope probe was utilized to monitor temperature and heart and lung sounds. Fluid warmer and Bair hugger were used to prevent hypothermia. Phenylephrine was needed to maintain MAP greater than 70 mmHg to preserve tissue perfusion. Maintaining this patient’s blood pressure was a challenge. The patient was very sensitive to the titration adjustments of phenylephrine. Excessive vasoconstriction that would compromise tissue perfusion was a concern when the patient’s blood pressure would increase above a systolic blood pressure (SBP) of 160 mmHg. When the infusion was titrated down in small increments, the SBP would decrease to 80 mmHg. Constant titration of the infusion was necessary to maintain optimum perfusion pressures. This instability may have reflected loss of feedback modulation.
reflexes. Dopamine and epinephrine infusions were immediately available if the phenylephrine infusion did not prove sufficient to maintain the desired MAP. According to current literature, a vasopressin infusion is an excellent choice for hypotension management. Exogenously administered vasopressin can produce a prolonged increase in arterial blood pressure within one minute. In this case, circulating vasopressin was lower due to the patient’s presurgical diagnosis of diabetes insipidus from endocrine disruption due to brain death. Hemodynamic instability may be due to the lack of endogenous circulating vasopressin. Perhaps, if the vasopressin infusion was continued intraoperatively in conjunction with the phenylephrine infusion, fluctuations in the patient’s blood pressure would not have occurred.

In addition to the phenylephrine infusion, NS intravenous solution was used to prevent hypotension due to hypovolemia and surgical fluid loss. The NS solution was also chosen as the intravenous fluid for this patient because of hypernatremia at 152 mEq/L preoperatively and a subsequent recorded value of at 149 mEq/L one hour into the operation. Measures to correct hypernatremia and hypovolemia seemed successful. Urine output was monitored hourly by Foley catheter to assure renal perfusion. ABGs were drawn hourly to monitor electrolyte imbalances/corrections and presence of acidbase derangement. ABG values remained within normal limits throughout the procedure. Mannitol was administered immediately before cross-clamping of the aorta to prevent reperfusion injury from oxygen-free radicals. Mannitol functions as a hydroxyl free radical scavenger. Total anticoagulating dose of heparin was administered intravenously to prevent increases in clotting factor activity or thrombus formation in response to cross clamping. These measures allowed maximum blood flow and tissue profusion needed for the procurement of the liver and kidneys. Intravenous fluid total was 1600 ml and urine output total was 560 ml for the duration of the case.

Organ donation over the last decade has increase by 3.7% while the recipient waiting list has grown by 19%. According to UNOS, the current number of people on organ transplant waiting lists is 94,299. The number of transplanted organs from January 2006 to September 2006 was 22,010, and 11,188 organ donations were made during this time. With these statistics, the most realistic option to increase organ donation is to maximize organ use from brain dead patients. The anesthesia practitioner has the responsibility to maintain tissue perfusion, adequate volume status, and oxygenation without injuring any potential donated organs. In this particular case, management techniques and medications were adequate. Due to the lack of randomized controlled trials conducted on brain dead organ donors, evidence based guidelines for anesthetic management are not available. Management is geared towards the needs of the harvesting surgeons and organ procurement personnel such as UNOS, while maintaining donor dignity. The guidelines provided by UNOS are the major resources for the management in this type of case. Further research that includes evidenced outcomes needs to be conducted in order to develop harvest specific guidelines for anesthetic management.

References

**Keywords:** Depodur, epidural, morphine, anesthesia

Depodur® is indicated for epidural administration, at the lumbar level, for the treatment of pain following major surgery. Depodur® is an extended release formulation of morphine in a liposomal carrier. A single injection into the epidural space of conventional morphine lasts 24 hours, which is clearly not long enough in patients recovering from lower abdominal surgery. Although one of the main concerns with the administration of Depodur® is respiratory depression, this side-effect is also seen with other opioids. One advantage of Depodur® is that it does not require an indwelling catheter which can limit patients’ mobility and anticoagulation treatment options following surgery. It can also augment the pain control provided by patient controlled intravenous analgesia (PCA).¹⁴

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**Case Report**

An 85-year-old ASA II male presented for a low anterior open colon resection for colon cancer. His past medical history included controlled hypertension treated with nifedipine daily. The patient was a former pipe smoker and reported drinking two alcoholic drinks per week. His exercise tolerance was good and included daily swimming, weight lifting, tennis, and racquetball. The patient was allergic to penicillin which caused urticaria. Past surgical history included two colonoscopies, carpal tunnel release, and a hydrocele repair at birth. There were no anesthetic complications with any of his prior procedures.

On the morning of surgery he weighed 82.2kg; vital signs were unremarkable with exception of mild hypertension (140/62). Laboratory results were within normal lim-
its and an EKG showed normal sinus rhythm and a rate of 62. His transthoracic echocardiogram showed mild concentric left ventricular hypertrophy with an ejection fraction of 60%. He had a Mallampati II airway with full range of motion of his neck. The patient was premedicated with midazolam 1 mg in the preoperative holding area.

The patient was brought to the OR where he assumed a sitting position on the OR table. Once positioned, an additional 1 mg of midazolam was administered. Routine monitors were placed and a total of 750 cc of LR had been infused by this time. Landmarks were confirmed, appropriate sterile skin preparation and draping were performed, and local anesthetic was infiltrated at the L3-4 interspace. An epidural needle was placed into this interspace and a loss of resistance was confirmed through easy injection of normal saline. Following a negative aspiration test, a test dose of 2% lidocaine with epinephrine, 2 cc, was administered with no changes in heart rate or blood pressure noted. Depodur® 10 mg was then administered into the epidural space and the needle was withdrawn. The patient tolerated the procedure well and was assisted to the supine position on the OR table.

General endotracheal anesthesia was induced with lidocaine 80 mg, propofol 200 mg, vecuronium 7 mg, and fentanyl 50 mg. Ertapenum 1G was administered over 10 minutes for antibiotic prophylaxis. Anesthesia was maintained with isoflurane 0.8-1.2% with air and oxygen at 1.5L/min flows each. A heated air blanket was placed over the patient’s upper extremities and an esophageal temperature probe was placed into the esophagus. Fentanyl was administered over the course of next two hours to a total of 200 mcg. Neuromuscular blockade was maintained with additional vecuronium. The total amount of vecuronium used during the case was 15 mg.

Approximately 2 hours into the case, the patient became hypertensive with blood pressures reaching 190/96 while the patient’s heart rate remained between 45-65 bpm. An additional 300 mg of Fentanyl was given over 30 minutes. Blood pressures remained unchanged. The fraction of inspired isoflurane was also increased but had little effect on the patient’s blood pressure or heart rate. Hydralazine, 20 mg, was given in 5 mg increments over 1.5 hours. The patient’s blood pressure returned to baseline and his heart rate remained at 50-60 bpm.

A total of 4200 cc of LR was infused over the case. Blood loss was 100 cc and urine output was 250 cc. A total of 500 mcg of fentanyl was given over the course of the case. Ondansetron, 4 mg, was given at closing. Bupivacaine was injected to the incision by the surgeon. Full muscle relaxant reversal with neostigmine and glycopyrrolate was administered with a return of four twitches and sustained tetany after seven minutes. Upon emergence, the patient was breathing spontaneously, opened his eyes, and followed verbal commands. His oropharynx was suctioned and endotracheal extubation was completed under positive pressure.

The patient was transported to PACU with oxygen administered via face mask. The patient remained comfortable in PACU and required small amounts (50 mcg/per administration) of fentanyl for the first few hours of his postoperative period. He was transferred to the floor where he reported mild pain over the next 48 hours and required minimal amount of additional narcotics. After a two week hospital stay complicated
by hematuria, suspicions of an anastomotic leak, delay in starting nutrition, hypokalemia, atrial flutter, and eventual TPN bridging to a regular diet, the patient was discharged to a rehabilitation facility.

**Discussion**

Epidural anesthesia and peripheral nerve blockade are widely used in the United States to achieve the goal of regional anesthesia and analgesia. In a prospective study of 5969 surgical patients over 7 years, a high mean score of 8.5 out of 10 was reported when patients were questioned about satisfaction with neuraxial opioid analgesia.

Epidural morphine has long been administered by single and intermittent bolus injection, continuous infusions, and PCA for the management of postoperative pain. Although single dose injection of conventional morphine affords up to 24 hours of pain relief, this can sometimes prove insufficient for patients having major surgery. A study found a 7-fold decrease in IV PCA fentanyl use in patients treated with epidural Depodur® when compared to conventional epidural morphine. Epidural PCAs require an indwelling catheter that can limit mobility, carry the risk of infection, and limit the use of anticoagulants for fear of possible epidural hematoma formation. Preoperative administration of Depodur® provides up to 48 hours of pain control postoperatively suggesting that patients could essentially be transitioned directly to oral analgesics; thus leading to reduction in costs stemming from drug cost, infusion sets and devices, and pain service time.

Depodur® consists of microscopic liposomal particles containing chambers that encapsulate preservative-free morphine. Following injection, under physiological conditions, the liposomes break down by erosion of the lipid membranes and slowly release the morphine over 48 hours. Morphine then slowly crosses the dura and diffuses to the cerebrospinal fluid producing high regional and low systemic drug concentrations. A one time dose of 10 mg for Depodur® results in lower systemic concentrations of the drug, resulting in decreased severity of systemic adverse effects such as nausea, sedation, and constipation.

Recommendations for dosages of Depodur® epidural injection include 10 mg for cesarean delivery, 10-15 mg for lower abdominal or pelvic surgery, and 15 mg for major orthopedic surgery of lower extremities. Generally, elderly and debilitated patients should be given dosages on the lower end of recommendations.

It is important to note that Depodur® is indicated for postoperative pain management, so the patient must have adequate narcotic given throughout the initial hours after injection and during surgery. Careful attention must be given to avoid long acting narcotics, such as additional morphine or hydromorphone, as the peak plasma concentration may coincide with the start of Depodur® breakdown possibly leading to undue sedation, respiratory depression, or hypotension. The time to first request for additional analgesics varies widely throughout the research with median times of approximately 3-21 hours. The most common adverse affects include pruritis and nausea.

In conclusion, single dose epidural injection of Depodur® can provide clinicians a valuable new option in the management of patients with pain after major abdominal surgery. It can provide pain relief for up to 48 hours following surgery,
although supplemental narcotics are often required in the immediate post operative period. The need for rescue medication is minimal, analgesic gaps are few, and a one-time injection avoids the need for catheters and pumps.3 A single epidural injection can lower opioid requirements and possibly shorten the postoperative hospital stay by decreasing complications and side effects of high dose parenteral opioid therapy or epidural PCA with indwelling catheters.2,3

References


Mentor: Janet A. Dewan, MS, CRNA

Potential for Postobstructive Pulmonary Edema
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Keywords: obstruction, airway, pulmonary edema, postoperative, anesthesia

Tonsillectomy and adenoidectomy (T&A) surgery is performed an estimated 750,000 times a year in the United States for several conditions including airway obstruction, sleep apnea, and persistent abscesses or throat infections.1 Approximately 70% of these surgeries are performed on children.2 There exists a potentially serious complication termed postobstructive pulmonary edema (POPE), which is acute and severe in onset. POPE can follow an acute airway obstruction (commonly known as negative pressure pulmonary edema) or the surgical relief of a chronic airway obstruction in otherwise healthy patients.3 The following case report describes the anesthetic care, postoperative course and clinical considerations for an adult patient undergoing T&A with the potential for development of POPE.

Case Report

A 26 year old female with a BMI of 42.5 (weight 102 kg and height 152.5 cm) and a recent history of obstructive adenotonsillar hypertrophy presented for partial inferior turbinatectomy with T&A. Her recent complaints included shortness of breath on exertion, snoring, recent weight gain and constant daytime fatigue. A sleep study to
evaluate for obstructive sleep apnea (OSA) had not been performed. Significant history included 1/2 pack/day smoking for ten years and untreated gastro-esophageal reflux disease. An ASA physical status of 3 was assigned, and her airway classification was Mallampati class 3 with normal neck range of motion and thyromental distance of three fingerbreadths. Examination of the oropharynx revealed enlarged and inflamed tonsils. The patient received famotidine 20 mg and metoclopramide 10 mg by mouth preoperatively. Pre-induction vital signs: blood pressure of 134/67 mmHg, sinus rhythm 89 beats/min, and room air oxygen saturation of 97%.

Upon arrival to the operating room (OR), the patient was positioned on the OR table with her head, neck and shoulders aligned in the sniffing position. The table was placed in reverse Trendelenburg, standard monitors were applied, oxygen was administered via mask at 10 liters/minute for 5 minutes and fentanyl 100 mcg was administered. A rapid sequence induction technique with cricoid pressure was then performed using rocuronium 3 mg, lidocaine 60 mg, propofol 180 mg, and succinylcholine 100 mg. Oral tracheal intubation was accomplished with ease, end-tidal CO₂ and bilateral breath sounds were confirmed. Anesthesia was maintained with an end-tidal sevoflurane of 2.2-2.4 % while the patient maintained spontaneous respirations with tidal volumes of 0.4-0.55 liters at a rate of 16-18 breaths/min. 1500 milliliters lactated ringers solution was infused and an estimated blood loss of less than 10 milliliters was noted.

At the conclusion of surgery, the patient was breathing spontaneously but not yet responding to commands. She was transported to the post anesthesia care unit (PACU) with the endotracheal tube in place connected to flow-by oxygen. Vital signs were: blood pressure 128/77 mmHg, sinus rhythm 69 beats/min, respiratory rate 16 breaths/min, oxygen saturation 91%, and temperature 36.7 degrees Celsius. Upon arrival in the PACU lidocaine 100 mg and fentanyl 50 mcg were administered intravenously. Approximately ten minutes after arrival, the patient was noted to be calm, alert and responding to verbal commands. Oxygen saturation was 96% and breath sounds were clear to auscultation and equal bilaterally. The trachea was extubated uneventfully with no significant change in vital signs. She maintained a stable respiratory pattern with no coughing. The patient was discharged home four hours later without complications.

Discussion

Anesthesia professionals are acutely aware of negative pressure pulmonary edema which is described in the literature as Type 1 (POPE 1), while the less commonly known post-surgical relief pulmonary edema is known as Type 2 (POPE 2). Presenting signs and symptoms for both are the same: pink frothy sputum, tachypnea, tachycardia, rales, oxygen desaturation, and possibly alveolar infiltrates appearing as “whited out” areas on a chest radiograph. POPE 1 occurs from 60 minutes after the obstructive event up to six hours later. POPE 2 develops soon after the relief of a chronic airway obstruction and can occur with tracheal intubation as well as surgical intervention. One report describes a 5 year old, healthy female admitted for T&A to treat chronic airway obstruction that developed acute pulmonary edema immediately following intubation and preceding the start of surgery. Surgery was cancelled and the patient transferred to pediatric intensive care for mechanical ventilation and treatment.
The pathophysiology of POPE 2 is associated with changes in respiratory mechanics caused by a chronic airway obstruction. Chronic obstruction creates a “compensated” state where inspiratory and expiratory pressures are elevated; this is termed “intrinsic positive-end-expiratory-pressure (PEEP).” Higher negative intrathoracic pressure on inspiration increases venous return and ultimately, pulmonary blood volume.

This is counterbalanced by higher expiratory pressure. This induces positive pleural and alveolar pressures that subsequently decrease the pulmonary blood volume. This is termed the “expiratory grunt mechanism.” With relief of the airway obstruction, the “grunt” is removed and intrathoracic pressures suddenly drop, followed by an abrupt increase in venous return. The consequence of increased venous return and pulmonary blood volume is increased hydrostatic pressure, which leads to pulmonary edema as transudation of fluid occurs from capillaries to alveoli.

The goals of anesthetic management for patients undergoing T&A for chronic airway obstruction are early recognition and prompt treatment of POPE 2. The clinical picture of POPE 2 can be mistaken for other postoperative respiratory problems. A helpful, though not necessarily preventive measure is careful management of fluid balance during the intraoperative period to avoid over-hydration. If signs and symptoms of POPE 2 develop shortly after relief of a chronic obstruction, treatment includes oxygen, ventilatory support, and possibly diuretics. Positive pressure ventilation is provided in the form of continuous positive airway pressure or mechanical ventilation with PEEP, whichever accomplishes adequate oxygenation. Careful assessment of airway patency is vital if the trachea has been extubated; re-intubation may be necessary. With prompt treatment, POPE 2 is generally resolved without complications.

The patient in this report was closely monitored for symptoms of pulmonary edema after intubation and again at the conclusion of surgery with no development of untoward effects. Anesthetic timing and interventions were directed at providing a smooth emergence and a safe extubation. T&A surgery is commonly performed on adults and children for chronic airway obstruction and the incidence of POPE 2 is difficult to ascertain. Studies of pediatric patients undergoing T&A have shown an incidence ranging from 9.4 to 44%. The frequency at which this procedure is performed dictates a need for anesthesia professionals to be prepared to identify and respond to POPE 2. Awareness facilitates prompt recognition and treatment.

References


Keywords: transurethral resection, prostate, hyponatremia, anesthesia

Transurethral resection of the prostate (TURP) is the most effective endoscopic surgical procedure for treatment of benign prostatic hyperplasia (BPH) and is performed approximately 100,000 times a year. BPH is the most common benign tumor in men. The prostate is positioned such that hypertrophy of the gland can compress the urethra and cause urinary retention. BPH is responsible for the majority of urinary symptoms in men over the age of 50 and results in the need for prostatectomy in approximately one-third of all men who live to age 80.

Case Report

A 64 year-old male, ASA class II, height 180 cm, weighing 66.5 kilograms, presented for a TURP. The patient’s past medical history revealed a history of BPH and urinary retention despite medical treatment. The patient reported taking dutasteride and tamsulosin for treatment of BPH with no allergies to medications. Lab work revealed hemoglobin 14.3 g/dL, hematocrit 43.0% and sodium 141 mEq/L. Surgical history included cystoscopy and bladder biopsy two months prior. The patient arrived from the pre-operative holding area with a 20 g IV in the right hand with lactated Ringer’s infusing. Standard monitors were applied in the operating room. Baseline vital signs were blood pressure 120/49 mmHg, pulse 68 bpm, temperature 35.7°C and room air oxygen saturation of 100%. After 5 minutes of preoxygenation with 100% O2, the patient was induced with fentanyl 100 mcg, lidocaine 40 mg, propofol 150 mg and rocuronium 40 mg intravenously (IV). Atraumatic endotracheal intubation was successful on the first attempt. Endotracheal tube placement was confirmed by chest rise and fall, the presence of CO2 waveform and auscultation of breath sounds bilaterally. A warming blanket was applied at 43°C. Mechanical ventilation was initiated with tidal volume 550 ml and rate of 8 per minute. Peak inspiratory pressures ranged from 16 to 22 mmHg. Anesthesia was maintained with > 1 MAC sevoflurane and oxygen delivered at 2 L/min. Pulse oximetry remained at 100%.

During the procedure the surgeon complained of continued blood loss and a large prostate weighing approximately 50 Gm. Blood loss was immeasurable due to the use of a floor drain for blood and irrigation evacuation. Approximately 2 hours following induction the circulating nurse reported the patient experiencing palpitations and warm, flushed skin. Baseline vital signs were blood pressure 135/70 mmHg, pulse 100 bpm, temperature 35.8°C and room air oxygen saturation of 99%. 

Hyponatremia Associated with Transurethral Resection of the Prostate (TURP)
Brandi L Lane, B.S.N.
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Mentor: Nelson L. Strother, CRNA, BS
that 3-liter bags number 13 and 14 of glycine had been brought into the room. Temperature was 33.0° C. Blood was drawn and sent to the lab for a sodium level. Lab results revealed a sodium level of 104 mEq/L. An 18g intravenous catheter was initiated in the left forearm and additional blood was drawn and sent for hemoglobin, hematocrit and a repeat sodium level. Lab results were hemoglobin 10.7 mg/dL, hematocrit 33.1% and hyponatremia was confirmed with a sodium level of 106 mEq/L. Furosemide 80 mg IV was given. Lactated Ringer’s was discontinued and 3% NaCl was initiated at 106 ml/hr in the operating room. The surgery was completed; midazolam 2.5 mg and rocuronium 30 mg IV were given. The patient remained intubated and was transported to the post anesthesia care unit (PACU) with ambu bag and 100% supplemental oxygen. The patient was placed on a ventilator with set tidal volume 600 ml, rate 8 per minute, and 50% FiO2. Post anesthesia care unit (PACU) temperature was 34.1° C. A full body bear hugger was applied and 3% NaCl was placed on a pump at 105 mL/hr. Three hours postoperatively the sodium level was 112 mEq/L and urine output was greater than 2 liters. 3% NaCl was discontinued and furosemide 40 mg IV was administered and the patient was extubated. Neurological assessment revealed a patient that was awake, alert and oriented x 3 following extubation. The patient was admitted to the intensive care unit (ICU) for further 3% NaCl and observation. Six hours postoperatively the patient received 200 mL of 3% NaCl and furosemide 40 mg IV. 10 hours post operative the sodium level was 118. The 3% NaCl was discontinued and furosemide 40 mg IV was administered. The sodium level 22 hours post operatively was 126 mEq/L. The patient was transferred to the urology unit for additional labs where he made a full recovery.

**Discussion**

Hyponatremia during TURP is common with serum sodium concentration decreases of 6 to 54 mEq/L having an incidence ranging from 7% to 26%.

Hyponatremia during TURP occurs due to the absorption of hypotonic irrigation solution. Absorption happens as surgical resection opens the prostatic venous plexus allowing irrigation fluid to be absorbed into the systemic circulation or it is absorbed from the retroperitoneal space. The amount of fluid that is absorbed depends on the length of the surgical resection time, the height of the irrigation bag above the patient, the vascularity of the prostate and amount of irrigation fluid used. It has been estimated that 10 to 30 mL of fluid is absorbed per minute of resection time. Gravenstein recommends limiting the height of the irrigation bag to 40 cm above the prostate to minimize the absorption of irrigation fluid.

Some anesthesia professionals believe that regional anesthesia is advantageous for patients undergoing TURP to allow assessment of mental status as an indicator of early sodium changes. Patients undergoing general anesthesia are unable to show the central nervous system (CNS) signs of hyponatremia such as confusion, nausea and convulsions. After a risk and benefit discussion of general versus regional anesthesia the patient in this case decided on general anesthesia for this procedure. In this case regional anesthesia may have revealed early CNS changes prompting an assessment of serum sodium.

It has been proposed that hypoosmolarity, not hyponatremia is the primary physiological cause of CNS dysfunction associated with TURP. The blood-brain barrier is not
permeable to sodium, but is freely permeable to water. Studies on hippocampal slices in rats have revealed that neurons with low sodium concentrations and normal osmolality have normal neuronal excitability. Regardless of the physiological cause of symptoms; treatment goals are to normalize the serum sodium and osmolality. Management includes the use of diuretics to decrease the fluid volume, fluid restriction and initiation of 3% NaCl for rapid correction of hyponatremia. Care must be taken to prevent central pontine myelinolysis (CPM), which results from rapid correction of hyponatremia leading to brain dehydration and separation of the myelin sheath from axons in the brain. In symptomatic patients it is recommend to correct hyponatremia at a rate of 1.5-2.0 mEq/L per hour for 3 to 4 hours or for the duration of symptoms, but not to exceed 8-10 mEq/L in the first 24 hours. Asymptomatic patients should be corrected at a rate of less than 0.5 mEq/L per hour not to exceed 8-10 mEq/L in the first 24 hours. Treatment is also aimed at controlling seizure activity with benzodiazepines. In this case administration of diuretics and 3% saline were initiated to normalize serum sodium and midazolam was chosen for sedation to raise the threshold for seizure activity. The patient in this case was at high risk for altered mental status and seizure activity, leading to the decision to keep the patient sedated, intubated and on a ventilator to correct serum sodium prior to extubation.

Hyponatremia is a rare but life threatening complication of TURP that requires a high index of suspicion, early recognition and prompt treatment. Treatment should be initiated quickly whether it is hypertonic saline or diuresis. Anesthesia practitioners must be aware of the high-risk situation and be vigilant about observing the patient for signs and symptoms of hyponatremia.

References


Mentor: Kristy Beaver, CRNA, MSN
General Anesthesia in a Patient with History of Acute Intermittent Porphyria
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Keywords: anesthesia, porphyria, stress, trigger

Acute intermittent porphyria is a rare inborn error of metabolism that can be life threatening. Acute intermittent porphyria occurs in about 1 in 10,000 in the general population. Acute intermittent porphyria produces serious symptoms such as systemic hypertension and renal dysfunction. Hypertension and renal failure are the most common causes of death in the patient with porphyria. There is a possibility of triggering an attack of acute intermittent porphyria, with the use of enzyme-inducing drugs that are often used in anesthesia. Therefore, it is essential to select drugs that are safe for use in the presence of acute porphyria. The following case report discusses the care of a patient with acute intermittent porphyria undergoing an anterior and posterior lumbar fusion.

Case Report

A 52 year old, 61 inch tall, 92 kg, male presented for an anterior and posterior L4-5, L5-S1 spinal fusion. He had a history significant for acute intermittent porphyria with acute episodes in 1998 and 2005. Although the triggering events for the acute episodes were unknown he had had previous surgery with no complications. He had an allergy to cefadroxil which included generalized swelling and throat closure. Preoperative vital signs were blood pressure 119/72 mmHg, heart rate 70 bpm, respirations 18, oxygen saturation 96%, and temperature 98.6°F. His bilateral breath sounds were clear. He had had previous posterior lumbar surgery with no anesthesia complications. The anesthesia airway evaluation revealed a Mallampati Class II airway with normal, 3 finger- breadth mouth opening, atlanto-occipital range of motion, and a thyromental distance of greater than three finger- breadths.

He was given midazolam 2 mg IV and taken to the operating room. In the operating room, he was given additional midazolam 1 mg and fentanyl 200 mcg in 100 mcg doses IV. He was preoxygenated with 100% oxygen by face mask and standard monitors were applied. Rocuronium 5 mg IV was given for defasciculation. General anesthesia was induced with lidocaine 80 mg and propofol 150 mg IV. Mask ventilation was confirmed and succinylcholine 140 mg IV was given followed by an atraumatic endotracheal intubation with an 8.0 mmID endotracheal tube under direct laryngoscopy. A right radial arterial line and additional 14 gauge peripheral IV were then started.

General anesthesia was maintained with one liter per minute (L/m) oxygen, 1 L/m air, and 1% isoflurane. Neuromuscular blockade was maintained throughout the procedure using vecuronium. Bispectral index monitoring was used with readings between 37 and 55 during the procedure. The patient received an additional 200 mcg fentanyl in 100 mcg doses prior to incision. After incision the heart rate increased to 90 bpm and blood pressure rose to 160/90 mmHg. Additional doses of fentanyl were administered during the procedure to a total of 2250 mcg. His heart rate was maintained at approximately 70 bpm and blood pressure in the 100-120/50-70 mmHg range. Urine output was monitored continuously.
via Foley catheter with the urine remaining clear yellow and the minimum hourly output being 0.86 ml/kg.

At the end of the procedure muscle relaxation was antagonized with neostigmine and glycopyrrolate and the trachea was extubated. Upon extubation, the patient’s heart rate was approximately 90 bpm and his blood pressure was 140/80 mmHg. He was given 10 mg of morphine in 2 mg increments. The heart rate and blood pressure remained elevated, and he was given a total dose of esmolol 30 mg followed by labetalol 10 mg. His heart rate decreased into the 70’s and blood pressure to 140/80 mmHg. He was then taken to the recovery room and was subsequently discharged to home on postoperative day six.

Discussion

Porphyria usually remains subclinical until an endogenous or exogenous stress triggers a porphyria crisis.\textsuperscript{2} Surgery is a stressful event that can trigger a porphyria crisis. The degree of stress associated with surgery is associated with the amount of painful stimuli imposed during the procedure such that a larger, more painful surgery generates/induces a greater stress response than a smaller minor surgery. Fentanyl was used throughout this procedure in order control pain and reduce the stress response which could have triggered a porphyria crisis. Additionally, some medications used in the practice of anesthesia such as barbiturates, etomidate, and glucocorticoids can trigger an attack. If a triggering agent is administered, and an attack occurs, the mortality rate is 10-40%.\textsuperscript{4} The anesthetic plan for this patient was developed with the goal of preventing an attack by avoidance of triggering medications.

In order to avoid triggering an acute attack, the plan was developed using recommendations for use of drugs in the presence of acute porphyrrias reported by Stoelting.\textsuperscript{1} Fentanyl, lidocaine, propofol, and succinylcholine are all listed as safe drugs to administer to a patient with acute porphyria. Midazolam, rocuronium, isoflurane, and vecuronium are all listed as probably safe and unlikely to provoke acute porphyria.

The two leading signs and symptoms of an acute attack of porphyria are abdominal pain and dark urine. This patient, having been under general anesthesia, was unable to indicate the presence of abdominal pain. After emergence, if he had an attack, it would have been difficult to differentiate this from incisional pain due to the anterior approach used for the lumbar fusion. This patient's urine flow remained greater than 0.5 ml/kg throughout the case and was clear yellow. Additional signs and symptoms of an acute attack of porphyria include vomiting, anxiety, confusion, autonomic instability manifested by hypertension and tachycardia, dehydration and electrolyte disturbances such as hyponatremia, hypokalemia, and hypocalcemia.\textsuperscript{5} This patient’s sodium, potassium, and calcium were checked twice during the course of the surgery with normal values maintained throughout.

If this patient had developed an acute episode of porphyria there are several important steps involved in treating a crisis. First, any known porphyria triggers must be removed. Second, symptoms such as tachycardia, hypertension and electrolyte imbalances must be treated, adequate hydration must also be maintained. It is important to note that if seizures occur they must be treated with benzodiazepines as other anticonvulsants are unsafe to use with porphyria.
ia. Last, in an effort to suppress ALA synthetase activity hematin 3 to 4 mg/kg IV over 20 minutes can be administered.

This case report illustrates the importance of a thorough preoperative evaluation. Knowing that this patient had a history of acute intermittent porphyria, it was possible to develop an individual anesthetic plan to safely perform anesthesia without triggering an acute attack. If this patient needs additional surgery in the future, anesthesia can be safely administered if the anesthesia practitioner is informed of the history of porphyria during the preoperative evaluation and an appropriate anesthesia plan is then followed.

References

Mentor: Nancy Bruton-Maree, CRNA, MS

Uterine Rupture in the Unscarred Uterus
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Keywords: anesthesia, uterus, rupture, pregnancy, complication

Severe postpartum hemorrhage remains a leading cause of maternal morbidity and mortality. Uterine rupture reportedly occurs in 1 in 2500 to 5000 deliveries. The leading cause of uterine rupture is a previous uterine scar. The incidence of uterine rupture in a previously unscarred uterus is 1 in 15,000 to 20,000. High parity, induction of labor, and augmentation of uterine contractions with oxytocin increase the risk of spontaneous uterine rupture in the unscarred uterus. A large amount of blood is lost very quickly following uterine rupture. The patient is at increased risk for many complications including hemorrhagic shock and myocardial ischemia.

Case Report
A 31 year old female (graviga 7, para 7) presented to the operating room for emergency laparotomy and possible hysterectomy. The patient had just vaginally delivered her seventh child complicated by an estimated blood loss of 1500-2000 mL. The bleeding was refractory to repeated doses of hemabate, methergine, pitocin, and misoprostol. The patient had no known drug allergies. Her medical history was significant for anemia; hemoglobin was 8.2 g/dL on admission. All pervious deliveries had been uncomplicated vaginal births and
there was no history of uterine surgery. The repeat hemoglobin reported on arrival to the operating room was 1.7 g/dL, which was repeated to confirm.

The patient was awake and oriented on arrival to the operating room. Heart rate was 85 bpm and blood pressure was 110/60. The patient had two well functioning 18 g peripheral IV’s for intravenous access. The second unit of PRBC’s was infusing. A rapid sequence induction with succinylcholine 100 mg, propofol 150 mg, and cricoid pressure was performed. A 7.0 ETT was placed under direct laryngoscopy to secure the airway and allow for mechanical ventilation. The patient tolerated induction remaining hemodynamically stable. Anesthesia was maintained with 6% desflurane, vecuronium and fentanyl. Six units of platelets were infused immediately following induction and additional blood products were ordered. A Baer Hugger® and fluid warmer were used to maintain normothermia.

Visualization of the uterus revealed rupture with possible dissection of the bladder cuff. Urology was consulted to evaluate bladder integrity. The patient had an indwelling Foley catheter and at this time was anuric, further evaluation was needed to determine if the cause was bladder injury or hypovolemia.

Vital signs remained stable. Ephedrine and phenylephrine were administered to maintain a systolic blood pressure greater than 100 mm Hg while maintaining a heart rate of 60-100. A third and forth unit of PRBC’s and two units of FFP were administered. A 20 g left radial arterial line was inserted for closer blood pressure measurement and blood gas analysis. After the fourth unit of PRBC’s the repeated hemoglobin was 6.8 g/dL with a hematocrit of 22%.

Urology found the bladder to be unharmed. After completion of a supracervical hysterectomy, hemostasis was achieved and surgical closure initiated. The total blood loss including the preoperative hemorrhage was estimated to be four liters. A total of six units of PRBC’s, four units of FFP, two six packs of platelets, 250 ml of 5% albumin, and three liters of crystalloid were administered. The final intraoperative hemoglobin was 9.0 g/dL. The patient was taken to the surgical intensive care unit chemically paralyzed and mechanically ventilated. A Propofol infusion was initiated to maintain sedation and allow for continuation of mechanical ventilation. The patient was evaluated for disseminated intravascular coagulation which was ruled out.

**Discussion**

On arrival in the surgical suite, the patient was awake and oriented and did not show signs of myocardial ischemia that would have been expected with a hemoglobin of 1.7 g/dL. Patients with such dramatic blood loss, even without cardiac disease, are at risk for myocardial ischemia. Hemorrhagic shock may also lead to circulatory collapse. Fortunately transfusion was initiated quickly and this did not occur. Careful management of hemodynamics are imperative to the outcomes associated with hemorrhage. Karpati et al. found that parturients experiencing postpartum hemorrhage, high heart rate, low blood pressure, and low hemoglobin were the greatest indicators of myocardial ischemia. Recognition of these findings is important because parturients are often healthy and not considered to have cardiac risk factors. Close attention to EKG changes, replacement of blood loss, and maintaining hemodynamics can improve patient outcomes.

The patient’s high parity placed her at
greater risk of uterine rupture. In a review of 5800 parturients, parity of seven and greater increased the incidence of uterine rupture to twenty times that of lower parity women.\textsuperscript{2,4} Oxytocin even at low doses should be used very cautiously in the augmentation of labor in women of high parity, historically its use has been associated with uterine rupture.\textsuperscript{4} Rupture of the unscarred uterus is associated with a higher morbidity and mortality of the mother and child than in rupture of a scarred uterus.\textsuperscript{2} In this case, fortunately, both the mother and child were treated and discharged without any further complications.

The patient delivered vaginally with an epidural for labor analgesia. Diagnosis of uterine rupture may be delayed because of the absence of pain or because pain is associated with a patchy epidural. Extreme and sudden decelerations in fetal heart rate are the most indicative sign of uterine rupture.\textsuperscript{4} Absence of fetal heart rate associated with the sudden onset of severe abdominal pain and excessive vaginal bleeding with cessation of uterine contractions are also common presentations of uterine rupture.\textsuperscript{4} The completion of vaginal delivery before the onset of bleeding coupled with no history of uterine surgery were deceptive. Diagnosis was not made until the uterus was visualized.

Maternal mortality associated with uterine rupture is often accompanied by hemorrhagic or septic shock, disseminated intravascular coagulation, renal failure, and pulmonary embolism.\textsuperscript{4} Fortunately, early surgical intervention and transfusion maintained hemodynamics, coagulation, and resulted in a positive outcome. Consideration should be given to the risk factor associated with high parity women receiving oxytocin to augment uterine contractions and the increased incidence of uterine rupture.\textsuperscript{2} Breakthrough pain may be masked or lessened by analgesic medications administered during labor. An inadequate epidural block may also be blamed for the occurrence of abdominal pain associated with uterine rupture.\textsuperscript{4} Therefore the anesthetist must be vigilant to changes in the mother and fetus during the labor and delivery.

**References**


**Mentor:** Russ Lynn, MSN, CRNA
Use of An Elastic Gum Bougie During Silicone Stent Retrieval
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**Keywords:** anesthesia, bougie, tracheomalacia, larynx, damage

Prolonged mechanical ventilation can be complicated by laryngeal damage. Although most injuries heal spontaneously, tracheomalacia (TM) is one of the potential long term complications.\(^1\) Tracheomalacia refers to softening of the tracheal cartilage resulting in weakness of the tracheal wall and premature airway closure during expiration; it can be classified as primary (congenital), or secondary (acquired). Secondary TM is most often a complication of prolonged intubation, tracheostomy, chronic infection, or chronic inflammation. Symptoms include chronic cough, sputum production, and hemoptysis. Diagnosis is often delayed because it is difficult to distinguish symptoms of TM from those of emphysema, chronic bronchitis, cigarette smoking, and/or asthma.\(^2\)

**Case Report**

A 44 year old female, 68” tall and 93 kg, presented for removal of a tracheal stent via rigid bronchoscopy. Significant medical history included a previous gunshot wound to the abdomen, chronic renal failure with hemodialysis, hypertension, and tracheomalacia. Prior surgical history included tubal ligation, laparotomy, splenectomy, tracheostomy and tracheal silicone stent placement. Her current medications were acetylcysteine and amoxicillin. Her preoperative vital signs were: blood pressure 188/87 mmHg; pulse 85 beats per minute; respiratory rate 22 breaths per minute; and temperature 36.5° C. Laboratory values were: hemoglobin 11.6 gm/dl; hematocrit 35%; platelet count 245,000; PT 11.2 seconds; PTT 29 seconds; serum potassium 4.4 mEq/L; blood urea nitrogen 53 mg/dl; and serum creatinine 3.3 mg/dl. She received hemodialysis the day before surgery. Pre-anesthetic physical evaluation of the patient was within normal limits except for a chronic moist cough with no dyspnea noted. Airway assessment was within normal limits and revealed a Mallampati II classification. She had no range of motion limitations.

She was placed in the supine position on the OR table. Standard monitors were applied and activated. Oxygen was administered at 100% via facemask. A remifentanil infusion was initiated at 0.1 \(\mu\)cg/kg/minute and propofol infused at 75 \(\mu\)cg/kg/minute to a level of sedation sufficient to allow airway instrumentation. Respiration was supported with positive pressure mask ventilation, as needed to maintain oxygen saturation greater than 90%. The OR table was turned 90° to the surgical field. A nasal cannula was placed to entrain oxygen during bronchoscopy. Remifentanil was titrated up to a maximum of 0.3 \(\mu\)cg/kg/minute, and the propofol was titrated up to 180 \(\mu\)cg/kg/min. Sevoflurane was added for a short period to provide additional anesthesia. The surgeon made multiple attempts to instrument the trachea with the rigid bronchoscope without success.

The surgeon asked to have a laryngeal mask airway (LMA) placed to serve as a conduit for a flexible bronchoscope. However, the standard size bronchoscope would not fit through the LMA. Direct
laryngoscopy was then used to place a gum elastic bougie which facilitated instrumentation of the trachea with the rigid bronchoscope. The stent was easily retrieved and the bronchoscope was removed.

Anesthetics were discontinued and an LMA was placed to maintain adequate ventilation until the patient was spontaneously breathing and fully awake. The LMA was removed and oxygen was delivered by nasal cannula for transport to the post anesthesia care unit (PACU). Upon arrival to the PACU, the patient was given 30% oxygen via mist mask. She exhibited signs of airway irritation and was treated with a lidocaine and albuterol nebulizer treatment and given intravenous fentanyl for airway irritation. She was also given ondansetron for nausea and hydralazine for hypertension. The patient’s recovery included lidocaine nebulizer treatments at night, saline nebulizers during the day, also steroids and antibiotics for 72 hours. She encountered no episodes of respiratory distress or desaturation postoperatively and was discharged from the hospital four days later.

Discussion

A gum elastic bougie, also called an Eschman stylet or a Sun Med bougie, is a tool that is helpful when encountering a difficult airway. A gum elastic bougie is a long flexible stylet, over which an endotracheal tube can be threaded. The bougie’s effectiveness is related to its’ angled tip, which can be advanced blindly past the oropharynx and into the trachea. As the bougie’s angled tip passes through the rima glottis, the tip will “bump” along the tracheal rings as an additional clue to proper placement. Tracheomalacia treatment is directed to supportive techniques initially. Patients with premature large airway (tracheal) closure may benefit from stent placement. Stents support the airway wall against collapse or external compression. Silicone stents are most favored because of their ease of deployment and removal. A rigid bronchoscope is necessary to place and remove silicone stents. The rigid bronchoscope is used to instrument the airway by lifting the epiglottis and advancing the bronchoscope through the vocal cords. Stent removal is indicated when there is a complication such as stent migration, chronic infection, marked tissue hyperplasia, or when no longer needed.

Tracheomalacia is not usually associated with a ‘difficult airway’ or problems in intubating. In addition, this patient did not present with any common conditions predictive of a difficult airway, such as: thyromental distance of less than 7 cm, sternomental distance less than 12.5 cm, facial deformity, limited neck extension, or a class III or IV Mallampati score. In this case, the gum elastic bougie was a practical alternative in the management of an unanticipated difficult airway instrumentation with a rigid bronchoscope. The gum elastic bougie has a reputation for being a useful and efficient aid in managing an anticipated or unanticipated difficult airway. A gum elastic bougie is listed in the ASA Practice Guidelines for the Management of the Difficult Airway as a useful strategy to improve intubation success and diminish airway-related adverse outcomes. It can also be used in reverse order, as described by Nekhendzy & Simmons, as an exchange device from a bronchoscope to an endotracheal tube. Anesthesia professionals could better serve their patients if they are aware of the usefulness of the gum elastic bougie for individuals in whom airway instrumentation is difficult.
References


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Pediatric Awake Craniotomy for Pallidal Deep Brain Stimulator (DBS) Placement

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Keywords: anesthesia, pediatric, craniotomy, awake, brain stimulator

Dystonia produces slow, twisting, involuntary muscle movements, affecting both passive and active muscle groups. The pathophysiology is not well understood and may arise from multiple cerebral structures including the basal ganglia, cerebellum, thalamus, and cortex.\(^1,2\) Treatment options have included biofeedback, application of restrictive braces, injection of acetylcholine receptor inhibitors such as botulinum toxin type A, or administration of anticholinergic agents such as trihexyphenidyl. Surgical intervention involving selective denervation or thalamotomy has also been utilized. Placement of deep brain stimulators for treatment of dystonia remains under investigation, with approximately 50 implantations completed by 2002.\(^3\)

Case Report

A 127cm, 41kg 10 year old female presented for elective placement of a deep brain stimulator. The procedure was scheduled to treat increasing manifestations of dystonia,
specifically dysarthria, balance and gait problems, and dystonic movements of her extremities. The patient demonstrated significant mobility issues and related being held back a year at her public school secondary to difficulties with writing. No congenital abnormalities were noted and her disorder was not elucidated until several years after birth.

Preoperative examination revealed involuntary muscular contraction of both upper extremities. The patient’s vital signs and laboratory studies were within normal parameters, and a type and screen was ordered prior to arrival in the OR. Airway evaluation revealed a Mallampati class II airway, with full cervical range of motion. Mouth opening was approximately 4cm. Her only medical history was of familial hypercholesterolemia, which was well controlled with simvastatin 10 mg daily. She had no previous surgical history and known allergies.

The parents consented for anesthesia following a significant risk/benefit discussion and formulation of an anesthetic plan. A 20G peripheral IV was inserted and 0.9% NS infusion was started in the MRI suite. Standard ASA monitors were placed and O2 via nasal cannula was started at 3L/min. Fentanyl 25 mcg and propofol 30 mg IV were administered for sedation along with local anesthetic to headpin sites during the placement of a stereotactic head frame. An MRI study was performed and the patient was transported to the operating room fully awake.

In the operating room the patient was placed in a sitting position and a transthoracic Doppler was employed for additional safety during the procedure. O2 remained at 3L/min via nasal cannula. Intraoperative deep brain neurological monitoring required isolation of all electrical circuitry and the standard anesthesia monitors were determined to cause significant electrical interference, therefore a transport monitor was used to document patient vital signs.

A dexmedetomidine infusion was initiated and a loading dose of 0.5mcg/kg IV was infused over one hour. Subsequently it was decreased to 0.2mcg/kg per hour and utilized to maintain sedation throughout the surgical procedure. Bupivacaine 0.25% was infiltrated in the incisional area and an additional 50mg of propofol was administered during creation of the bone flap. The patient remained conscious but sedated throughout the procedure, and retained the ability to follow verbal commands and complete tasks as requested. The patient’s vital signs were stable throughout the procedure. Following successful mapping and placement of DBS leads the craniotomy was closed. Bupivacaine local anesthetic infiltration provided additional anesthesia for the flap and skin incision closure. The dexmedetomidine infusion was terminated, and the patient was transported to the PICU for postoperative care. The procedure lasted 4 hours and 20 minutes. EBL was 200 ml with approximately 1300 ml of crystalloid administered throughout the procedure. Postoperative recovery was uneventful.

Discussion

Deep brain stimulator implantation is a relatively new treatment for dystonia which requires an awake patient to perform selected tasks throughout the pallidal mapping procedure. Use of neurological monitoring in combination with operative stereotaxis minimizes damage to normal brain tissue while identifying target structures. Significant risks include intraoperative intracerebral hemorrhage in 1-3% of cases, and postoperative infection in approximately 4-5% of patients.4
Issues regarding pain, patient cooperation, and potential airway obstruction present major impediments to awake craniotomy procedures. In adults a range of anesthetic techniques usually combining an opioid, droperidol, or propofol, have been utilized with various rates of success. Few literature references specifically address the anesthetic requirements and approaches to an awake craniotomy in the pediatric population. Anticipated complications may include pain, vomiting, airway obstruction, respiratory depression and hemodynamic instability.

Developing a safe and effective anesthesia plan for a pediatric awake craniotomy presents a significant challenge for the CRNA. Requirements for analgesia, anxiolysis, and sedation must be addressed, yet leave the patient able to perform crucial neurological testing. Adequate protection of airway reflexes must be preserved, and depression of ventilation must be avoided. In addition, the patient must be able to tolerate 4-5 hours of an awake procedure.

Patient selection is critical to the success of planned anesthesia care for pediatric awake craniotomy patients. Preoperative patient assessment is of vital importance, and a frank discussion with both the parents and child regarding the entire operative process is essential. All phases should be discussed, emphasizing the need to cooperate, understand, and follow instructions. Distractions and diversions, such as a selection of the patient’s favorite books or videos, should be explored at this time and prepared before arrival on the day of surgery. A patient representative from the hospital’s Child Services Department met with the child on a preoperative visit, then stayed with the child intraoperatively and read several stories as a diversion during the long procedure. Additionally, several back-up anesthesia plans that afford awake neurological monitoring should be formulated should the patient not tolerate the selected primary mode of anesthesia.

Dexmedetomidine is a highly selective adrenoceptor agonist which reliably produces analgesic, sedative, and anesthetic-sparing effects. It does not directly suppress ventilation, although it may produce obstruction subsequent to relaxation of pharyngeal muscles. Dexmedetomidine’s primary action is a CNS mediated reduction of sympathetic tone. Inhibited release of norepinephrine directly attenuates excitation within the central nervous system, which may in turn produce both hypotension and bradycardia. However, both receptors remain unaffected and are able to be activated to treat these side effects as required.

Dexmedetomidine was selected as the primary anesthetic for this procedure as it provided the essential elements of analgesia and sedation, with minimal potential for side effects. Its lack of respiratory depression offered a distinct advantage in dealing with a pediatric patient. Additionally, its unique pharmacological profile allowed titration of a delicate balance between sedation and wakefulness that could be rapidly adjusted as needed. Dexmedetomidine has been shown to produce a sleepy, comfortable patient that arouses easily to a “calm and alert” state. Stimulating portions of the procedure required administration of propofol, a field block by the surgeon, and fentanyl was on hand should additional narcotic coverage be required. Additional airway monitoring was required as additional sedation was administered. Propofol was immediately available, and a #3 LMA was prepared should the urgent need to convert to a general anesthetic arise.
Augmentation of the dexmedetomidine with an opioid infusion was considered, however concern was expressed regarding a potential decrease in patient responsiveness secondary to fentanyl or remifentanil administration. A remifentanil/propofol infusion technique, with its quick metabolism and rapid reawakening, was selected as a back-up anesthetic agent should the dexmedetomidine infusion not be tolerated.

Dexmedetomidine provides an excellent choice for patient sedation, individually or in combination with a remifentanil infusion. Further experience with dexmedetomidine in pediatric awake craniotomy patients is needed to gain additional data, knowledge, and familiarity with the drug’s utilization and individual’s response.

References


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Unanticipated Difficult Intubation
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Keywords: anesthesia, difficult intubation, difficult airway, unanticipated

Unanticipated difficult intubations are a source of significant morbidity and mortality in anesthesia. The incidence of a difficult intubation is 1%-18%, whereas, the incidence of cannot ventilate and cannot intubate is estimated to occur 0.0001%-0.02%. Difficult intubation is defined by the American Society of Anesthesiologists as when “proper insertion of the endotracheal tube by an individual skilled in airway management with conventional laryngoscopy requires more than three attempts, or more than ten minutes.” This case report evaluates an unanticipated difficult intubation and implementation of the difficult air-
way algorithm to establish endotracheal intubation.

Case Report

A 59 year-old female, ASA II, 5 feet tall and weighing 65 kg presented for elective total abdominal hysterectomy. Medical history was insignificant. The patient took no prescription medication and all preoperative labs were within normal limits. Electrocardiogram revealed normal sinus rhythm. On preoperative examination, the patient was a Mallampati class II with good dentition and adequate neck flexion and extension. An 18 gauge peripheral intravenous catheter was placed and midazolam was administered.

In the operating room, standard monitors were placed on the patient. The patient was denitrogenated with 100% oxygen. Upon induction, lidocaine 100 mg, propofol 150 mg, fentanyl 100 mcg, and rocuronium 7 mg were administered intravenously. Mask ventilation was easy with a 9 cm oral airway in place. Direct laryngoscopy (DL) was performed with a Miller 2 blade by the student registered nurse anesthetist (SRNA). A grade 2 airway was visualized and a 7.0 mmID oral endotracheal tube (ETT) was attempted to be placed without success. The patient was then mask ventilated with 100% oxygen and 2% sevoflurane; the pulse oximeter remained 100%. A second DL was performed with the headrest removed, revealing a grade 1 view. The second attempt of ETT placement was also unsuccessful. The patient was again hand mask ventilated with 100% oxygen and 2% sevoflurane. A third and fourth attempt at DL by the CRNA was performed with a Macintosh 3 blade, both with unsuccessful placement of the ETT. The patient’s oxygen saturation dropped to 65%, now requiring two person mask ventilation. The patient’s pulse oximeter increased to >90% saturation, and a laryngeal mask airway (LMA) size 4 was inserted with ease and the difficult airway cart was called to the operating room.

Ventilation and general anesthesia were maintained with the LMA, 100% oxygen and 2% sevoflurane. Glycopyrrolate 0.2 mg was administered and the fiberoptic bronchoscope prepared. The LMA was removed and an asleep laryngeal fiberoptic bronchoscope intubation was attempted. Supraglottic edema was evident and the vocal cords were not visualized. Two person mask ventilation with a 9 cm oral airway resumed while a Fast-Trach LMA™ size 4 was prepared. The Fast-Trach LMA™ was inserted followed by successful intubation with a 6.0 mm Fast-Trach Endotracheal Tube™. Placement was verified with the fiberoptic bronchoscope, bilateral breaths sounds, and end tidal carbon dioxide. The remainder of the case was uneventful. General anesthesia was maintained with 1% isoflurane. A total of 350 mcg of fentanyl was administered, as well as rocuronium 12 mg; decadron 10 mg and kytril 0.1 mg. Neuromuscular blockade was reversed with neostigmine 4 mg and glycopyrrolate 0.6 mg at the end of the surgical procedure. The patient met standard extubation criteria and was extubated without incidence. On post operative day one the patient was examined. The patient reported a sore throat, but denied recall of the event. The patient was notified of being a difficult intubation and given a letter for future anesthesia reference.

Discussion

The unanticipated difficult intubation can be managed by understanding and application of the difficult airway algorithm. The unanticipated difficult airway can be of
great consequence as the anesthesia professional would not take the same conservative approach as compared to the obvious difficult airway. Through knowledge of the published practice guidelines on difficult airway management and preparation by practicing airway management techniques, the anesthesia professional is able to manage life threatening situations and the unanticipated difficult airway.

Prevention and preparation for difficult airway management has led to the development of ASA Practice Guidelines. The guidelines suggest a thorough airway examination preoperatively with consideration for the possibility for the patient to be difficult to ventilate, difficult to intubate, difficult with patient cooperation or consent, and a difficult tracheostomy. With consideration of preoperative examination findings, the anesthesia professional determines the appropriate approach to place an endotracheal tube choosing between: 1) awake intubation versus intubation after induction of general anesthesia, 2) use of noninvasive techniques for the initial approach to intubation versus the use of invasive techniques (surgical or percutaneous tracheostomy or cricothyrotomy) and 3) preservation of spontaneous ventilation during intubation attempts versus ablation of spontaneous ventilation during intubation attempts. The anesthesia professional further determines the preferred management on a case by case basis for the following situations: awake intubation, adequate ventilation but difficult intubation, and the life threatening situation in which you cannot ventilate or intubate. The ASA guidelines suggest having a portable storage unit specifically for difficult airway management that has: rigid laryngoscopy blades of various sizes with possibly a rigid fiberoptic laryngoscope, tracheal tubes of assorted sizes, tracheal tube guides including semirigid stylets, ventilating tube changer, light wands, and forceps, exhaled carbon dioxide detector, LMAs of assorted sizes, intubating LMAs, flexible fiberoptic intubation equipment, retrograde intubation equipment, a device suitable for an emergency noninvasive airway such as a Combitube (Kendall-Sheridan Catheter Corp., Argyle, NY) a hollow jet ventilation stylet, a transtracheal jet ventilator and equipment suitable for emergency invasive airway access (cricothyrotomy).

The difficult airway algorithm focuses on developing a primary and alternative strategy to managing the airway. After induction of general anesthesia and the initial intubation attempt is unsuccessful, it is pivotal to determine if face mask ventilation is adequate. If hand mask ventilation is adequate the non-emergent pathway of the algorithm is followed. At this point the anesthesia professional should consider: calling for help, returning to spontaneous ventilation, and awakening the patient. After instrumentation of an airway with rigid laryngoscopy during multiple attempts to manage an airway, supraglottic structures become edematous and visualization is further compromised by soft tissue edema, bleeding and saliva. Hand mask ventilation also becomes increasingly difficult. At this point when ventilation is inadequate and intubation attempts are unsuccessful, a life threatening emergency ensues. Call for help and attempt placement of a non-invasive emergency airway. If ventilation is inadequate with this approach, emergency invasive airway must be attempted.

Our case study followed the ASA guidelines on difficult airway management. After induction of general anesthesia, hand mask ventilation was established with an oral air-
way in place. After multiple unsuccessful intubation attempts utilizing traditional DL and fiberoptic bronchoscope, hand mask ventilation became increasingly difficult. The airway was established with the intubating Fast-Trach LMATM. Correct placement was verified with the fiberoptic bronchoscope, bilateral breath sounds and end tidal carbon dioxide.

References


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Acute Post-Operative Laryngospasm With Negative Pressure Pulmonary Edema

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Keywords: negative pressure pulmonary edema, acute laryngospasm, respiratory distress, inspiratory pressure, stridor, anesthesia

Acute laryngospasm is a known complication in anesthesia care. Although attributed to significant mortality if unrecognized, it can usually be resolved if treated quickly resulting in a good patient outcome. The following is a case report of negative pressure pulmonary edema in a healthy female following an acute laryngospasm that was quickly recognized and remedied.

Case Report

A 48-year-old woman was admitted to the hospital for same-day surgical repair of a left shoulder sub-acromian decompression via arthroscopy. A pre-operative assessment was significant for obesity (64”, 89 kg, Body Mass Index-BMI 33.7) and uterine fibroids. She was taking no prescription medications. An airway assessment revealed a Mallampati II, a thyromental distance of 3 finger breadths, intact teeth and full neck range of motion. A general anesthetic was determined to be most appropriate for this ASA II patient.

The patient was premedicated with midazolam 2 mg and glycopyrrolate 0.2 mg. After a routine intravenous induction with propofol 200 mg, vecuronium 10mg and fentanyl 150 mcg, direct laryngoscopy was performed and a 7.0 endotracheal tube (ETT) was inserted without difficulty. Positive
pressure ventilation was initiated at a rate of 10 breaths per minute (BPM) with tidal volumes of 650 ml. Sevoflurane was chosen as the inhalational anesthetic agent.

The arthroscopy proceeded uneventfully for the next 140 minutes. No further neuromuscular blockade was administered. An additional 200 mcg of fentanyl was given for a total of 350 mcg of fentanyl (4 mcg/kg). Total crystalloids were 1700 cc, estimated blood loss was <25 cc. Near the end of the case the anesthetic agent was turned off and the oxygen flow was increased to 8 L/min. A train-of-four was performed and the patient was noted to have four strong twitches. Neostigmine 4 mg and glycopyrrolate 0.6 mg were given to antagonize any residual neuromuscular blockade. The patient began breathing spontaneously however her respiratory rate was slow and with decreased tidal volumes. She was also slow to respond to commands. After approximately 15 minutes her respiratory rate increased to 12-14 breaths per minute with spontaneous tidal volumes 300-400 ml. She responded to voice command and was able to perform a sustained head lift for five seconds. Once these extubation criteria were met, the ETT was removed. The patient was given 4 L/min of supplemental oxygen via nasal cannula and transported to the Post Anesthesia Care Unit (PACU).

Immediately upon entering the PACU the patient was noted to be in respiratory distress with obvious stridor. An initial pulse oximetry reading was 78%, BPM 6, heart rate 58, blood pressure 102/52. The patient was obtunded and did not respond to repeated verbal commands. Anesthesia providers were immediately available and began to give positive pressure ventilations via bag-valve mask with 100% oxygen. A nasal pharyngeal airway was inserted and the oxygen saturation quickly rose to 99%. Naloxone (Narcan) 120 mcg was administered to antagonize any residual narcotic that may have been causing the patient’s unresponsiveness. A few minutes after the administration of naloxone the patient’s respiratory rate was 14 and she no longer required bag-valve mask assistance. A non-rebreathing mask with 15 L/min of oxygen was placed on the patient. Auscultation of lung sounds revealed wheezing in the upper bronchi. A nebulized albuterol breathing treatment was ordered along with a chest X-ray and an arterial blood gas. Cardiac enzymes were drawn and a bedside 12-lead ECG was preformed.

After the breathing treatment, the patient began to cough and expectorate small amounts of bloody, frothy sputum. Blood gas results were as follows: pH-7.33, \( \text{paCO}_2 \)-51, \( \text{paO}_2 \)-264, \( \text{HCO}_3^- \)-27.3, \( \text{O}_2 \text{Sat} \% \)-100, Base Excess (+1). Re-intubation was discussed, however, it was felt that the patient was responding to therapy and would not immediately require this. The bedside chest X-ray revealed diffuse patchy alveolar infiltrates consistent with flash pulmonary edema. A bedside 12-lead electrocardiogram (EKG) revealed no evidence of cardiac ischemia and cardiac enzymes were: creatine phosphokinase (CPK) -341, myoglobin (MB) -3.2 and troponin (TnT) I <0.1. A Foley catheter was inserted and furosemide 10 mg was administered. After several hours of observation in the PACU, the patient was much more alert and without signs of respiratory distress. Pulse oximetry was 97% on 8 L \( \text{O}_2 \) via face mask, BP 116/72, HR 98, BPM 20. Lungs sounds were noted to be coarse with faint expiratory wheeze. A total of 1600 cc of urine output had been recorded. The patient was admitted to the Intensive Care Unit (ICU) for further observation.
The patient’s progress was followed closely by the medical house staff as well as the anesthesia staff. A cardiologist was also consulted. On post operative day (POD) #1 the patient was without any signs or symptoms of respiratory distress and was transferred from the ICU to a medical/surgical unit. Serial cardiac enzymes and EKGs continued to reveal no evidence of a myocardial infarction. A chest X-ray on POD #2 showed no pulmonary edema and was greatly improved from the original PACU film. The patient’s room air oxygen saturation was now 99%; however a persistent non-productive cough was still noted. Lung sounds revealed some rhonchi and no wheezing. The patient was discharged with a diagnosis of acute laryngospasm, resulting in negative pressure pulmonary edema (NPPE).

Discussion

Laryngospasm is a forceful involuntary spasm of the laryngeal musculature resulting in closure of the vocal cords and the inability to ventilate. This spasm is caused by sensory stimulation of the superior laryngeal nerve.¹ It is most commonly caused by an irritating stimulus to the airway typically occurring during induction or emergence.¹² Common noxious stimuli that may induce this reflex include secretions, vomitus, blood, volatile anesthetics, artificial airway placement, laryngoscopy, painful stimuli, and peritoneal traction during light anesthesia.¹ It occurs more frequently in children, and patients with a history of asthma, bronchitis, smoking, bronchiectasis and chronic obstructive lung disease.¹⁵

Negative pressure pulmonary edema (NPPE) has been reported in 11% of healthy young patients who experience laryngospasm.⁵ The incidence of NPPE has been reported to be as high as 1 in 1,000 anesthetic cases.¹⁵ Inspiration against a closed glottis creates an exaggerated negative intrathoracic pressure. This may reach a level of -100 cm H₂O or as much as five times more negative than normal.¹⁴⁵ Negative intrapleural pressure induces the formation of pulmonary edema by increasing venous blood return to the right heart and pulmonary artery. This results in a significant increase in volume and pressure within the microvasculature in the pulmonary bed. The physiologic response to hypoxia is a massive catecholamine release resulting in increased systemic vascular resistance. This augments venous blood returning to the right heart and pulmonary circulation, further increasing pulmonary microvascular pressures.¹⁴⁵ The elevation of blood volume into pulmonary circulation increases the hydrostatic pressure within the pulmonary capillaries. Simultaneously, the interstitial pressure within the lungs will decrease, as a result of the transmission of the negative intrathoracic pressures. This results in the gross production of intra-alveolar transudative edema. The negative pressures can also result in rupture of the capillaries leading to the formation of interstitial edema and bleeding leading to the appearance of pink frothy sputum.¹³⁴⁵

This patient likely experienced an acute upper airway obstruction secondary to redundant pharyngeal soft tissue and loss of muscle tone related to the combined effects of residual narcotics, benzodiazepines and anesthetic agent. This state was enough to trigger laryngospasm, which resolved with positive pressure ventilation. Inspiratory efforts against an obstructed upper airway led to the development of negative pressure pulmonary edema. Supportive treatment included 100% oxygen administration, nebulized beta 2 agonists, appropriate monitor-
ing and laboratory studies to evaluate the extent of this episode. A chest X-ray taken shortly after the respiratory distress began in the PACU revealed diffuse patchy alveolar infiltrates consistent with flash pulmonary edema. Treatment of the pulmonary edema then became the main focus of therapy.

Traditionally, acute pulmonary edema is treated with endotracheal intubation, oxygen therapy and positive end-expiratory pressure (PEEP) via a ventilator. The major effect of PEEP is to increase functional reserve capacity (FRC). It also acts to increase lung volume, improve lung compliance, increase oxygen delivery and reverse ventilation/perfusion mismatching. At the alveolar level, PEEP helps to stabilize and expand partially collapsed alveoli; this is often referred to as recruitment.

While diuretics will help to reduce pulmonary capillary pressure, PEEP may help to reduce intra-alveolar permeability and act to redistribute or slow edema “leaking”. In patients with persistent hypoxemia, other maneuvers to improve oxygenation may include the use of inhaled nitric oxide, inhaled prostacyclin (PGE) or ventilation in the prone position.

The patient was admitted to the intensive care unit overnight and for further treatment with oxygen, diuretic and nebulized Beta adrenergic medication (albuterol). Serial cardiac enzymes and electrocardiograms failed to show signs of myocardial infarction and this was ruled out as a possible cause of the pulmonary edema. The patient's oxygen requirement decreased progressively over the ensuing 48 hours and she was discharged from the hospital to home. Despite the quick recognition and treatment of this patient’s acute laryngospasm, negative pressure pulmonary edema can manifest minutes or even hours after the initial emergency is over.

References


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Pulmonary Artery Catheter Criteria in Abdominal Aortic Aneurysm Repairs

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Keywords: pulmonary artery catheter, criteria, aneurysm, anesthesia

Pulmonary artery catheters (PAC) can provide clinically useful information in cardiac and major vascular surgery by allowing the direct measurement of cardiac output and pressures on both the right side of the heart and in the pulmonary vasculature. Making an appropriate decision regarding the use of a PAC is imperative because of the complexity of its use, inherent risks, and the level of expertise required placing, monitoring, and interpreting data from the catheter. Major risk factors associated with PAC insertion include pulmonary artery rupture, pneumothorax, arrhythmias and infection.

Consideration for PAC use should also take into account the cost-benefit ratio. The cost of a PAC includes equipment and personnel. Published estimates range from $300 to $1,649 with one study documenting PAC cost to be $667 on the initial day of placement and $541 each additional day. Each year in the United States approximately 220,000 new cases of abdominal aortic aneurysms (AAA) are diagnosed with about 45,000 undergoing surgical repair. It is critical for anesthesia practitioners to have the ability to determine a safe and effective anesthetic plan for each patient. This report will describe a case for which PAC monitoring was not utilized for the repair of an AAA.

Case Report

A 69 year old female weighing 68 kg and 168 cm tall presented with an infrarenal AAA for elective surgical repair. The patient noted a pulsating mass in her abdomen two years prior and had since been followed by her primary care physician. The aneurysm measured 5.2 cm by computed tomography scan with a probable 0.4 cm enlargement in the past year. She presented on the day of surgery without a history of chest pain, dizziness or shortness of breath. A stress echocardiogram revealed an ejection fraction of 68%. The patient’s medications for depression and hypercholesterolemia included atorvastatin calcium, escitalopram oxalate, lamotrigine and quetiapine fumarate as needed. Additionally, she quit smoking 18 months prior to surgery. She had no known drug allergies. Her pre-operative laboratory values were unremarkable. The hematocrit was 39.8%. Her pre-operative blood pressure was 133/64 mmHg with a heart rate of 73 beats per minute. Cefazolin one gram was given via an 18 gauge peripheral intravenous line that was started in the pre-operative area.

In the operating room she was given midazolam two mg and fentanyl 50 mcg intravenously. A T-8 thoracic epidural was placed while in the sitting position. A 20 gauge left radial artery catheter was placed which revealed a blood pressure of 112/69 mmHg. Standard monitors were applied and general anesthesia was induced with fentanyl 150 mcg, propofol 100 mg and vecuronium seven mg. Her trachea was intubated with a 7.0 mmID endotracheal tube. Isoflurane was titrated between 0.8-1.2% in a mix of one liter of air and one liter of oxygen. After induction, a 7-French catheter was inserted into her right internal
jugular vein using ultrasound guidance. Parameters for acceptable vital signs were discussed with the surgeon and anesthesia practitioners. Phenylephrine 90 mcg total was administered through the central line to maintain the mean arterial pressure between 70-90 mmHg. An upper body warmer was set at 44 degrees and a fluid Hot Line was used at 41 degrees to maintain normothermia. A 14-French oral gastric tube was placed to suction, and an esophageal temperature/stethoscope was inserted. A Foley catheter was placed. The aneurysm was surgically identified and heparin 3,500 units was administered intravenously before the aorta was clamped just below the renal arteries. The aneurysm was dissected and the aorta was anastomosed. Aortic cross clamp time was 26 minutes and the patient tolerated it well. Blood loss was 850 ml and urine output was 350 ml. Normovolemia was maintained with the infusions of two units of salvaged red cells and 2200 ml of lactated Ringer’s solution.

An epidural infusion of 100 ml of normal saline with bupivicaine one mg/ml and fentanyl 2.5mcg/ml was started at six ml an hour 20 minutes before completion of the procedure. Three milliliters of two percent lidocaine were given epidurally just prior to extubation. Neuromuscular blockade was antagonized upon completion of the surgery. The trachea was extubated after appropriate criteria were met. The patient was transported with an oxygen mask to the intensive care unit. She was discharged on the seventh post-operative day following an uncomplicated recovery.

**Discussion**

An aortic aneurysm is a "permanent localized dilation of the aorta that is at least 50% larger than the normal or expected diameter." The etiology may be degenerative, atherosclerotic or non-specific. Risk factors include hypertension, atherosclerotic disease, dyslipidemia, infection, smoking and trauma. The vessel wall is predisposed to dilation from internal pressure with concomitant increase in wall tension resulting in an expanded radius. The risk of aneurysmal rupture correlates with luminal diameter and surgery is considered as the aneurysm approaches 4.5-5.0 cm in diameter.

The anesthetic goal in an AAA repair is to maintain major organ perfusion and oxygenation while minimizing the risk of rupture in relation to blood pressure and blood volume. Choosing the appropriate devices for invasive pressure monitoring is individualized based on assessment of the patient’s history, co-morbidities and anticipated extent of surgery and cross clamp time. Identifying high risk patients such as those with a recent myocardial infarction, congestive heart failure, unstable angina, suprarenal aneurysms, or an emergent AAA rupture would guide monitoring decisions. A central venous pressure (CVP) line may be sufficient in patients such as the one described in this report with unimpaired ventricular function and exercise tolerance of a flight of stairs or more. A PAC was not placed in this case because of the patient’s underlying good health and the infrarenal level of the aneurysm. Conventional monitors with a CVP and arterial line provided adequate information to manage her hemodynamics intra-operatively. Even with her absence of co-morbidities, a PAC would have been considered if the aneurysm had extended suprarenally. A suprarenal aneurysm would have put her at a higher risk of end organ hypoxia and decreased systemic perfusion because of the intra-operative aortic clamping and unclamping.
The PAC is a valuable monitoring device for measuring cardiac output. The use of a PAC may be reserved for patients who are at risk for significant blood loss or pulmonary and cardiovascular complications. Because of the complexity and associated co-morbidities of major vascular surgery, these patients are more likely to have a longer recovery period resulting in higher hospital costs. The increased cost of a PAC should not deter the anesthesia practitioner in correctly identifying patients who would benefit from its use. A PAC, however, may not benefit a patient who is not at a high risk, such as the one whose case is described above. In this case report the CVP and arterial line provided adequate hemodynamic monitoring for surgery. This choice of invasive monitors was the best anesthetic plan for this patient and may have decreased the length of stay, risk of complications and hospital costs compared to recovery with a PAC. If a PAC was used during this case, assuming an estimated three day indwelling time, the projected costs may have been an additional $1750.

Technology in healthcare is progressing. Surgical and anesthetic techniques have advanced and diminish the risks associated with routine AAA repairs. In 1998 Valentine et al. concluded that routine use of PACs for routine use and might have a higher rate of intraoperative complications during low risk vascular repairs. Many medical institutions are utilizing transesophageal echocardiography (TEE) probes to evaluate cardiac output and ventricular function where a PAC may have previously been used. With the recent advancement of endoluminal aneurysm repairs, CVP and PAC monitoring are no longer the standard of care.

The benefit of any monitoring device will be optimized when the anesthetist has thorough knowledge of its use, benefits and risks. Our patient who had normal ventricular function, an infrarenal aneurysm and no other co-morbidities had a successful outcome without the added risks and costs of a PAC. The use of a PAC should be evidence based and therefore used selectively for AAA repairs.

References


**Mentors:** Paul Sawler, CRNA, Lana Leinbach Yaney, CRNA, MS
Mid-cavity Ballooning Syndrome Following Ondansetron
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**Keywords:** mid-cavity ballooning, left ventricular apical ballooning, Takotsubo cardiomyopathy, anesthesia

Mid-cavity ballooning syndrome refers to a variant of transient left ventricular apical ballooning syndrome. Also known as Takotsubo cardiomyopathy, this syndrome was initially identified in Japan in the early 1990’s. Typically, it presents in post-menopausal women following emotional stress and results in temporary akinesis of the left ventricle. Because it is difficult to distinguish this cardiomyopathy from an acute myocardial infarction, a recent history of emotional stress should prompt anesthesia professionals to consider this diagnosis when faced with a female patient who exhibits chest pain, elevated cardiac enzymes, electrocardiographic changes, mid-ventricular hypokinesis and lack of coronary artery disease on angiography.

**Case Report**

A 46-year old, 72 kg female (BMI 27.5) presented to the OR for outpatient elective excision of redundant right breast/axillary tissue (non-malignant). Past medical history included non-specific muscle pain, low back pain, chondromalacia patella, arthritis and gastrointestinal reflux disease. She did not have a history of coronary artery disease. She denied recent tobacco, ETOH or illicit drug use. Current medications included methocarbamol, omeprazole, ranitidine, calcium acetate and celecoxib. She described an allergy to ampicillin. Preoperative laboratory values were within normal limits. An ASA 2 and Mallampati class III airway were determined. PONV prophylaxis included diphenhydramine 12.5 mg IV and ondansetron 4 mg IV. Approximately two minutes after administration of ondansetron, the patient complained of pain at the IV site and bilateral paresthesia of the upper extremities, dizziness, throat discomfort and chest tightness. Cool, clammy skin and bilateral hand and wrist rigidity were noted. Her heart rate was 40 beats per minute (bpm) and respirations were 32 breaths per minute. Cardiac monitors were applied and oxygen was administered. Atropine 0.5 mg IV and diphenhydramine 25 mg IV were administered. Her heart rate increased to 130 bpm. She continued to complain of chest tightness, throat pain and extremity tingling. Bilateral breath sounds were clear and equal. Erythema multiforme was noted proximal to the IV site. An additional dose of diphenhydramine 25 mg IV was administered. Her blood pressure and heart rate measured 120/72 mmHg and 117 bpm, respectively. Esmolol 50 mg IV was administered. Her heart rate decreased to 90 bpm. The patient was monitored for an additional forty-five minutes when she complained of chest pain. Systolic blood pressure measured 80/63 mmHg and heart rate 100 bpm. The surgery was cancelled and a cardiac consult was requested. An EKG revealed normal sinus rhythm and blood analysis revealed a troponin level of 2.55 ng/ml. After admission to the coronary care unit, a 2-D echocardiogram revealed global hypokinesis with an ejection fraction (EF) of 35-40%. An emergency cardiac catheterization revealed normal coronary arteries with mid-cavity akinesis. The cardiologist made a diagnosis of mid-cavity ballooning syn-
drome, a variant of transient left ventricular apical ballooning syndrome. An intra-aortic balloon pump (IABP) and a Swan Ganz® catheter were placed. Overnight, the patient remained stable and IABP was discontinued after approximately 48 hours. A follow-up 2-D echocardiogram revealed normal left ventricular systolic function with an EF of 55-60%. On the sixth day following the initial presentation, the patient was discharged to home.

Discussion

A patient scheduled for outpatient, elective excision of redundant right breast/axillary tissue (non-malignant) presents with symptoms suggesting extrapyramidal dysfunction following administration of ondansetron for prophylactic treatment of post-operative nausea and vomiting (PONV). Despite pharmacologic intervention, additional signs and symptoms, including elevated troponin levels and chest pain, result in cancellation of the surgery and further medical evaluation. Echocardiogram and cardiac catheterization reveal left ventricular akinesis supporting a diagnosis of mid-cavity ballooning syndrome. The stress response associated with a presumed adverse reaction to ondansetron may have contributed to the development of this transient cardiomyopathy, which mimics an acute myocardial infarction.

Ondansetron, a selective serotonin receptor antagonist, is a popular medication used to prevent and treat PONV. As a class, the 5-hydroxytryptamine (5-HT) antagonists are considered safe and are usually well tolerated by most patients. Although typically insignificant, in some patients, minor electrocardiographic changes associated with ondansetron administration have been identified. The first case of ondansetron-induced extrapyramidal side effects was documented in 1991 and additional cases have subsequently been described. Although rarely life threatening, dystonic reactions can produce significant anxiety. While extrapyramidal side effects are typically associated with dopamine antagonists - most notably neuroleptic agents - research data suggest that the dopaminergic and serotonergic systems may overlap. This theory may explain how the antagonism of serotonergic receptors can initiate dystonic reactions, traditionally thought to be associated only with the dopaminergic system. Ritter describes “a regulatory role of serotonergic innervation to the basal ganglia in the limbic system on the central dopaminergic motor inhibitory activity.” Even though ondansetron does not demonstrate an affinity for dopamine receptors, Ritter reports evidence that ondansetron may indirectly stimulate dopamine receptors in a small number of patients. Additional research is needed to thoroughly understand this relationship.

While the exact etiology of transient left ventricular apical ballooning syndrome, or Takotsubo cardiomyopathy, is unknown, it is considered a “non-ischemic, metabolic syndrome caused by stress-induced activation of the cardiac adrenoceptors,” which results in a stunned portion of the myocardium. The “tako-tsubo-like” left ventricular dysfunction received its name from a short-necked, round fishing pot used to trap octopi because of the similarity in appearance to the left ventricle on left ventriculography. Mid-cavity ballooning syndrome is described as a variant of transient left ventricular apical ballooning syndrome. Research data indicate that a relationship exists between stress-induced cate-
cholamine surges and the adrenergic innervation of the heart. Emotional stress precipitates transient cardiomyopathies, which mimic acute myocardial infarctions. These transient syndromes are associated with chest pain, EKG changes, and elevation of cardiac enzymes. Typically, there is no evidence of sustained myocardial ischemia or injury. The pathological mechanism of these transient, catecholamine-associated, cardiac dysfunctions is not well understood. Multiple explanations have been proposed including “multi-vessel epicardial spasm, coronary microvascular spasm, acute coronary syndrome with reperfusion, impaired fatty acid metabolism, myocarditis, transient obstruction to left ventricular outflow and catecholamine-mediated myocardial dysfunction.” Since its identification, the syndrome has been recognized worldwide. Patients exhibit an acute onset of chest pain with minor myocardial enzyme release, transient wall motion abnormalities and ST-segment elevation. The mortality rate and risk for recurrence appear to be low, although additional research is required to substantiate this hypothesis. Typically, the left ventricular dysfunction resolves in three to fourteen days. In a meta-analysis, Donohue reported most patients were female (173 of 185 cases) with Asians and Caucasians comprising the majority of the reported races. Further investigation is required to determine whether this is an inherited disorder.

This patient presented a challenging puzzle to the anesthesia care team. The differential diagnosis was symptomatic bradycardia versus adverse reaction to ondansetron suggested by extrapyramidal symptoms to include limb dystonia, tremors and rigidity. Resolution of the skeletal muscle rigidity in the patient’s upper extremities following administration of diphenhydramine pointed to dystonic reaction to ondansetron. The emotional stress stemming from a presumed adverse reaction to ondansetron may have masked the presentation of this uncommon, underlying cardiomyopathy. Chest pain, slightly elevated cardiac enzymes, mid-ventricular hypokinesis and lack of coronary artery disease on angiography support a diagnosis of mid-cavity ballooning syndrome, a variant of transient left ventricular apical ballooning syndrome.

References


Continuous Femoral Nerve Block for Total Knee Arthroplasty
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Keywords: anesthesia, femoral nerve block, knee arthroplasty

Postoperative pain has been reported as being severe in 60% of patients and moderate in 30% of patients after total knee arthroplasty (TKA). The most influential factor in postoperative rehabilitation is postoperative mobilization and physiotherapy. Postoperative pain may hinder these factors and prolong rehabilitation. Intravenous (IV) opioids are the mainstay of effective pain relief immediately following total knee arthroplasty (TKA). However, nausea, pruritus, constipation, and respiratory depression associated with IV opioids are often unpleasant and disabling to both the patient and the postoperative care team. A continuous femoral nerve block is an alternative to the traditional methods of postoperative pain management after TKA. It has been shown to reduce the amount of intravenous analgesics, promote mobilization, and decrease opioid induced side effects thus providing patients with a superior method of pain management.

Case Report
A 73 year old male patient, height 6’1” and weight 110 kilograms presented for a left TKA. Comorbidities included hypertension, a history of atrial fibrillation, gastroesophageal reflux disease, arthritis, degenerative joint disease, chronic renal insufficiency, and a history of treated testicular cancer. The patient previously underwent a right TKA. His current medication regime included hydrochlorothiazide, isosorbide, lisinopril, verapamil, amitriptyline, aspirin, baclofen, flunisolide, and lansoprazole.

Laboratory values were within normal limits and a recent radiographic chest examination revealed no active disease process. A 12-lead electrocardiograph (ECG) revealed a right bundle branch block, ST changes in leads V4-V6 and T wave inversion in lead V2. The patient denied ever having a myocardial infarction or chest pain.

A lactated Ringers (LR) infusion was started and the patient was administered 100 micrograms of fentanyl IV for placement of the peripheral nerve block. A lactated Ringers (LR) infusion was started and the patient was administered 100 micrograms of fentanyl IV for placement of the peripheral nerve block. The patient was given oxygen at 4L/m via nasal cannula and he was then prepared for a femoral nerve block and catheter placement. With a two inch insulated 18 gauge Tuohy needle with integrated wire, the femoral nerve was stimulated and a patellar snap was
achieved, with a loss of twitch at 0.35 milliamps. Thirty milliliters of 0.5% bupivacaine with five micrograms per milliliter of epinephrine was injected and a 20 gauge catheter was then threaded into the femoral sheath to provide postoperative analgesia. The patient denied any signs of neuronal toxicity (e.g., tinnitus, circumoral numbness, metallic taste in mouth) nor was there any sign of intravascular injection. After approximately twenty minutes the patient reported to have a decreased sensation of pain in the operative leg and was also noted to have decrease quadriceps strength to the operative leg, revealing that the block was successful.

In the operating room a pulse oximeter and blood pressure cuff were applied. The initial cuff blood pressure of 158/71 millimeters of mercury (mmHg) and heart rate of 69 beats per minute (bpm) were recorded. The patient was given oxygen at 4 L/minute via nasal cannula and was then positioned for a sitting spinal anesthetic. Fifteen milligrams of bupivacaine was injected in the subarachnoid space after cerebrospinal fluid was seen in all four quadrants. After five minutes the patient reported to have a sensory blockade at thoracic level six and a 10 mmHg decrease in the patient’s systolic blood pressure was noted. There were no synergistic effects noted from the combination of the femoral nerve block and the subarachnoid block.

After the patient was positioned supine, a Foley catheter was placed, the patient was prepped for the surgical procedure and a left leg tourniquet was then inflated at 350 mmHg. A propofol infusion was then started at 25 micrograms per kilogram per minute (mcg/kg/min) which was titrated to keep the patient sedated and hemodynamically stable. The propofol infusion was maintained at 10 mcg/kg/min for the duration of the procedure. Despite the propofol infusion, analgesia was assessed per the patient’s denial of pain throughout the procedure.

The patient’s blood pressure was supported with incremental 5 mg doses of ephedrine (total of 30 mg) and 0.1 mg doses of phenylephrine (total of 0.5 mg) IV during the procedure. The patient required this vasopressor support during the initial part of the case after the subarachnoid block was placed. The patient’s heart rate was maintained at a rate of 45 to 69 bpm and systolic blood pressure was maintained between 92 and 158 mmHg. There were no significant ST changes noted throughout the procedure. The patient received a total of 2100 milliliters (ml) of LR for the case with approximately 320 ml of urine output. The procedure lasted 130 minutes and there was an estimated 250 ml of blood loss.

The patient was transferred to the post anesthesia care unit (PACU) where the patient’s spinal blockade was noted to be at a thoracic level of 8 and the patient reported having no pain. A continuous infusion of 0.125% bupivacaine was started at eight ml per hour via the femoral nerve catheter. After the patient’s spinal blockade had receded to a thoracic level of 10, the patient was transferred to the surgical care ward. The patient required no additional IV opioids in the PACU. On postoperative day one the patient reported adequate pain control on the anterior and medial portion of the operative knee, however, the patient was receiving morphine sulfate IV for posterior pain (20 mg total). On postoperative day four the catheter was removed without incident and the patient was discharged one week later after rehabilitation therapy.
Discussion

When postoperative pain after TKA is inadequately treated, it intensifies reflex responses, which may lead to serious complications, such as pulmonary or urinary problems, thromboembolism, hyperdynamic circulation, and increased oxygen consumption. Moreover, it hinders early physical therapy, which is the most influential factor for beneficial postoperative rehabilitation. After knee surgery, poorly managed pain may inhibit the early ability to mobilize the knee joint. This, may result in adhesions, capsular contracture, and muscle atrophy, all of which may delay or permanently impair the ultimate functional outcome of the operative knee.

The knee is innervated by the lumbosacral plexus nerve roots. The femoral and obturator nerves innervate the anterior aspect of the knee, while the sciatic nerve innervates the posterior aspect of the knee. After TKA, postoperative pain relief can be achieved by various techniques, such as patient controlled analgesia (PCA) with IV opioids, epidural analgesia with local anesthetics and/or opioids, intrathecal opioids, and/or a continuous or single-shot peripheral nerve block.

Epidural with opioid and/or local anesthetics is a well established analgesia regimen after TKA, as it provides superior pain control than PCA with opioids. However, frequent side effects such as urinary retention, dizziness, sedation, pruritis, nausea, vomiting, catheter displacement, or the spread of analgesia to the non-operative limb may interfere with the patient’s postoperative recovery.

Chelly et al. observed that continuous femoral infusion decreased morphine requirements by 35%. Chelly et al. found a number of advantages to continuous peripheral nerve blockade: better recovery and a 90% decrease in serious cardiovascular and pulmonary complications. Long et al reported that those subjects who had received a femoral catheter, consumed less IV morphine on postoperative day one compared to the epidural group (p<0.05). In comparison to traditional analgesia approaches, the use of continuous femoral nerve block provides prolonged duration and superior analgesia. Continuous femoral nerve block not only provides a similar high quality of analgesia in comparison with continuous epidural analgesia but also provides less motor blockade because of the unilateral effect of the block.

Single-injection femoral nerve blocks have also been shown to significantly improve postoperative analgesia compared with systemic opioid therapy, which may reduce the length of hospital stay after TKA. Placement of a femoral nerve catheter provides patients with prolonged site-specific analgesia. This technique may be of benefit, because the duration of analgesic effect from a single-injection block typically lasts 12-24 hours, depending on the local anesthetic chosen and the proximity of the nerves to the needle tip upon injection. However, severe pain after TKA may persist beyond the duration of the single-injection, often hindering the patient’s rehabilitation.

In a study conducted by Salinas et al., the use of a continuous femoral nerve block resulted in lower pain scores than the single-injection femoral nerve block beginning on postoperative day one, despite a significantly larger opioid consumption in the single-injection group. However, the
researchers found that the improved analgesia did not improve long-term functional outcome or decrease the patient’s length of stay in the hospital. While, Long et. al. found that the continuous femoral catheter provided patients with a shorter hospital stay which was attributed to the reduced incidence of opioid side effects. The patient in our report used a significantly reduced amount of intravenous opioids, in comparison to those who do not receive a continuous femoral nerve catheter at our facility. Additionally, his rehabilitation was not hindered due to postoperative pain management allowing for unlimited participation in the rehabilitation process.

Morin et. al. conducted a study to compare the effectiveness of a psoas compartment block (continuous posterior lumbar plexus block), a continuous femoral nerve block, and a combination of a continuous femoral and sciatic nerve block. They found that adequate analgesia after TKA cannot be achieved with continuous femoral nerve block alone and that the addition of a sciatic nerve block significantly improved the analgesic effects to the patient. However, the researchers found that there were no differences between the groups when comparing postoperative functional outcome. If avoidance of pain is the goal of the practitioner, the combined continuous femoral and sciatic nerve block was deemed the superior technique.

Based upon a Medline review from 1966 to 2006 there were no similar studies or case reports discussing the efficacy of the combined technique reported in this case report.

Placement of femoral nerve catheters requires additional skill, time, and postoperative management. In addition, placement of catheters poses the potential for infection and nerve damage. Thus, continuous femoral nerve blocks are not ideal in every setting or every patient; however, if they are used appropriately, they may efficiently enhance a patient’s postoperative recovery after TKA.

References


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**Intra-Operative Colloid Replacement Therapy**

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**Keywords:** anesthesia, colloid, fluid replacement, fluid balance, volume expansion

Infusion of crystalloid solutions remains the primary treatment to replace intra-operative fluid loss.¹ However, many situations occur where anesthesia providers may implement colloid replacement therapy. Practitioners may choose from synthetic colloids, such as dextrans or starches, or the nonsynthetic colloid, albumin.² Although research does not indicate a superior colloid for use, there are factors to consider when implementing colloid replacement therapy, such as a patient’s current health status, medical history, allergies, religious beliefs, and costs to the patient and institution. It is prudent to note that blood products, also being colloids, should not be used for the sole purpose of volume expansion, but rather to improve oxygen carrying capacity.¹

**Case Report**

A 55 year old, ASA 3, 83 kg white male, presenting with peritoneal carcinomatosis and pseudomyxoma pertonei from an appendical primary lesion, was to undergo intraperitoneal hyperthermic chemotherapy. Medical history was significant for hypertension, noninsulin dependent diabetes mellitus, malignant melanoma, and recent onset of gastroesophageal reflux disease. Pre-operative assessment and labs
were within normal limits with the exception of a hemoglobin of 10.9 g/dl and hematocrit of 32%. Current medications included olmesartan, amlodipine/benazepril, spironolactone, glimepiride, and iron.

The patient was transported to the operating suite at 6:51 a.m. Standard monitoring was initiated. After intravenous induction with 150 mcg of fentanyl, 2 mg midazolam, and 400 mg thiopental, 100 mg succinylcholine was administered to rapidly secure airway after encountering unanticipated difficult 2-person manual ventilation. Direct visual laryngoscopy was performed and a 7.5 mm ID endotracheal tube secured after auscultation of bilateral breath sounds and visualization of an end tidal carbon dioxide tracing. Anesthesia and paralysis was maintained with oxygen, air, isoflurane, and vecuronium. A nasogastric tube, radial arterial line, 16 gauge peripheral intravenous catheter, and a right internal jugular triple lumen catheter were inserted.

The patient was placed in lithotomy position for cystoscopy, bilateral retrograde pyelogram, and stent placement. He was then returned to the supine position for resection of the colon, proximal rectum, spleen, distal pancreas, distal stomach, gallbladder, omentum, and umbilicus. After surgically entering the abdomen, 4.5 liters of serous and serosanguineous fluid was evacuated. A sufentanil infusion was initiated for intermittent elevations in blood pressure and titrated between 0.1 - 0.2 mcg/kg/hr. An ionized calcium level of 0.89 mmol/L was treated with 2 grams of calcium chloride, with levels increasing to 0.97 mmol/L. Metoprolol and phenylephrine were used to maintain a heart rate of 80 and a systolic blood pressure greater than 100 mmHg. Chemoperfusion channels were placed intra-abdominally and intraperitoneal hyperthermic chemotherapy was initiated after abdominal closure.

The patient received 1250 ml of 5% albumin, 4 units of packed red blood cells, 4 liters of normal saline, thirteen liters of plasmalyte, and 1 liter of hetastarch. One liter normal saline with 20 mEq potassium chloride was infused to treat a potassium level of 3.65 mEq/L. Urinary output was 3.5 liters, and blood loss was estimated to be 1200 ml.

At the conclusion of chemotherapy treatment, the abdomen was reopened, irrigated, and an ileostomy was created. The patient emerged from anesthesia, was extubated, and transported to the post-anesthesia care unit at 1930 hours. He was subsequently transferred to the intensive care unit after an uneventful recovery. On the second post-operative day, the patient was stable, alert and reporting no anesthetic complications.

**Discussion**

Colloid solutions are superior over crystalloid solutions in their ability to increase colloid osmotic pressure (COP), thereby increasing intravascular fluid. While a percentage of crystalloid solutions will leak into the interstitial space, colloid solutions not only remain intravascularly, but create an osmotic gradient pulling additional fluid from the interstitial space into the intravascular space. In comparison, normal saline decreases COP pressure by 12% while albumin increases COP by 11% and hydroxyethyl starch increases COP by 36%. Colloids continue to have this effect for hours to days after administration, depending in the formulation used. When implementing colloid therapy, anesthesia providers must consider certain adverse effects. Practitioners should monitor for signs of fluid overload, anaphylactic reac-
tions, and induced coagulopathies. Central venous pressure monitoring may be indicated. In some clinical situations, such as sepsis, venom poisoning, trauma, drug overdose, or anaphylaxis, increased capillary permeability allows colloids to leak into the interstitial space. The displaced colloids would cause an osmotic gradient with the net movement of fluid from the intravascular space to the interstitial space resulting in third space fluid loss. During these situations, colloids should be avoided.

In addition to these effects, providers must consider the cost benefit ratio when considering colloid therapy. Albumin remains the primary nonsynthetic colloid, a natural protein derived from donated plasma. Most commonly used intra-operatively is a 5% concentration of albumin, which is isotonic and iso-oncotic with normal plasma. Initial doses should begin at 12.5 – 25 grams (250 – 500 ml of 5% solution). However, albumin can be titrated up to doses of 250 grams (5000 ml of 5% solution) over a 48 hour period. Dosing should be based on desired heart rate, blood pressure, central venous pressure, and urinary output. Desired intravascular effects may persist for 24-36 hours. However, the half life for synthetic albumin is around 24 hours, considerably different from a half life of 22 days in naturally synthesized albumin.

There are adverse effects associated with albumin administration. Albumin will bind to free calcium, possibly causing decreased cardiac contractility or dysrhythmias. Albumin should be titrated carefully in patients with cardiac or renal disease to prevent adverse sequele such as circulatory overload or pulmonary edema. Practitioner should consider the effect of albumin on the availability of drugs that are highly protein bound. Albumin does carry a minute risk for transmission of blood borne pathogens including HIV and hepatitis. However, these risks are remote due to donor screening and sterilization processes, including alcohol fractionation and heat treatment.

The synthetic compound, hydroxyethyl starch (HES), is equally effective to 5% albumin for intravascular volume replacement, but less expensive. HES compounds will expand intravascular volume for 24 – 36 hours after infusion, and they have a half life of 17 – 48 days. The 6% solution is commonly used and the recommended dose is 20 ml/kg, up to 1500 ml. Doses exceeding 30ml/kg will have greater anti-thrombotic effects on coagulation. This dose dependent effect results from accelerated conversion of fibrinogen to fibrin, decreased activity of factor VIII, and decreased platelet agglutination. Hextend®, a newer form of 6% hetastarch, is prepared in a solution with balanced electrolytes and a lactate buffer. The newer formulation has a decreased incidence of adverse side effects (i.e. hyperchloremic metabolic acidosis) that were associated with Hespan®.

Hextend is more commonly used than its 6% hetastarch predecessor, Hespan®, which was prepared in a normal saline solution. HES compounds are relatively contraindicated in patients with renal disease because of their potential to exacerbate renal damage. The mechanism behind this contraindication is unclear. One theory asserts that as starches are cleared renally, tubular inflammation and elevated creatinine levels become evident. HES compounds cannot be eliminated with hemodialysis. Hetastarch solutions should also be avoided in patients with an allergy to corn.

Dextran, another synthetic colloid, can also be used to increase intravascular volume.
However, due to its prominent anticoagulation effects, its use may be more limited. Dextran may be advantageous for patients with an increased risk for thrombosis due to its ability to decrease blood viscosity. These effects could make Dextran an attractive choice for vascular surgery. If administered for its anticoagulation effects, Dextran 40 is the preferred formulation. Dextran 70, however, is favored for volume expansion. The recommended dose is 500 – 1000 ml, or a maximum dose of 20 ml/kg over the first 24 hours. If therapy is needed beyond 24 hours, the dose should be decreased to 10 ml/kg over any subsequent 24 hour period. Although onset may occur within minutes, its effect is not as prolonged as other colloids, being excreted in the urine within 24 hours. At doses greater than 1.5 ml/kg, a patient may have coagulation deficits which resemble Von Willebrand’s disease from decreased Factor VIII levels. This effect may be partially reversed with desmopressin. Dextran or HES compounds may be colloid alternatives for the Jehovah’s Witness patient, as they may object to the use of albumin. In addition, these synthetic compounds are less costly as compared to albumin.

There were many implications to consider during this case. Of primary importance was the consideration of fluid shifts from an open abdominal cavity, fluid deficits, and resuscitation requirements from blood and insensible fluid loss. In order to facilitate extubation at the conclusion of surgery, fluid administration had to be carefully managed. Regrettably, CVP monitoring was not initiated until later in the case, after considerable resuscitative efforts had been made. If initiated early, it would have provided a baseline as well as given another parameter in which to measure fluid status. Colloid therapy was initiated early due to the large amount of serous fluid that was evacuated upon entering the abdominal cavity. Different colloids were utilized to prevent adverse effects from over-administration of albumin, hextend, or crystalloids. Anesthesia professionals should be familiar with various colloid solutions to better manage cases involving large fluid requirements in order to achieve favorable outcomes.

References
ABSTRACT: Projected CRNA Retirement in Michigan over the Next 20 Years
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Keywords: CRNA, retirement, Michigan

Introduction: The average age of the practicing CRNA is 48 years old and an estimated 32% of practicing CRNAs will retire within the next decade. The retirement trends of CRNAs in Michigan have not been studied in the past ten years.

Purpose: This research was designed to study retirement and exit from practice of Michigan CRNAs over the next 20 years.

Hypotheses: The outflow from the workforce will be greater than the inflow of anesthesia providers in Michigan.

Methodology: A single mailing of 1178 surveys were sent to the Michigan CRNAs via U.S. mail. They were asked about their primary place of work, years in practice as a CRNA, average hours worked per week, and anticipated future retirement.

Results: The response was 529 for a return rate of 45%. Of the respondents, 37% were male and 63% were female with the mean age of 50 years. Their primary employment was at mid-size hospitals (101-499 beds) at 51%. The average Michigan CRNA was employed in more than one setting with an average 8 hours per week of overtime. The mean age for anticipated retirement was 61.7 years old with an expectation to work 14.5 hours per week after retirement. The strongest reasons to continue working after retirement were maintaining friends and social contact at 58% and maintain skills at 35%. After retirement, 38.4% will relocate on seasonal basis, 14.6% permanently, and 1.3% as locum tenums.

Conclusion: The current literature states there will be a 32% deficit in CRNA services, yet the response to our survey predicts a 42% deficit. The impact may be somewhat modulated by the number of responses of CRNAs planning to provide anesthesia services part time after retirement.

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