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Front Cover:

Kathryn Cass, BSN, a graduate student enrolled in the Goldfarb School of Nursing at Barnes-Jewish College Nurse Anesthesia Program, performs an anesthesia machine pre-use check in preparation for a clinical day.

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Case Reports

Anesthetic Management for a Patient with Chronic Idiopathic Angioedema

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Keywords: idiopathic angioedema, airway edema, laryngeal mask airway, prophylactic antihistamine

Idiopathic angioedema, which should be differentiated from hereditary angioedema, is not well documented in the anesthesia literature. Idiopathic angioedema is a pathogenic response triggered by atopy (a genetic hypersensitivity reaction), antigen hypersensitivities, or physical trauma.[1,2] It is necessary to prepare a plan of care that minimizes exposure to anesthetic adjuncts possessing the potential to trigger hypersensitivity reactions or cause airway trauma in the at risk patient.

Case Report

A 70-year-old female with a past medical history significant for chronic angioedema (resulting in oropharyngeal and larygneal edema), osteoarthritis, hyperlipidemia, hypertension, and breast cancer presented for a partial mastectomy and sentinel node biopsy. The patient weighed 62 kg and height was 157 cm. The patient had no previous surgical or anesthetic history and had no family history of adverse anesthetic events. The patient had a Mallampati class II airway with full neck range of motion. The patient's medications included naproxen 250 mg by mouth (PO) twice daily, nebivolol 2.5 mg PO daily, rosuvastatin 10 mg PO daily, fexofenadine 60 mg PO twice daily, and epinephrine 1:1000 solution 0.2 mg via subcutaneous injection as needed with the onset of angioedema. The patient had no known drug allergies. The cause of her angioedema was determined idiopathic, and no medications were identified as triggers for her attacks.

Diphenhydramine 25 mg was intravenously (IV) administered in the preoperative holding area. One hundred percent oxygen was administered via facemask for five minutes, while the standard American Society of Anesthesiology monitors were applied. After preoxygenation, IV lidocaine 90 mg and propofol 150 mg were administered for induction of anesthesia. Upon loss of lash reflex, a size 4 laryngeal mask airway (LMA) was inserted into the patient's oropharynx. The LMA placement was confirmed by the presence of bilateral breath sounds and chest rise, and end tidal CO_2 on capnography.

General anesthesia was maintained with delivery of 1.8% sevoflurane in combination with 1.25 L/min oxygen and 0.75 L/min air. The patient remained breathing spontaneously, and IV fentanyl was administered in 25 mcg intervals titrated to her respiratory rate. Dexamethasone 4 mg IV and cefazolin 1 g IV were administered during the maintenance phase of the case.

The patient had no adverse reactions to medications or airway manipulation throughout the case. She remained hemodynamically stable and developed no signs of acute angioedema. The patient was lethargic as she awoke from the anesthesia, which was attributed to the diphenhydramine given preoperatively. Although lethargic, the patient followed commands, sustained an adequate respiratory effort of 500 mL tidal volumes, respiratory rate of 12, oxygen saturation of

98%, and maintained a patent airway upon removal of the LMA.

The patient was transferred to the post anesthesia care unit, where she remained stable without symptoms of angioedema. The patient was discharged home later in the day.

Discussion

Angioedema can result from a variety of stimuli, although the underlying cause is often unknown.[2] Patients may be exposed to various angioedema triggers throughout the course of anesthesia, including antigen hypersensitivity and physical trauma to the airway.[2]

Anesthesia management for the patient with angioedema includes minimizing exposure to anesthetic adjuncts that could elicit a hypersensitive response, particularly avoiding agents that release histamine or involve IgE-activating mechanisms.[1,2] Neuromuscular blockers are the most common anesthetic adjunct to elicit an IgE reaction or to release histamine secondary to mast cell stimulation.[1,3,4] IgE reactions are hypersensitivity reactions that result from antibodies developed during a prior exposure to an antigen. IgE-dependent reactions occur more frequently during the administration of aminosteroid neuromuscular blockers, such as pancuronium, vecuronium, and rocuronium.[4] Histamine release occurs more frequently with benzylisoquinoline neuromuscular blockers, such as atracurium, cisatracurium, and mivacurium.[4] Meperidine and morphine also release histamine via the mast cell pathway.[4]

Avoiding histamine releasing or IgE-activating adjuncts influences the anesthetic management of the patient with angioedema. In the plan of care of this 70-year-old patient, histamine release was addressed three-fold: the patient was on chronic anti-histamine therapy, she was supplemented with anti-histamine therapy that doubled as a preoperative sedative, and histamine-releasing adjuncts were avoided. If intubation was necessary, succinylcholine would have been the most appropriate choice for muscle relaxation because it has the lowest potency for histamine release and its short duration of action makes it necessary in an airway emergency.[4] Fentanyl was the opioid of choice for perioperative analgesia as it does not release histamine.[4]

Airway management of the patient with angioedema can be addressed using a risk to benefit ratio. An endotracheal tube (ETT) poses a risk of physical trauma to the airway which could trigger angioedema.[2,5] Conversely, the airway security provided by the ETT provides argument for its use. The LMA is less traumatic and less stimulating to the airway, thus poses a lesser risk of angioedema with airway manipulation.[2,5] However, the risk of angioedema development due to other factors during the perioperative period with an unprotected, edematous airway could be a detrimental risk of the LMA. Oropharyngeal and laryngeal angioedema without a secure airway could precipitate the inability to ventilate or intubate, requiring an emergent tracheostomy or cricothyrotomy.[2]

The LMA was chosen for the patient with chronic angioedema because the LMA would be less stimulating and less traumatic than the ETT, therefore decreasing the chance of airway manipulation triggering angioedema. An airway set up was ready at all times to convert to endotracheal intubation if necessary. The combination of head extension and jaw lift was utilized for

LMA insertion to minimize the introduction of additional foreign bodies, such as a tongue blade, into the patient's oropharynx. The patient demonstrated no adverse reactions to LMA placement. However, the surgical duration was short which allowed for spontaneous ventilation, and many drugs were avoided to decrease the likelihood of angioedema. An LMA may not be an appropriate choice when mechanical ventilation is required, when histamine releasing or IgE activating anesthetic adjuncts cannot be avoided, or if physical manipulation or trauma to the airway is a possibility, as with ENT procedures.

The treatment of choice for acute angioedema is IV epinephrine (1:1,000) and IV antihistamine (diphenhydramine 50 mg every six hours and cimetidine 300 mg).[2] Use of epinephrine is limited by the beta agonist effect of tachycardia, and the alpha agonist effect of hypertension.[2] Methylprednisolone 60 mg every six hours can be administered, although not beneficial with acute attacks.[2]

A component of the anesthetic plan for the patient with chronic idiopathic angioedema included readily available IV epinephrine (1:1,000) in case the patient developed signs and symptoms of angioedema. Because of the patient's age, and her history of hypertension and hyperlipidemia, the adverse effects of epinephrine must be considered. In attempt to minimize the risk of myocardial ischemia due to epinephrine induced hypertension and tachycardia, other adjuncts, such as an additional dose of IV diphenhydramine 25 mg and cimetidine 300 mg, would have been concomitantly administered in effort to decrease the amount of epinephrine required.[2]

The patient must be monitored for signs and symptoms of myocardial ischemia, and medications must be readily available to treat hemodynamic alterations associated with myocardial ischemia. In addition to the standard ASA monitors, real-time ST-segment analysis should be recorded to aid in detection of myocardial injury.[6] Throughout the operative case, it is necessary to maintain hemodynamic stability and minimize blood pressure and heart rate changes because intraoperative myocardial ischemia occurs more frequently with occurrence of increases in blood pressure 10% above baseline and/or rapid heart rate changes.[7] Nitroglycerin and beta blockers can be utilized to treat ST-segment changes, hypertension, and tachycardia.[8] The acute administration of short acting nitrates decreases ischemia severity, size of perfusion defect, and ST-segment depression.[8] Beta receptor blockade reduces myocardial oxygen consumption and demand through reduction of heart rate, blood pressure, and contractility.[8] The goal of ST-segment analysis and readily available medications to treat hemodynamic alterations and myocardial ischemia is to minimize the untoward myocardial effects of epinephrine in the at risk patient.

When reviewing the plan of care for this case, there are some factors worth altering for future management of the patient with angioedema. Steroid therapy was not considered (other than dexamethasone 4 mg IV) but perhaps IV administration of methylprednisolone 60 mg twelve, six, and one hour prior to surgical incision would provide an additional defense with this patient population. Another supplement to the anesthetic plan is use of the intubating LMA to serve as a bridge to an ETT if angioedema occurred and conversion to ETT was required.

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Emergence Agitation

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Keywords: Emergence agitation, emergence delirium, endotracheal tube (ETT), remifentanil, physostigmine

Emergence agitation (EA) or emergence delirium occurs in 4.7% to 21.3% of adults after receiving a general anesthetic.[1] EA definitions vary but it occurs in the post-operative period either immediately upon emergence or after arrival in the post-anesthesia care unit (PACU).[1,2] Patients are awake but disoriented, exhibiting behaviors such as thrashing, crying, incoherent moaning, restlessness, and aggressive movements.[1,2,3] EA is self-limiting, lasting from minutes to hours and resolving before PACU discharge.[1,4] Possible dangers of EA include injury to patient or staff, self-extubation, disruption of catheters and drains, increased pain, and damage to surgical incision or procedure.[5]

Case Report

The patient was a 51-year-old, 157 cm tall, 74.4 kg African-American presenting for bilateral ureteroscopic stone manipulation. One month earlier, this patient had placement of bilateral ureteral stents for hydronephrosis. Medical history was significant for coronary artery disease status post placement of 4 drug eluting stents,

asthma, hypertension, chronic anemia, diabetes, hypothyroidism, fibromyalgia, occasional chest pain, and occasional shortness of breath. Home medications included amlodipine, aspirin, atenonol, duloxetine, esomeprazole, fluticasone/salmeterol, gabapentin, hydrocodone/acetaminophen, hyoscyamine, glipizide, losartan, metformin, and levothyroxine. Clopidogrel was stopped five days before surgery.

An 18 gauge peripheral intravenous catheter (PIV) was placed in the left forearm. Standard monitors were placed, and the patient was pre-oxygenated on 100% O_2 for five minutes. Induction medications included midazolam 2 mg intravenously (IV), fentanyl 200 mcg IV, lidocaine 50 mg IV, and propofol 200 mg IV. The patient obstructed upon initial attempt to mask ventilate, and an oral airway was placed to open the airway. Easy mask ventilation with oral airway was established, and rocuronium 50 mg IV given. After the patient had no twitches with neuromuscular monitoring, the trachea was intubated with a 7.0 endotracheal tube (ETT) using a Miller 2 blade. Respirations were controlled by a ventilator.

The patient was placed in lithotomy position, and a forced air warmer was applied. During the case, the patient was maintained on isoflurane (0.6-0.7%), nitrous oxide at 1 liter per minute and oxygen at 0.5 liters per minute. At the end of the case, 4 of 4 twitches were present, a nasal trumpet was placed, neuromuscular blockade was antagonized with neostigmine 2 mg IVand glycopyrrolate 0.2 mg IV, and inhalation agents were stopped. The ventilator respiratory rate was decreased to 6 breaths per minute. The patient was taken off the ventilator and was breathing spontaneously with adequate tidal volumes and respiratory rate 16-20; at this point, the patient became agitated. Eyes were opened but did not focus, thrashing of the extremities occurred, and verbal commands were not followed. Oral suctioning preceded ETT removal with positive pressure. Oxygen was administered via face mask. The patient remained agitated but was breathing well, so the nasal trumpet was removed. Agitation decreased. The patient was taken to PACU on oxygen. Vital signs were stable, and no further sign of agitation was observed.

Discussion

Any patient undergoing general anesthesia has the potential for EA. However, certain adult patients have a higher risk of experiencing EA. Risk factors include male gender, inhalational anesthesia, postoperative pain, receipt of benzodiazepines preoperatively, breast or abdominal surgery, surgery of longer duration, and endotracheal tubes or urinary catheters.[1,4,5] Patients experiencing EA may exhibit restlessness, thrashing, aggression, moaning, and disorientation.[1,2] Aggression and thrashing can be a danger to both patient and staff. These behaviors can cause bleeding, aggravation of pain, traumatic removal of tubes and catheters, and injuries from falls.[4,5]

In order to help prevent the adverse effects of EA, anesthesia professionals need to address EA immediately. Emergence Agitation is self-limiting; however, interventions can be provided that may decrease agitation. Interventions include evaluating for and correcting any physiological causes of EA such as hypoxia, providing adequate pain control, removing PIVs, ETTs, and urinary catheters when the patient situation allows, offering reassurance in a calm voice, and removing harsh stimuli such as loud noises and bright lights.[1,3,4] The

goal and focus of these interventions is to decrease agitation and prevent patient injury. If these interventions fail to adequately protect patient and staff, physical or chemical restraints, such as sedatives including propofol or benzodiazepines, may become necessary.[1,4]

Upon emergence from general anesthesia, the patient thrashed while the ETT remained in place, and no response to verbal instructions from the anesthesia professionals was noted. The literature associates these behaviors with EA.[1] The anesthesia professionals and operating room registered nurses gently restrained the patient's arms and legs to prevent injuries and to prevent dislodging of the PIV and ETT. The patient could not be allowed to remove the ETT due to the inflation of the tube's cuff. However, patients with an ETT in place are more likely to present with EA due to discomfort related to the tube's presence.[5] The ETT was immediately removed to prevent patient thrashing from dislodging it. Tidal volumes averaged 400 ml and respiratory rate was 15-23 breaths/min. Literature supports removing tubes or catheters as soon as possible to help remedy EA.[1] Removal of the ETT offered the potential benefit of reducing the patient's agitation. Risk of removing the ETT before the patient was fully awake and following commands would be the possibility of having to mask ventilate or re-intubate the patient if unable to maintain an airway. Benefit was considered to outweigh risk in this case as the patient was previously easy to ventilate by mask with an oral airway in place and no difficulty had been encountered with placement of the ETT. The patient had demonstrated the ability to achieve adequate respiratory rate and tidal volumes.

After controlled removal of the ETT, the patient began to moan incoherently and continued to thrash. Oxygen was administered via a face mask. Since the patient had required use of an oral airway during mask ventilation, the anesthesia professionals considered the patient to be at risk for obstruction after extubation and had placed a nasal trumpet toward the end of the case. SpO_2 was 98-100%, and chest wall excursion appeared to be adequate. Since no obstruction was apparent, the nasal trumpet was removed. The literature supports this decision as it has been found that tubes and catheters can contribute to EA.[1] Upon removal of the nasal trumpet, the patient immediately ceased thrashing and moaning, and rested quietly during the transport to PACU. The patient remained calm and began to answer simple questions appropriately, resolving the 10-15 minute episode of EA.

The literature also offers some possible pharmacological adjuncts in the treatment of EA. IV opioids can be given prior to emergence but may then increase the duration of emergence. One study examined the effectiveness of continuing remifentanil infusions at a low dose through the emergence phase to decrease agitation and coughing related to the ETT. The study found remifentanil to be effective without delaying emergence.[6] Another study in the pediatric population indicated that physostigmine may be useful in some patients with severe agitation. If pain and life threatening conditions such as hypoxia, hypercarbia, and acidosis can be eliminated as causes, EA may be related to a central anticholinergic syndrome, especially if tachycardia and dry, reddened skin are present with the EA.[7]

This case demonstrated the necessity of making decisions for patient care on an individual basis. Several interventions were implemented until agitation began to

resolve. Tubes were removed earlier than originally planned to facilitate patient safety, and removal resulted in problem resolution. An anesthesia provider that is flexible and adjusts quickly can successfully manage EA.

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Ventilatory Management during Robotic Prostectomy

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Keywords: COPD, robotic surgery, prostatectomy, pneumoperitoneum, ventilator management

Robotic-assisted laparoscopic prostatectomy (RALP) is a surgical procedure indicated for the resection of prostate cancer. The robotic approach is associated with better patient outcomes including lower blood loss, less pain, shorter hospital stays, and better postoperative potency and continence than traditional surgical approaches.[1] The popularity of robotic technology has grown as indicated by 1,300 robotic systems purchased nationwide as of March 31, 2011.[1] This popular surgical technology also entails the physiologic implications of pneumoperitoneum (PPT) and trendelenberg positioning (TP) that pose challenges to the anesthetic plan for ventilator management.[2]

Case Report

A 59-year-old Caucasian male, measuring 193 cm and 93 kg, presented for RALP secondary to a diagnosis of prostate cancer. Preoperative vital signs included blood pressure of 121/69 mmHg, heart rate of 84 beats/ min, respiratory rate 14 breaths/min, and oxygen saturation of 95% on room air. The patient had a medical history of smoking and chronic obstructive pulmonary disease (COPD), but had quit smoking in

1994. Preoperative pulmonary function tests (PFTs) were performed and revealed a forced expiratory volume in one second to forced vital capacity ratio (FEV_1/FVC) of 22%. Preoperative arterial blood gas values were $PaCO_2$ of 36 mmHg, bicarbonate of 23.1 mEq/L and PaO_2 of 73 mmHg. The patient was on a daily medication regimen including scheduled citalopram, fluticasone-salmeterol, ipratropium-albuterol, tiotropium bromide monohydrate. Albuterol sulfate was taken as needed. Physical assessment revealed diminished, clear lung sounds. Despite the low FEV_1/FVC ratio, it was concluded by the anesthesia and surgical teams to proceed with surgery secondary to the patient's compliance with his medication regimen and his present physical assessment.

The patient was given midazolam 2 mg intravenously (IV) en route to the operating room (OR) for anxiety. Upon arrival to the OR, the patient was assisted to the surgical table and intraoperative monitors were applied. Preoxygenation was initiated via facemask with oxygen saturation maintained at 100%. An intravenous induction was performed with fentanyl 150 mcg, lidocaine 100 mg, propofol 150 mg, and rocuronium50 mg intravenously. The vocal cords were visualized by direct laryngoscopy with a Macintosh size three blade and a 7.5 endotracheal tube was inserted into the trachea. Positive end-tidal CO_2 and bilateral breath sounds were confirmed. Mechanical ventilation was initiated with volume control settings of 500 mL tidal volume and respiratory rate of 10 breaths per minute with an inspiratory to expiratory (I:E) ratio of 1:2.5. The fraction of inspired oxygen (FiO_2) was maintained at 50% throughout the duration of the case.

During initial positioning of steep trendelenberg, peak inspiratory pressure (PIP) and oxygenation were within normal limits. The patient was stable upon incision and the procedure was uneventful. Volume control ventilation was maintained throughout the case with adequate PIP, oxygen saturation, and end-tidal CO_2 noted. Anesthesia was maintained with vecuronium, fentanyl, and isoflurane. The patient was hemodynamically stable for incision and the course of surgery was uneventful.

As the procedure ended, the isoflurane was discontinued. The neuromuscular blockade was antagonized with neostigmine 4 mg and glycopyrrolate 0.6 mg. The train of four (TOF) count was noted as four out of four with equal double burst stimulation. As the patient resumed spontaneous respiration mechanical ventilation was discontinued. Adequate tidal volumes of greater than 500 mL were observed. Upon return of adequate gag and swallowing reflexes paired with the ability of the patient to follow commands, extubation was performed followed by placement of 100% O_2 delivered via facemask. After ensuring airway patency, the patient was transported to the post anesthesia care unit (PACU).

Discussion

During RALP, a pneumoperitoneum is introduced, which causes cephalad displacement of the diaphragm consequently producing pulmonary effects that require vigilant ventilatory care.[2] These effects of pneumoperitoneum include decreased lung compliance, increased airway pressures, and increased ventilation/perfusion (V/Q) mismatch.[3] These effects are compounded by the addition of the steep trendelenberg position utilized for surgery, which causes cephalad movement of abdominal viscera. Pulmonary impediments associated with this position include decreased compliance,

reduced vital capacity and functional residual capacity, 20% decrease in lung volumes, and V/Q mismatch. [5] In addition, CO_2 insufflation is systemically absorbed and within 15 – 30 minutes hypercapnia with resultant acidosis, tachycardia, arrhythmias and CNS effects can occur. [3]

Generally speaking, utilizing positive end-expiratory pressure (PEEP) and maintaining adequate minute ventilation through increasing the respiratory rate in lieu of an increased tidal volume can be utilized to manage some of the aforementioned derangements incurred during this procedure. [2] PEEP can assist in minimizing alveolar collapse however PEEP must be used with caution as it can further compromise a reduced cardiac output associated with pneumoperitoneum.[4] Research regarding superiority of either volume control ventilation (VCV) or pressure control ventilation (PCV) is equivocal.

Volume control ventilation is the most common ventilator mode and entails a constant flow to deliver a target tidal volume. [5] Utilizing this mode intraoperatively during RALP can yield high peak airway pressures requiring a decrease in set tidal volume and an increase in respiratory rate to maintain effectiveness. [6] With this mode, there is increased risk of barotrauma and high inflation pressures. [4] An alternative to VCV is PCV, which controls peak airway pressures and inspiratory time depending upon ventilator settings. [7] The disadvantage to this mode is that the tidal volume is not guaranteed, as any change in compliance, e.g. loss of pneumoperitoneum intraoperatively, will affect the volume delivered to the patient. [7] A recent study found no significant difference regarding respiratory mechanics and hemodynamics between VCV and PCV during RALP and recommended that either mode may be applied intraoperatively. [6] During the presented case, we chose to initiate the patient in volume control ventilation mode as his oxygenation was maintained between 98 – 100%, peak pressures were between 25 – 31 cm H_2O, and end-tidal CO2 remained between 36 – 40 mmHg.

Pressure control ventilation was the contingent ventilatory plan secondary to his diagnosis of COPD and poor PFTs. Patients with COPD undergoing RALP must be assessed for risk and counseled for possible postoperative pulmonary complications. [2] In this case, the patient had PFTs that revealed significant obstruction with FEV1/FVC ratio of 22%. Patients who have an FEV1/FVC ratio < 50% are considered to be at increased risk of postoperative pulmonary complications.[7] The anesthesia team discussed the patient's affliction thoroughly with the patient and inquired about compliance with his treatment regimen and whether or not he had any recent exacerbations or infections. He indicated that he was very compliant with his medication regimen and his last exacerbation requiring hospitalization was six months prior to the day of surgery. Given these findings the anesthesia team felt comfortable with providing this patient with general anesthetic and ventilator support required for surgery.

Chronic obstructive pulmonary disease presents ventilatory considerations independent of the procedure performed. The main goals of mechanical ventilation with a COPD patient are to ensure sufficient arterial oxygenation and avoid gas trapping, or intrinsic PEEP. [8] A means to accomplishing this is by using moderate tidal volumes defined as < 9 mL/kg, low respiratory rate defined as 10 – 12 breaths

per minute, and a long expiratory time defined as an I:E ratio of 1:3. [8] As our patient weighed 93 kg, our set tidal volume of 500 mL was appropriate and actually provided room for adjustment if needed throughout the case. Our respiratory rate and I:E ratio were also managed appropriately throughout the case at 10 breaths per minute and an I:E ratio of 1:2.5. Additionally, peak inspiratory pressures for the patient with COPD should be less than 30 cmH_2O and can be achieved by minimizing minute ventilation to restrict airway pressure. [8] In this case, the patient did incur peak pressures of 31 cmH_2O, however it was not sustained long enough to warrant adjustment in ventilator settings.

Upon first glance, the patient appeared to be difficult from a ventilatory standpoint with poor PFTs and an extensive treatment regimen for COPD. Despite the preoperative concerns, the case went smoothly. On subsequent cases similar in nature, it would be prudent to closely monitor peak inspiratory pressures and ensure they remain less than 30 cm H_2O as high pressures can contribute to barotrauma in the COPD patient. Additionally, it would be judicious, as an anesthesia provider, to appropriately adjust ventilator alarm settings to assist in watchful ventilatory care. By adjusting the alarms to parameters appropriate for the patient and the procedure, the anesthesia provider will be alerted to increasing pressures allowing for the implementation of appropriate adjustments to provide the safest care possible.

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Difficult Mask Ventilation

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Keywords: mask ventilation, difficult mask ventilation, difficult airway, obesity, obstructive sleep apnea

Effective mask ventilation is a necessary skill for every anesthetist. Moreover, mask management of the difficult airway is a skill which requires experience and expertise with multiple tools and techniques. As novice anesthetists attempt to gain these advanced skills, they must begin by perfecting effective mask ventilation with every patient. The anesthetist must always be mindful of the fact that the ability to mask ventilate the patient is a life-saving measure; the ability to intubate is not. This case report will focus on the assessment, planning, documentation, and evaluation of mask ventilation.

Case Report

A 69-year-old, 135kg, 188cm Caucasian male presented for an inset nasal flap with tissue rearrangement. His past medical history was significant for basal cell carcinoma of the nose, hypertension, obesity with a body mass index of 38 kg/m^2, hyperlipidemia and obstructive sleep apnea (OSA). Medications included lisinopril 10 mg twice daily and simvastatin 20 mg daily with no known drug allergies. Past surgical history included excision of the basal cell carcinoma on the right side of the nose with reconstruction and free flap from left forearm to nose which was completed two months prior to this admission. Anesthesia documentation from these surgeries was notable for a two-handed mask technique with use of an oral airway. Airway exam revealed a Mallampati score of III with thyromental distance > 6cm, supple neck tissue, and oral aperture > 6cm. He was able to move his neck with full range-of-motion and was edentulous. Further examination of the face revealed a raised skin flap on the right side of the nose and reddened right eye. The nose was asymmetrical in size and appearance.

Due to the history of difficult mask ventilation (DMV) and the Mallampati score, the potential for difficult mask ventilation was anticipated. In the operating room prior to induction, an additional 15 ml of air was added to the mask cuff to improve its fit over the irregularly-shaped nose. Intravenous induction of anesthesia began with midazolam 2 mg, fentanyl 100 mcg, lidocaine 100 mg, and propofol 200 mg. After the onset of apnea, the patient was mask ventilated with some difficulty. First, an oral airway was placed along with a two-handed mask technique which showed improvement in chest rise and end-tidal CO_2 readings. The patient's head and torso were further elevated with foam padding to achieve the sniffing position. After these modifications, mask ventilation was deemed adequate, the patient was given 50mg of rocuronium, and mask ventilation continued without desaturation. The patient required three attempts at intubation with intermittent mask ventilation and eventual successful passage of a gum-elastic bougie through the vocal cords. A 7.5 endotracheal tube was threaded over the bougie and into the trachea, and was secured in place following confirmation of correct placement.

Maintenance anesthesia and emergence care proceeded without incident.

Discussion

Difficult mask ventilation occurs in 1.4-5% of anesthetic cases[1] and is defined by the American Society of Anesthesiologists as a patient care situation where "it is not possible for the anesthesiologist to provide adequate face mask ventilation."[2] Therefore, the patient in this scenario would not be considered a DMV because the addition of several maneuvers (positioning, oral airway, two-handed technique) allowed for effective mask ventilation and maintenance of oxygen saturation. Another definition of DMV includes "challenging" mask ventilation where there is a need for a two practitioners, inadequate oxygenation, or unstable mask ventilation.[1] This allows for anesthetists to accurately describe scenarios, such as this one, which required additional maneuvers but did not result in "impossible" end-points or acute desaturation events. While DMV presents the possibility of inadequate oxygenation, it also creates the potential for gastric distention which could lead to vomiting and pulmonary aspiration. Prolonged and difficult attempts at airway management may also lead to an inadequate level of anesthesia, which could cause laryngospasm or unintended patient awareness.

During the pre-operative assessment of this patient, several specific factors were noted to cause concern for potential DMV: nasal malformation, OSA, obesity, and lack of teeth. In the event of abnormal facial anatomy, the risk of difficult mask fit must be consciously accounted for in the plan for mask ventilation. The addition of 15 ml of air to the mask during pre-oxygenation and mask ventilation attempted to overcome this difficult fit. According to a study by Kheterpal et. al., the mandibular protrusion test and presence of a beard are listed as independent risk factors for the prediction of DMV.[1] While these factors are not routinely documented on the pre-operative anesthesia evaluation, they should be considered "red flags" and appropriately accounted for in the plan to mask ventilate each patient.[3]

Factors which predict DMV often overlap with factors which predict a difficult intubation.[3] In this patient, a Mallampati score of III, obesity, and OSA predicted that he may be difficult to intubate. For this reason, it was crucial to this patient's care that we develop an effective plan for mask ventilation in case of the need for additional intubation attempts. First, the patient must be positioned with torso and head elevated in the sniffing position, and the body semi-upright such that pharyngeal anatomy is optimized for ventilation.[4] Secondly, tools were immediately available for mitigating a potential DMV including multiple sizes of oral airways and laryngeal mask airways. Oftentimes an oral airway will provide structure to facilitate the fit of a facemask in an edentulous patient.[5] Alternative techniques to mask ventilation, such as the use of the laryngeal mask airway ProSeal (Venner Medical, Singapore), could be considered when an elevated BMI suggests a possible DMV prior to intubation.[6] The presence of additional anesthetists and elimination of modifiable risk factors (such as shaving a beard) are additional suggestions to prepare for an anticipated DMV.[1]

Without a standardized tool for documenting DMV, this patient's narrative record is the only way to document mask ventilation. Descriptive words such as "easy" and "difficult" are subjective and could put the patient at risk for repeated difficulties with the same technique that could have been

identified from previous practitioner documentation. Han et al.[7] proposed a numeric scale to document DMV such that: grade 0, ventilation by mask not attempted; grade 1, ventilated by mask; grade 2, ventilated by mask with oral airway or other adjuvant; grade 3, DMV (inadequate, unstable, or requiring two practitioners); grade 4, unable to mask ventilate. This scale has not been widely accepted or validated by research and it does not account for the skill level of the practitioner. Use of this grading scale is not recommended by the American Society of Anesthesiologists; but is a common means of communicating such information in multiple research articles.[1,3] Variability in the use of grading scales for mask ventilation has caused difficulty in comparing similar research projects on this subject. However, a comprehensive and objective grading scale would allow practitioners to use a common language to describe the patient experience and at the same time allow for data collection and comparison.

Anesthesia practitioners must effectively communicate difficulties encountered during mask ventilation, modifiers that allow for successful ventilation, and opportunities for improvements in patient care.[3] Documentation and communication of DMV will promote safe patient practices and allow practitioners to learn from their shared experience. While the incidence of DMV is relatively low, the potential for DMV demands our respect much like the possibility of malignant hyperthermia and homozygous atypical pseudocholinesterace.[1] Thorough patient assessment with evidence-based tools, effective preparation for anticipated and unanticipated difficulties, objective and uniform documentation, and professional evaluation are critical to the safe and effective care of our patients.

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Challenges in Remote Anesthesia

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Keywords: non-operating room anesthesia, off-site anesthesia, remote anesthesia, risk, safety

Remote anesthesia, or the administration of an anesthetic outside of the operating room (OR), is a growing area of anesthetic practice. A recent study at a major academic medical center revealed 12.4% of anesthetics performed in the facility were delivered outside of the operating room.[1] This expanding area of practice presents several factors that complicate the delivery of a safe anesthetic.[1-3] The importance of addressing these issues is stressed by a recent review of the American Society of Anesthesiologists (ASA) Closed Claims database that revealed the severity of injuries for remote anesthesia claims is significantly greater than for OR claims.[4]

Case Report

A 65 year-old, 53 kg female presented for insertion of a Mini Fletcher applicator (Nucletron B.V., The Netherlands) and high-dose-rate brachytherapy for stage IIIB adenosquamous carcinoma of the cervix. The Mini Fletcher applicator is a device that facilitates intravaginal radiation therapy. She had a past medical history significant for poliomyelitis, osteoarthritis, and gastric ulcer. Her surgical history included bilateral foot surgeries, an open reduction internal fixation of the right radius, and a cervical biopsy under general anesthesia three months prior to the current procedure. The patient's home medications included baclofen, diphenoxylate/atropine, fentanyl, fexofenadine, hydrocodone/acetaminophen, lorazepam, ondansetron, prednisone, scopolamine, and zolpidem. Additionally, she completed external beam radiation and cisplatin chemotherapy two weeks prior and indicated recent complaints of nausea and vomiting.

On arrival in the radiation treatment room, all standard anesthesia monitors were applied and preoxygenation was completed. Induction of general anesthesia was accomplished with intravenous administration of fentanyl 100 mcg, propofol 90 mg, and rocuronium 40 mg. An endotracheal tube was placed under direct laryngoscopy and the anesthetic was maintained with isoflurane. Placement of the Mini Fletcher applicator was completed in approximately one hour.

The patient then required transportation to a nearby computed tomography (CT) scanner to assure correct positioning of the device. Ventilation was accomplished with a self-inflating manual resuscitation bag and a transport monitor was utilized. A bolus dose of propofol 20 mg was administered during the transportation. In the CT scanner suite, the patient was reattached to all standard anesthesia monitors and an anesthesia gas machine was used to provide general anesthesia with isoflurane. The patient was monitored by direct visualization from the CT control room while the study was completed.

Once correct positioning of the device was confirmed, the patient was transported back to the radiation treatment room. Again, a self-inflating manual resuscitation bag and transport monitor were utilized and a bolus of propofol 30 mg was given. With the

monitors reapplied and utilizing the anesthesia gas machine to deliver isoflurane, the brachytherapy treatment was administered. This procedure required remote monitoring by videography for approximately 10 minutes.

The Mini Fletcher device was removed and the patient was allowed to emerge from anesthesia following reversal of the neuromuscular blockade. Extubation was accomplished without complication and oxygen was administered by nasal cannula. The transport monitor was reapplied and the patient was prepared for transportation to the post anesthesia care unit (PACU). However, prior to leaving the treatment room, the patient experienced emergence delirium requiring the administration of midazolam 2 mg. The patient was then safely transported to the PACU.

Discussion

The challenges presented by remote anesthesia can be grouped into three broad areas – those related to the patient, the procedure, and the environment.

Patient factors complicating remote anesthesia include extremes of age, obesity, and increasing ASA physical status.[1,5] It would seem intuitive that these high risk patients should be anesthetized in the operating room rather than in a remote location. However, a growing number of diagnostic and interventional radiologic, cardiovascular, and endoscopic procedures are being performed in specialized suites. Additionally, the comorbidities that result in an increased ASA physical status may also result in the patient being deemed inappropriate for traditional surgical intervention. The recognition that these patient factors cannot be altered reinforces the need for increased vigilance and adherence to the related standards of anesthesia care.[6,7]

In this case, the patient was an ASA physical status 3, and the advanced nature of her cervical cancer made it inoperable. The ASA Standards for Basic Anesthetic Monitoring, the ASA Statement on Nonoperating Room Anesthetizing Locations, and the American Association of Nurse Anesthetists (AANA) Standards for Office Based Anesthesia Practice provide the minimum guidelines to encourage quality and safety in the provision of remote anesthesia care and were adhered to in this case.[6-8]

The anesthesia professional's lack of familiarity with the procedure being performed may further complicate remote anesthesia. The number of new and emerging interventional therapies increases the possibility that the procedure will be unfamiliar to the anesthetist. In addition, the procedure may have unique anesthetic concerns or involve techniques that specifically affect the delivery of anesthesia. Further, the remote location of these procedures almost assures that the anesthetist has limited interaction with the providers working in this area. Frankel addresses these issues describing them as a lack of standardization and reliability that anesthesia professionals have come to expect in the operating room.[3] These concerns underscore the need for effective communication and team building skills.

This case involved an anesthetic technique that has been described in the literature, but is certainly not routine.[9,10] The necessity of transporting the anesthetized patient from the radiation treatment room to the CT scanner and back during the procedure required a second anesthesia machine and interruption of the administration of the

volatile anesthetic. In addition, collaboration with the radiation oncology team and the CT personnel, as described in the AANA Scope and Standards for Nurse Anesthesia Practice, was necessary to facilitate a safe and effective procedure.[11]

Many environmental related factors present safety concerns during the delivery of remote anesthesia including the location, design, and physical hazards. The location is often distant from the OR, PACU, and intensive care unit (ICU). Being distant from the OR increases the response time should specialized equipment or the assistance of additional anesthesia practitioners become necessary. Significant distance to the PACU or ICU increases the risks associated with patient transport following the anesthetic. The availability of space, lighting, and access to the patient is often also a concern in the remote anesthesia site. The logistics are frequently less than ideal since the delivery of anesthesia is not the primary focus in the design of these areas. Finally, the nature of many of the procedures presents safety risks to the anesthesia practitioner, specifically from radiation and strong magnetic fields.

This case involved all of the aforementioned environmental factors. The radiation oncology department was located in the cancer center, which is in an entirely separate building from the OR, PACU and ICU. This presented a concern at the end of the case when the patient became agitated and resulted in a delay to assure that the transfer could be safely completed. Design of the CT scanner suite required that the patient be transferred to the table and then attached to an anesthesia circuit that was fed through the CT scanner. In both the CT scanner suite and the radiation treatment room, the radiation hazards necessitated remote monitoring.

Remote locations present a number of challenges to the safe delivery of an anesthetic. Although these concerns can be categorized, the specific issues will be unique to each case. By fastidiously addressing each area of concern the anesthetist can minimize the risk in this growing area of anesthesia care.

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Physiologic Considerations for Patients in Steep Trendelenburg Position

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Keywords: steep Trendelenburg, robotic surgery, anesthesia

Robotic surgical procedures are changing the way many laparoscopic surgeries are being performed. Robotic techniques reduce surgery time and blood loss when compared to traditional laparoscopic procedures.[1] However, obtaining the benefits from robotic surgical techniques presents a unique set of challenges in patient positioning. The use of steep Trendelenburg (30° or more) position leads to physiological changes that require in-depth knowledge and astute monitoring on behalf of the anesthesia practitioner in order to administer optimal anesthesia care.

Case Report

A 54 year-old, 173cm, 76kg male with prostate cancer but without other significant medical history presented for robotic radical prostatectomy with bilateral pelvic lymph node dissection. Preoperative vital signs were: blood pressure 111/57 mm Hg, heart rate 65 beats/min, respirations 14 breaths/min, and oxygen saturation 95% on room air. The patient was assessed in the holding room and noted to have allergies to latex and lactose. He was premedicated with midazolam and transferred to the operating room. The patient was placed in the supine position and preoxygenated via face mask. Anesthesia was induced using intravenous lidocaine and propofol. Adequate mask ventilation was confirmed, and rocuronium was administered for muscle relaxation. Following confirmation of neuromuscular blockade by nerve stimulator, intubation was performed via direct laryngoscopy. Endotracheal tube placement was confirmed, the tube was secured, and maintenance anesthesia was started with isoflurane.

Following the placement of shoulder restraints, the patient was placed in steep

Trendelenburg/lithotomy position and monitored for changes in respiratory compliance. Changes in peak airway pressures ranging from approximately 16 to 26 cm H_2O were observed. Initial flow loop volumes were analyzed and the ventilator was set to a volume control modality. Following placement of the patient in steep Trendelenburg position and incision, the patient's blood pressure increased from a baseline of 120/70 mm Hg to 140/90 mm Hg. Prompt administration of clonidine 50 mcg IV provided a decrease in blood pressure and a return to baseline of preoperative vital signs. The case was completed without additional hypertension. Maintaining the patient's blood pressure within 20% of preoperative range required the use of phenylephrine boluses totaling 240 mcg. Fentanyl was administered throughout the case for pain control.

Upon completion of the procedure, the robot was undocked from the patient and the table was returned to the level position. Isoflurane was discontinued and oxygen was increased to assist the patient during emergence from anesthesia. Upon meeting the criteria for extubation, the endotracheal tube was removed and the patient was placed on oxygen via a transport circuit. The patient was assisted to the stretcher and transported uneventfully to the post-anesthesia care unit (PACU). The patient denied pain upon admission to the PACU and initial vital signs remained within the acceptable 20% preoperative range.

Discussion

Robotic surgical techniques have changed the way many surgeons are performing laparoscopic surgery. In order to allow the robotic console to come into contact with the patient's abdomen, the patient must be placed in a steep Trendelenburg position (minimum of 30° head down) while the lower extremities are placed in a lithotomy position to allow room for proper docking of the robotic column. When creating the anesthetic plan, the anesthesia professional must be aware of the physiologic changes that occur when the patient is placed in the steep Trendelenburg position. Hemodynamic changes result from the displacement of blood from the extremities to the central vasculature.[1] This displacement can lead to an increase in central venous pressure, systemic vascular resistance, mean arterial pressure, and stroke volume. A gradual increase in cardiac index and myocardial oxygen consumption may occur. These changes may induce hypertension which may necessitate treatment. In this case, the use of clonidine 50mcg IV was administered to reduce the blood pressure to within 20% of preoperative baseline.

The steep Trendelenburg position can alter the patient's cerebral perfusion. The required carbon dioxide pneumoperitoneum combined with steep Trendelenburg positioning can lead to a decrease in cerebral venous return, causing an increase in intracranial pressure.[1] A recent study performed at the Yonsei University College of Medicine examined the relationship between steep Trendelenburg positioning and induced pneumoperitoneum on cerebral oxygenation.[3] Since increasing intracranial pressure (ICP) will lead to a reduction in regional cerebral oxygenation (rSO_2) the researchers used continuous rSO_2 measurements to monitor changes in rSO_2 that occurred during robotic radical prostatectomy surgery. Their findings suggest that a slight increase in rSO_2 was enough to prevent cerebral ischemia from being induced by steep Trendelenburg and pnuemoperitoneum in robotic surgery. However, patients with underlying cerebral

ischemia or cerebrovascular disease prior to surgery may be at greater risk for cerebral ischemia due to increased ICP. The patient's neurological assessment and history plays an important role in deciding if the patient would be a candidate for surgery requiring steep Trendelenburg positioning. In this case, the patient did not have a history of cerebral vascular disease or ischemia that would warrant concern over the patient's neurological status resulting from steep Trendelenburg positioning.

Over time continuous steep Trendelenburg positioning will lead to a decrease in the body's ability to regulate intraocular pressure (IOP) leaving the patient with the potential for perioperative vision loss. Steep Trendelenburg positioning can cause a significant amount of facial and periorbital edema that eventually resolves during the postoperative phase. Although the facial edema can be considered a benign consequence, there is new evidence to suggest that ophthalmic circulatory autoregulation is not able to overcome increases in IOP when the patient is maintained in steep Trendelenburg for more than two hours at a time.[2] Increases in IOP accompanied by decreases in ocular perfusion pressure may put patients who are in steep Trendelenburg position at increased risk for postoperative vision loss. In order to reduce this risk, researchers suggest that elevating the MAP or decreasing the IOP may be important among patients placed in steep Trendelenburg for increased lengths of time. Current research on this issue is examining the changes in IOP and the risk for postoperative vision loss when the patient is returned to the level position for five minute rest periods after each hour of surgery. As this research continues, the use of five minute rest periods may prove to be an important action in reducing the risk of postoperative vision loss during steep Trendelenburg.

Steep Trendelenburg positioning also results in important physiologic changes to the respiratory system. This position decreases lung compliance and may result in atelectasis due to displacement of the diaphragm from the carbon dioxide pneumoperitoneum.[1] Studies comparing pressure control ventilation (PCV) and volume control ventilation (VCV) have been performed to determine which settings may improve gas exchange and reduce atelectasis during steep Trendelenburg. There is some evidence to suggest that dynamic compliance is improved and peak airway pressures are reduced when using PCV in steep Trendelenburg.[3] However, another recent study only using VCV suggests that cardiovascular, cerebrovascular, and pulmonary homeostasis was maintained within acceptable ranges.[1] In the case mentioned above, the patient was maintained on VCV while monitoring pressures throughout the case.

As robotic procedures become more common, it is increasingly important for anesthesia professionals to understand how steep Trendelenburg positioning changes the patient's physiologic state. Changes in hemodynamics, the choice of ventilator settings, and consideration of the risk for injury associated with prolonged steep Trendelenburg must be weighed against the benefits of performing robotic surgery that require this position.

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Hydroxyethyl Starch 130/0.4 Administration to the Chronic Renal Failure Patient

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Keywords: hydroxyethyl starch, Voluven, artificial colloid, chronic renal failure, volume replacement

Intraoperative fluid management in the chronic renal failure patient can be challenging, especially when large amounts of blood loss are anticipated. In addition to packed red cells or crystalloid solutions, intravascular volume may be replaced by artificial colloid solutions such as hydroxyethyl starch (HES) formulas. Tetrastarch (HES) 130/0.4, trade name Voluven (Fresenius Kabi Deutschland GmbH, Bad Homburg, Germany), is the most recently developed HES formula.[1] As discussed later, HES types are significantly different in regards to pharmacokinetics.[1,2] Therefore hydroxyethyl starch 130/0.4 must be evaluated for administration in the chronic renal failure patient.

Case Report

A 57 year old male, who weighed 127.1 kg and was 180 cm in height, presented for an elective left anterior supine total hip arthroplasty for treatment of degenerative joint disease. Past medical history was significant for hypertension, hyperlipidemia, obesity, renal artery atherosclerosis, stage III chronic kidney disease, insomnia, allergic rhinitis, and osteoarthritis. Past surgical history included right total hip arthroplasty and laparoscopic gastric band placement. Laboratory values included: sodium 135mEq/L, potassium 5.0mEq/L, chloride 101mEq/L, glucose 109 mg/dl, calcium 9.5 mg/dl, urea nitrogen 50.8 mg/dl, creatinine 2.32 mg/dl, estimated glomerular filtration rate 29 ml/min/1.73 m^2, white blood cell count 8.8 x 10^3/uL, hemoglobin 14.3 g/dl, hematocrit 42%, and platelet 266,000 mm^3. Once in the operating room, standard monitors (NIBP, ECG, pulse-oximetry, and capnography) were placed and oxygen was administered by nasal cannula at 4 L/min. Midazolam 2 mg IV and fentanyl 100 mcg IVwere administered for sedation prior to subarachnoid block placement. With the patient in a sitting position the interspace

between the 3rd and 4th lumbar vertebrae was identified, prepped, and draped in a sterile fashion. The skin was anesthetized with an injection of 2ml lidocaine 1% and a 25g pencil point spinal needle was placed. Following a return of clear CSF, 2 ml of bupivacaine 0.75% was slowly administered and the needle was removed. The patient was assisted to a supine position. After achieving a sensory block at T8, a propofol infusion at 50 mcg/kg/min IV was started for sedation.

A foley catheter was inserted to monitor urine output during surgery. Surgery proceeded with 100 minutes of operating time. The patient's estimated blood loss was 1000 ml. Intraoperative fluid management included1600 ml of 0.9% Sodium Chloride crystalloid solution and 1000 ml of HES 130/0.4 solution. The patient's total urine output for this case was 170 ml.

Discussion

As an alternative to albumin, HES solutions were developed as artificial colloids. Hydroxyethyl starch solutions have developed over several generations following the development of gelatin and dextran.[2] Hydroxyethyl starch originates from a polysaccharide in maize and consists of amylopectin molecules.[3] Different preparations of HES are available. Molecular weight, molar substitution, and C2/C6 ratio distinguish the various HES types.[1,3] Additionally these characteristics determine the rate of decomposition. Slower decomposition and higher plasma accumulation are found in solutions with higher molar substitution and C2/C6 ratios.[3]

Hydroxyethyl starch solutions, being polydisperse, have a distribution of molecular sizes. Smaller molecules are immediately excreted by the kidneys, while larger molecules are split by plasma amylase until small enough to be excreted.[1,4] Although primary elimination is renal, transient tissue storage is variable and dependent on the formula of the HES.[2] Large residual plasma concentrations of HES solutions after 24 hours lack therapeutic properties and may have adverse effects.[4]

The physiochemical properties of different HES solutions can adversely affect hemostasis,[5] by dilution and alteration of coagulation factors. Newer generations of HES formulas, such as HES 130/0.4, were developed to improve the safety profile by decreasing the effects on coagulation.[5] A pooled analysis of seven clinical trials compared blood loss and use of blood products after HES 130/0.4 or HES 200/0.5 administration during major surgery.[5] Both perioperative blood loss and transfused red blood cell volume were found to be significantly less in the HES 130/0.4 group. Coagulation factors in the early postoperative period also differed between groups. The HES 130/0.4 group was found to have a shorter activated partial thromoplastin time, a higher von Willebrand factor antigen and ristocetin cofactor, and slightly higher platelet counts. Due to these differences, this study indicates that HES 130/0.4 may have a lower impact on the plasmatic coagulation system, therefore, resulting in less blood loss and need for transfusion during the perioperative period.[5]

Another study compared administration effects on renal function with gelatin, HES 200/0.6 and HES 130/0.4 during aortic aneurysm surgery.[6] Serum urea was lower in both groups receiving HES as compared to gelatin. The HES 130/0.4 group serum creatinine was lower when compared to gelatin. Overall, HES solutions were shown to have improved renal function and reduced

renal injury when compared to gelatin. However, no significant difference was found between the HES groups.[6]
In a meta-analysis completed by the Cochrane Collaboration, 34 studies were evaluated comparing HES solutions to other fluid therapies and their effects on kidney function.[7] Primary indicators included acute kidney injury and need for renal replacement therapy. Secondary indicators included creatinine clearance, glomerular filtration rate, and serum creatinine. While analyzing studies comparing high versus low molecular weight HES, no significant differences were found between types of HES solutions for any of the outcome measures.[7] Furthermore, the authors stated there was insufficient evidence to support claims that HES 130/0.4 was pharmacokinetically favorable when compared to older HES formulas in relation to kidney function.

While the above studies evaluated patient populations with adequate renal function, one study analyzed HES 130/0.4 administration to patients with known renal impairment. Renal impairment in subjects ranged from creatinine clearance (CLcr) values from nearly normal (CLcr=80-<120 ml/min/1.73m) to severe (CLcr<30 ml/min/1.73m).[4] A group of 19 volunteers with stable, non-anuric renal impairment were given a single 500 ml bolus of HES 130/0.4 over 30 minutes. Both plasma concentrations and urinary excretions were subsequently measured. All subjects, even those with severe renal impairment, demonstrated only small residual HES plasma concentrations (mean 0.5 mg/ml) after 24 hours. Additionally, after a single dose, no further deteriorations in CLcr were found. As long as urine flow is preserved, this study concluded HES 130/0.4 could safely be used in renal impairment patients without significant plasma accumulation.[4]

Administration of HES formulas to patients with known renal impairment is controversial.[6] Conflicting past studies of older HES solutions[1] may have prematurely lead to optimistic views of HES 130/0.4 administration on renal function. Larger studies with adequate power in perioperative patients are needed to establish if the pharmacokinetics are better for renal function.[7] Further HES 130/0.4 studies regarding renal function need to have additional follow-up.[7]The anesthetic community needs additional research on HES 130/0.4 during the perioperative period with both normal and impaired renal function populations.

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Sjogren's Syndrome

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Keywords: Sjogren's, Sicca, autoimmune, xerostomia, xerophthalmia

Sjogren's syndrome (SS) is the second most common autoimmune rheumatic disorder, and the two forms (primary and secondary) have been estimated to affect up to 1% of the population in the United States or 0.5-3 million people.[1,2] SS is frequently underdiagnosed, undertreated, and under-researched.[3] Compared with other autoimmune rheumatic diseases such as rheumatoid arthritis (RA) and systemic lupus erythematosus (SLE), SS is relatively mild and without a significantly increased mortality.[3] Thus, SS is a disease of morbidity rather than mortality, which means that it does not attract the same clinical and research interest as other autoimmune diseases.[3]

Case Report

A 37-year-old, 137 cm, 90 kg, female presented for a laparoscopic cholecystectomy due to cholelithiasis. Her past medical history included sleep apnea requiring a continuous positive airway pressure machine, obesity with a BMI of 34, osteoarthritis, history of proteinuria, and SS. The patient's manifestations of SS included chronic fatigue, dry eyes and mouth, and probable renal disease. Current medications included losartan, hydroxychloroquine, iron, prednisone, and cholecalciferol. She received only her losartan the morning of surgery. All preoperative lab results were within normal limits including a complete blood count and hepatic function test.

The patient was given midazolam 2 mg intravenously (IV) and transported to the operating room (OR) where the patient positioned herself comfortably on the OR table. Noninvasive monitors were applied and oxygen was administered at 8 L/min via face mask for five minutes. A heat and moisture exchanger (HME) was included in the breathing circuit. Fentanyl 100 mcg, lidocaine 100 mg, propofol 180 mg, and rocuronium 40 mg were administered IV prior to direct laryngoscopy with a MAC 4 blade. A 7.0 mm lubricated endotracheal tube was used to intubate the trachea. Placement was confirmed via positive end-tidal CO_2, tube fog, equal chest rise, and auscultation of bilateral breath sounds. Respiration was controlled by a mechanical ventilator, oxygen flow was decreased to 0.75 L/min, and air flow was added at 0.75 L/min. Ophthalmic lubrication was placed

into the patients eyes, and then the eyes were gently taped.

General anesthesia was maintained with isoflurane at an end-tidal concentration of 1.5%, fentanyl 100 mcg, rocuronium 10mg, and vecuronium 2 mg IV. The patient received famotidine 20 mg and hydrocortisone 100 mg IV prior to induction and granisetron 1 mg IV approximately 30 min prior to emergence. The patiet was kept warm during the procedure using an upper body forced air warmer, and her temperature was monitored via an esophageal temperature probe. Her temperature remained greater than 36.1°C throughout the case. The patient received lactated ringers 450 mL and hetastarch 500 mL IV during the case.

Once the surgery was completed, neuromuscular blockade was antagonized using neostigmine 3 mg and glycopyrrolate 0.6 mg IV. A lubricated nasal airway was inserted. The patient had a 4 of 4 train-of-four count and sustained tetanus for 5 s, opened her eyes to verbal command, and generated significant tidal volumes of 300-400 mL. The endotracheal tube was removed with positive pressure and the patient was transported to the post anesthesia care unit (PACU) where she received meperidine 25 mg approximately 10 min after arrival.

Discussion

Sjogren's syndrome (also known as sicca syndrome) is a systemic autoimmune connective tissue disorder characterized by inflammation of the exocrine glands that leads to secretory hypofunction and dryness of mucosal surfaces, most commonly of the eyes (xerophthalmia) and mouth (xerostomia).[1] The histological hallmark is a focal lymphocytic infiltration of the exocrine glands.[4] The exocrinopathy can be encountered alone (primary SS) or in the presence of another autoimmune disorder such as RA, SLE or progressive systemic sclerosis (secondary SS).[5] Up to 25% of SS patients experience other systemic effects (extraglandular manifestations) including inflammatory arthritis and cutaneous, vascular, neurological, renal or pulmonary involvement.[1,4]

Women constitute approximately 90% of patients with SS, with onset of symptoms typically occurring in middle age.[1] The multiple facets of SS make it difficult to diagnose.[6] As a consequence, SS commonly remains either undiagnosed or is diagnosed years after the onset of symptoms.[6] Early recognition of this disease is of pivotal importance to optimize therapeutic intervention.[6] Treatment is based on muscarinic agonists (pilocarpine and cevimeline) for sicca features and immunosuppressive/biological agents (corticosteroids, hydroxychloroquine, interferon-alpha, infliximab, and rituximab) for extraglandular features.[4] However, there are no evidence-based therapeutic guidelines for the management of SS.[2] Xerophthalmia is managed with local and systemic stimulators of tear secretion and supportive surgical procedures.[6] Xerostomia treatment includes intense oral hygiene, prevention and treatment of oral infections, use of saliva substitutes, and local and systemic stimulation of salivary secretion.[6]

Oral and dental disease in SS is extensive, persistent, and represents a significant burden of illness.[1] Vigilant oral care is crucial. Lubricating the endotracheal tube, oral or nasal airways, and esophageal temperature probe is imperative. For patients with dental manifestations, use of a mouth guard during direct laryngoscopy may be helpful to prevent injury. Eye care such as

artificial tears and ophthalmic ointments should be continued perioperatively.[7] Avoidance of medications that exacerbate dryness such as anticholinergics, antihistamines, and diuretics is recommended.[6] In this case the patient could have received a decreased dose of the anticholinergic, glycopyrrolate. Adequate hydration during the intraoperative period is essential and a prolonged NPO time should be avoided in these patients.

Chronic fatigue is one of the most prevalent and debilitating symptoms of SS with approximately 70% of SS patients affected.[3] Arthritis occurs in about 30% of SS patients.[3] Allowing the patient to self-position comfortably on the OR table and careful positioning once the patient is rendered unconscious will help prevent injury and postoperative discomfort. Raynaud's phenomenon occurs in about 30% of SS cases.[3] To prevent Raynaud's phenomenon intraoperatively warming techniques should be implemented including forced air warmers, fluid warmers, low gas flows, and increasing the ambient temperature of the room.

Pulmonary function abnormalities are found in approximately 25% of patients with SS, although these are rarely clinically significant.[3] Lung lesions are caused by interstitial infiltrate of lymphocytes around the bronchioles and are described as lymphocytic interstitial pneumonia or bronchiolitis.[3] Dryness of the upper respiratory tract mucosa can cause dry, crusted secretions and bronchial hyper-responsiveness.[6] A HME on the breathing circuit will help keep the patient warm and help prevent the buildup of mucus in the lungs.

Although the frequency of clinically significant renal disease is only approximately 5%, the frequency of subclinical renal disease is approximately 30%.[3] This presents as either interstitial nephritis, leading to renal tubular acidosis, or glomerulonephritis.[3] Patients with SS have an approximately 20-fold increase in the risk of developing B-cell lymphomas and about 5% of patients with SS eventually develop lymphomas.[1,3] Studies have found signs of autonomic nervous system dysfunction in SS including both parasympathetic and sympathetic dysfunction.[8] Various gastrointestinal (GI) abnormalities such as dysphagia, gastroparesis, and irritable bowel syndrome have been reported to be more common in patients with SS than in the general population.[8] Patients with SS demonstrate varying degrees of esophageal dysmotility mainly manifesting as gastroesophageal reflux.[6] Medications to prevent aspiration and postoperative nausea/vomiting should be implemented. Patients with SS may often be taking long-term steroid medication and should receive supplemental doses for surgery due to hypothalamic-pituitary-adrenal axis suppression.

When providing care to a SS patient there are many considerations for anesthesia practitioners. Special attention to oral and ophthalmic care is crucial. Also, adequate hydration and avoidance of medications that exacerbate dryness is of upmost importance. It is essential to keep in mind positioning implications for arthritis involvement and warming techniques to prevent Raynaud's phenomenon. Lastly, pulmonary, renal, GI, and autonomic nervous system abnormalities should be considered. Good communication with OR and PACU staff and others involved in the care of a SS patient by the anesthesia team is imperative when striving for the best patient outcome.

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Minimizing Post-operative Nausea and Vomiting after Thyroid Surgery

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Keywords: post-operative nausea and vomiting, antiemetic, anesthesia, thyroid surgery

Post-operative nausea and vomiting (PONV) is one of the most debilitating side effects experienced after surgery. Many patients consider PONV as an incapacitating side effect that impedes a smooth recovery post-operatively. The focus of anesthesia providers is to maintain patient safety throughout a surgical procedure. Diligent care should be devoted to minimizing post-operative side effects. This case study highlights risk factors and prevention modalities for PONV. The overall goal is to promote the best possible post-surgical outcome.

Case Report

This case involved a 62-year-old female who weighed 70 kg and was approximately 165 cm. The patient had developed a multinodular goiter over a decade ago. A total thyroidectomy was recommended. Surgical treatment was based upon the large size of the left sided nodule as well as the presence of two nodules on the right. On the day of surgery, the patient presented asymptomatic, euthyroid, and with no signs or symptoms of tracheal compression. Her past medical history included gastro-esophageal reflux disease (GERD) and a hiatal hernia. The patient's pre-operative assessment revealed a history of PONV associated with each of her past surgical procedures including a tonsillectomy, an open reduction internal fixation of her left elbow, and an arteriovenous malformation repair. The patient expressed concern over experiencing PONV post-operatively. The patient was unaware of any specific contributing factors to her history of PONV

but stated that ondansetron helped her with the symptoms. Ondansetron, 4 mg by mouth every 6 hours PRN for nausea, was listed among her current medications for the treatment of her frequent intermittent nausea and vertigo. Her current home regimen of famotidine for GERD provided daily relief of symptoms and as instructed, the patient took famotidine 20 mg by mouth the morning of surgery.

Her allergies included morphine sulfate and codeine, both which caused nausea and vomiting, omeprazole which caused abdominal cramping, and metoclopramide which caused anxiety. Physical examination revealed a visible goiter dominant on the left and palpated at approximately 4 cm. Her trachea was midline with full neck range of motion. She denied compression symptoms, including shortness of breath, hoarseness, sore throat, cough, or a feeling of pressure in her throat, while sitting upright as well as while lying flat. The patient's history of PONV and plan of care was discussed among the anesthesia providers.

Midazolam 2 mg was administered intravenously (IV) prior to transporting the patient to the operating room (OR). Once in the OR, the patient was moved onto the OR table. ASA standard monitors (NIBP, ECG, pulse oximeter, and capnograph) were applied and the patient was pre-oxygenated with 100% FiO2 via mask. Induction was initiated with lidocaine 200 mg IV and propofol 200 mg IV. Succinylcholine 100 mg IV was then administered to provide neuromuscular blockade and tracheal intubation with a nerve integrity monitoring (NIM) electromyography (EMG) endotracheal tube (Medtronic Inc., Minneapolis, MN) was performed. Anesthesia was maintained with a continuous propofol infusion titrated between 75-150 mcg/kg/min and an inhaled anesthetic (sevoflurane) titrated between 1.7-2.3%. Dexamethasone 5 mg IV was administered after induction for PONV prophylaxis. Clonidine 100 mcg IV was administered after induction to help blunt sympathetic responses during the procedure, since muscle relaxant was not being used to allow for nerve monitoring. Fentanyl 150 mcg IV was administered throughout the case for analgesia. Droperidol 0.625 mg IV and ondansetron 4 mg IV, both for the prevention of PONV, were administered prior to emergence. Anesthetic emergence was smooth and tracheal extubation was uneventful. The surgery concluded without incident. No immediate post-operative complications were noted. The patient was transferred to the post-operative unit awake and without evidence of PONV. No emesis was recorded during the post-operative period. However, upon follow-up the patient had reported "severe nausea" during the post-operative period.

Discussion

PONV adversely affects patient satisfaction and safety while contributing to the economic impact of prolonged post-operative stays and unanticipated admissions.[1] PONV is frequently cited as a patient's foremost concern associated with anesthesia and surgery.[1] Researchers agree that PONV is one of the most undesirable side effects related to surgery under general anesthesia.[1-4] This supports the claim that PONV is the most common cause of decreased patient satisfaction during the postoperative period.[1-4] Poor patient satisfaction has been correlated with the mental and emotional anguish associated with experiencing PONV.[1-3,5] Patient safety concerns, as well as life threatening complications are also associated with PONV. The act of nausea and vomiting may initiate a vagal nerve response, leading to

severe bradycardia and hypotension. Extreme hypertension, pulmonary aspiration, and wound dehiscence as well as bleeding are among the life threatening medical events associated with PONV.[1-5] Post-operative complications may lead to costly delays in patient discharges as well as unforeseen re-admissions to the hospital. According to researchers, PONV is reported in at least 12% of patients undergoing general surgery, and some report the incidence as high as 70%.[2-4] Identification of a patient's risk for developing PONV and correlating individual patient presentation to appropriate prevention modalities, is imperative in the planning and administration of anesthetics.[4]

The prevention of PONV, and/or minimizing its symptoms, begins pre-operatively with a thorough review of the patient's history, medications, risk factors, and physical assessment. In accordance to the researchers' descriptions of risk factors for PONV, this patient's gender, previous history of PONV, non-smoking status, and throat surgery place her at a high risk for experiencing PONV.[1-5] Thyroidectomy is associated with a relatively high incidence of PONV, ranging from 51% to 76%.[6] This finding may be associated with vagal nerve stimulation during surgery.[3] The patient's history of nausea and vomiting related to specific narcotics should be taken into consideration. Avoiding administration of intra and post-operative high dose narcotics is appropriate since patients typically have only mild-to-moderate pain after thyroid surgery.[3] This patient routinely takes ondansetron for chronic intermittent nausea, which prompts suspicion for the likelihood of her experiencing PONV.

Studies have shown that perioperative opioid use and inhaled anesthetics can cause PONV.[1,3,4] It is recommended that these agents be used cautiously if PONV is suspected.[1,3,4] A remifentanil infusion was initially chosen as the anesthetic for this case report. However, after review of the patient's history, physical presentation, and plan for outpatient surgery, an alternative anesthetic was selected. A propofol infusion was chosen as the primary anesthetic agent in this case. Sevoflurane and fentanyl were used as anesthesia adjuncts and in low doses. In a recent study by Vari et al.,[3] women receiving inhalation agents for anesthetic maintenance only, had a significantly higher incidence of PONV (70.6%) after thyroid surgery than with maintenance using propofol and nitrous oxide (42.4%). Propofol's antiemetic effect is thought to involve the depression of various nausea triggering centers in the brain. Independent of its sedative effects, the exact mechanism of propofol's antiemetic properties is not fully understood. [3,4] Propofol is also a good choice for providing general anesthesia with respect to minimizing PONV in ambulatory surgery.[1]

A propofol infusion, along with the administration of a combination of antiemetic medications, is an appropriate anesthetic approach to minimizing PONV. Researchers have identified antiemetic medications that interact with the 5-HT3, dopaminergic D2, histamine H1, muscarinic cholinergic, opioid, neurokinin NK1, and $\alpha 2$ receptors.[1,2,4-6] Current research supports that preventing PONV in a high-risk patient population involves manipulation of more than one of the many receptors associated with PONV.[4,5] The intraoperative administration of dexamethasone (corticosteroid), droperidol (D2 receptor antagonist), and ondansetron (5-HT3 receptor antagonist) was in accordance with this approach for preventing PONV. This patient may also have been a candidate for metoclopramide due to her history of

chronic intermittent nausea, GERD, and a hiatal hernia. However, her allergy to this dopamine receptor antagonist prevented the use of this medication to help minimize PONV.

Clonidine, in this particular case, was administered to provide additional sedation via the α2-adrenergic receptors. However, this medication may also have an influence on preventing post-operative nausea and vomiting.[1,5] A recent study by Fujii[5] focused on the efficacy of clonidine administration for the prevention of PONV after breast surgery. Clonidine may provide relief in other surgical procedures that are associated with a high risk for the development of PONV such as a thyroidectomy. Research supports that a multifactorial mechanism exists in the prevention of PONV using alpha-$_2$-adrenergic agonists.[1,5] These drugs effectively reduce the inhalation agent requirement and therefore minimize the side effects of nausea and vomiting seen with the administration of higher doses of these agents.[1,5] Clonidine administration during induction, along with a total intravenous anesthetic (TIVA) using propofol, may greatly reduce PONV incidence compared to a pure inhalation anesthetic.[1,5]

Despite the anesthetic plan to minimize PONV in this case report, the patient regrettably admitted to nausea during the post-operative period. Although not as cost effective, the exclusive use of propofol may have been an alternative approach to minimizing PONV in this case report.[3] The application of a scopolamine patch four hours prior to surgery, may have also been beneficial in preventing PONV. The addition of scopolamine would offer a more comprehensive combination therapy in an attempt to cover the numerous receptors involved in triggering PONV.[5] In conclusion, it is important to recognize that there are many approaches to preventing PONV. However, one "cure-all" approach to preventing PONV does not exist. Promoting a positive outcome during the post-operative phase begins with a thorough and careful assessment of the patient pre-operatively. This includes a comprehensive anesthetic plan with the end goal of preventing PONV.

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Alternatives for Anesthetic Management of Pheochromocytoma

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Keywords: pheochromocytoma, adrenalectomy, anesthetic management, catecholamine, hypertension

A pheochromocytoma is defined by the World Health Organization as an intraadrenal paraganglioma.[1] These tumors arise from chromaffin cells and actively synthesize and secrete catecholamines: most predominantly norepinephrine and epinephrine and, in rare cases, dopamine.[2, 3] Signs and symptoms are highly variable and depend on the catecholamine produced. The most frequent sign is hypertension that can be lethal if not treated before surgery.[3] Pheochromocytomas remain a challenge, and it is important for the anesthetist to be aware of all available methods of hemodynamic control and choose the appropriate drug therapy to improve patient outcomes.

Case Report

A 59-year-old, 175 cm, 86 kg male presented for laparoscopic right adrenalectomy for a suspected pheochromocytoma. Two weeks prior, the patient presented with complaints of headache, night sweats, syncope, and weight loss. A computed tomography scan without contrast of the patient's abdomen was performed and a lesion measuring 3.1 cm was identified on the right adrenal gland. His norepinephrine level was 4877 pg/ml. All other lab values appeared to be within normal limits for this patient except a blood glucose of 180 mg/dl the morning of surgery. Other medical history included hypertension, congestive heart failure with an ejection fraction of 25-35%, chronic obstructive pulmonary disease, gastroesophageal reflux disorder, and diabetes mellitus. Two weeks before surgery, Prazosin 2 mg po was prescribed twice daily with an increase to three times a day for the second week. Current medications also included glipizide, omeprazole, lisinopril, spironolactone, furosemide, carvedilol, montelukast, tramadol, and insulin glargine. He received only his omeprazole and carvedilol the morning of surgery.

Prior to surgery, midazolam 2 mg intravenous (IV) was administered, a central venous catheter was placed in the right internal jugular vein and normal saline 1 L was administered preoperatively. A lactated ringers infusion was then initiated and the patient was transferred to the operating room. Upon arrival, noninvasive monitors were applied and the left radial artery was cannulated. The arterial line was connected to a pulse contour cardiac output monitor. The previously placed central venous line was connected to an invasive monitoring system. Oxygen 10 L/min was administered by mask. Initial vital signs included a blood pressure of 178/78 mmHg, heart rate of 80 beats/min, central venous pressure of 9 mmHg, and cardiac output of 4.8 L/min.

A rapid sequence induction was performed using midazolam 3 mg, fentanyl 400 mcg, and succinylcholine 100 mg IV. A MAC 3 blade was used for direct laryngoscopy and a 7.5 mm endotracheal tube was used to intubate the trachea. Endotracheal tube placement was confirmed by tube fog; chest rise; equal, bilateral breath sounds; and positive end tidal CO_2. Once placement was confirmed, respiration was controlled by a mechanical ventilator, oxygen flows were reduced to 2 L/min, and isoflurane 1% was used to maintain anesthesia. Cisatracurium 10 mg was used to maintain neuromuscular blockade. The patient was positioned for surgery in the left lateral decubitus position. Blood pressure was maintained with three boluses of phenylephrine 100 mcg until incision. Infusions prepared for this patient included nitroglycerine and phenylephrine.

After surgery start, the patient's blood pressure remained stable, not requiring additional phenylephrine until the tumor was removed. At that time, the patient's blood pressure decreased to 85/50 mmHg, and the phenylephrine infusion was started to maintain a systolic blood pressure greater than 115mmHg. Two hours into the procedure the approach was converted from laparoscopic to open; total surgical time was 300 min. The patient received lactated ringer's solution 5000 ml during the case. Postoperatively, the patient did not require any medications to support his blood pressure and the phenylephrine infusion was discontinued.

Discussion

The incidence of pheochromocytoma is approximately 0.5% of all episodes of hypertension.[2] Specifically, a pheochromocytoma is a catecholamine-producing tumor in the adrenal medulla.[1] Pheochromocytomas are tumors of the sympathetic nervous system (SNS), and the SNS remains active even in the presence of these tumors.[3] During surgery, the excess catecholamines released from these tumors can be fatal if the acondition is unknown or the patient is not properly premedicated. Proper medical management greatly reduces the mortality rate of pheochromocytomas; however, medication requirements vary greatly between patients. Currently, there are no randomized, controlled, clinical studies comparing methods of medical management.[3] Due to lack of standardization of treatment and the variable presentation, it is imperative for the anesthetist to be educated about all possible alternatives to optimize patient outcomes.

Current medical management of pheochromocytomas aims to block catecholamine receptors in order to normalize the blood pressure and heart rate, restore intravascular volume, and prevent catecholamine storm intraoperatively.[1] Phenoxybenzamine, a non-specific α-adrenergic antagonist, has long been the standard treatment and has proven to be effective at normalizing patients' blood pressure and blocking the effects of catecholamines preoperatively; however, treatment is not without complications.[4] Because of prolonged effects of treatment, patients frequently experience hypotension immediately after tumor resection that can be extended into the postoperative period.[4] Regardless of its ability to block adrenergic receptors, significant hypertension often results from tumor manipulation. Because phenoxybenzamine is not a selective α_1 antagonist, blockade of α_2 receptors may result in tachycardia.[3] With healthcare ever evolving and newer medications becoming available, there are now more options for the treatment of these patients.

One option is to use a shorter acting,

selective α_1 receptor antagonist such as urapidil, combined with a short acting β-blocker with or without a calcium channel blocker. Urapidil's high bioavailability, high clearance rate, and short elimination half-life make it easily titratable and ideal for IV use both before and during surgery.[5] One prospective study examined urapidil use in 18 patients having an adrenal tumor resection. Urapidil successfully prevented extremes of hypertension, regardless of high plasma catecholamine levels, suggesting that it effectively blocked the adrenergic receptors.[5] Other short-acting α-adrenergic blockers, such as phentolamine, have also been used successfully to maintain hemodynamic control during surgery.[2]

Another method to control blood pressure, used previously in pediatric patients, is magnesium sulfate.[6] Magnesium sulfate causes vasodilation by inhibiting catecholamine release, directly inhibiting catecholamine receptors, and functioning as an endogenous calcium antagonist.[6] Because of its stabilizing effects on cardiac conduction, magnesium sulfate may also have indications in the treatment of pheochromocytomas that present with cardiac complications.[6] Due to its low cost, wide availability, and safety profile, magnesium sulfate is an attractive option for managing hemodynamics during tumor resection.[6]

Approved by the United States Food and Drug Administration in 2008, clevidipine is another choice for control of hypertension. Clevidipine is a very short-acting dihydropyridine CCB that selectively dilates arteries, thereby decreasing peripheral vascular resistance without decreasing venous return.[6] Clevidipine has a rapid onset, approximately 2 to 4 minutes, and is metabolized by plasma esterases with a terminal half-life of 15 minutes. This leads to little accumulation and can be safely infused up to 96 hours.[6]

A different approach to blocking the effects of catecholamines is preventing their synthesis. Metyrosine (α-methyl-L-tyrosine) inhibits tyrosine hydroxylase, the rate limiting enzyme in the production of catecholamines.[3] This prevents synthesis of dopamine, the precursor to epinephrine and norepinephrine.[2] It is especially effective at blocking the excessive catecholamine release during induction of anesthesia and manipulation of the tumor.[1] Metyrosine significantly, but not completely, reduces catecholamine stores.[1] This drug may need to be combined with other adrenergic blockers due to the incomplete blockade of catecholamines.[1]

In the case presented here, the patient was prepared for surgery with the short acting, competitive α_1-adrenergic blocker, prazosin. According to the literature, this is an effective preoperative treatment, and the selective α blockade was especially beneficial for this patient, considering his history of heart disease.[1] The patient in this case study had very little hemodynamic variability during surgery. Neither induction of anesthesia nor manipulation of the tumor caused great increases in blood pressure. The only additional hemodynamic control needed was after removal of the tumor when an infusion of phenylephrine 10 mg in normal saline 100 mL was required. This infusion was titrated to maintain a systolic blood pressure greater than 110 mmHg.

In conclusion, pheochromocytomas remain a challenge for anesthesia practitioners. Patients should be considered individually, and an appropriate management plan created that will optimize the patient's hemodynamic status before surgery. The anesthetist needs to be aware of all available

means of controlling the wide variability in hemodynamics associated with this type of procedure. Of more importance than the choice of agent, the need for the appropriate therapy and vigilance is critical to the care of these patients.

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Video Laryngoscopy for Management of Unanticipated Difficult Airway

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Keywords: difficult airway, anesthesia management, video laryngoscopy, direct laryngoscopy, difficult intubation

Intubations are traditionally performed using direct visualization of the vocal cords with the use of a standard laryngoscope handle and blade. However, video laryngoscopy has become a new airway management tool that makes the practice of anesthesia safer for patients.[1] The challenge of an unanticipated difficult intubation remains a significant problem because the inability to secure a patient's airway may result in a failure to maintain and protect the airway which may lead to cerebral anoxia or death. A difficult airway is defined when ventilation is difficult through a mask and/or tracheal intubation, and complex interactions exist between the patient, setting, and the skill of the practioner.[2] The video laryngoscope has assisted in these instances and provides a 10% better laryngeal view and also increases intubation success rates by 7%.[2]

Case Report

A 46-year-old, 75 kg, 155 cm female presented for a laparoscopic cholecystectomy. The patient's past medical and surgical history revealed that she had intermittent asthma which was well

controlled and had a previous cesarean delivery with no anesthesia complications from the subarachnoid block. On physical examination, the patient had a Mallampati class II airway with intact dentition and an adequate thyromental distance. The flexion and extension of the neck were full range of motion. Her preoperative vital signs were blood pressure 133/72 mmHg, heart rate 78 beats/min, respiratory rate 11 breaths/min, and SpO_2 99% on room air.

The anesthesia team collaborated with the patient regarding the plan for peri-operative care and agreed on a general anesthetic with endotracheal intubation. Preoperative midazolam 2 mg IV was administered for sedation. After being transported to the operating room, the patient was positioned supine and pre-oxygenated for five minutes via face mask at 10 L/min. The vital signs were stable and the patient was induced using fentanyl 100 mcg IV, lidocaine 1% 40 mg IV, propofol 200 mg IV, and rocuronium 30 mg IV. The patient was easy to mask ventilate and an oral airway was not necessary to achieve adequate ventilation.

Direct laryngoscopy was attempted a total of three times, first using a Macintosh 3 blade by the student registered nurse anesthetist (SRNA); despite external manipulation and neck extension only a Grade Cormack-Lehane III view was obtained. Subsequently, a Miller 2 blade was used again by the SRNA and a Grade III was obtained. The endotracheal tube was inserted resulting in an esophageal intubation with no end tidal CO_2 present or breath sounds. The endotracheal tube was removed and the patient was easily mask ventilated, but the oxygen saturation remained around 95%. An additional attempt was made by the certified registered nurse anesthetist using a Miller 2 blade and again a Grade III was obtained with an unsuccessful intubation attempt. The patient was mask ventilated with 100% oxygen, and the oxygen saturation levels were maintained at 98%. The GlideScope (Verathon Inc., Bothell, WA) and a pre-curved stylet were then used for endotracheal intubation. Upon placement of the GlideScope, a Grade I view was obtained by the SRNA and edematous tissue was noted around the glottic opening. The endotracheal tube was inserted easily through the vocal cords and into the trachea with no external manipulation necessary. Bilateral breath sounds were auscultated and end tidal CO_2 was noted. The endotracheal tube was secured and the surgical procedure began.

General anesthesia was maintained with sevoflurane 2% inspired concentration in a mixture of O_2 1 L/min and air 1 L/min throughout the case and the surgical procedure was performed with no complications. At the end of the procedure, the neuromuscular blockade was reversed with neostigmine 3 mg IV and glycopyrrolate 0.6 mg IV, spontaneous and regular respirations with adequate tidal volumes were noted along with appropriate responses to verbal commands. The endotracheal tube was removed when the patient was fully awake with no complications and then she was transported to the post anesthesia care unit with 4 L/min of oxygen delivered by nasal cannula. There were no subsequent complications and she was discharged the following day. She was provided with a difficult airway note and the intubation difficulties were discussed with the patient and documented in the medical chart.

Discussion

Endotracheal intubation of the airway is the gold standard in securing the airway for

patients. The use of video laryngoscopes can aid anesthesia professionals during difficult laryngoscopies. Poor glottic visualization is defined using the Cormack-Lehane criteria and is actually encountered in up to 8.5% of intubation attempts using a direct laryngoscopy.[3] Therefore, video laryngoscopes may be especially helpful when an unanticipated difficult airway is encountered. The use of video laryngoscopy is a similar technique to direct laryngoscopy, but does not require a direct line-of-sight for intubation or neck extension to align the axes for proper visualization. The movement of the atlanto-occipital joint is not needed because the unique blade angulation that provides a video assisted display of the glottis. With the image captured on a video camera, the glottic opening is easier to identify, potentially reducing the number of laryngoscopy attempts and subsequent airway trauma.[3] In comparison, pressure must be applied with the standard laryngoscope blades, and multiple attempts can obscure the operator's view due to the resultant tissue edema, secretions, or blood.[2]

Video laryngoscopy provides an improved laryngeal view and could increase intubation success rates if used for the unanticipated difficult airway patient.[3] With multiple intubation attempts with standard laryngoscopy there is the increased risk of excessive sympathetic stimulation, hyperextension of the neck, risk of dental trauma, and airway edema possibly leading to airway obstruction and hypoxemia.[1] Video laryngoscopy can be used as a first line intubation device for expected intubation difficulties or as an early adjunct in the difficult airway scenario when a rescue device is necessary.

Video laryngoscopy has been shown to shorten intubation times compared to standard laryngoscopy which is crucial for proper ventilation.[3] Decreasing the amount of time needed for intubation and the number of attempts of intubation would allow for shorter periods of patient apnea and minimize the potential for hypoxic episodes.[4] Moreover, successful endotracheal intubation rates have increased with the use of the video laryngoscope. Video laryngoscopes have a 98% success rate compared to 94% with the standard laryngoscopes.[2] Difficult intubations can also lead to unsuccessful airway management, decreased patient oxygenation, and can result in a declining course leading to mortality. Although this is relatively infrequent, development of new devices such as the video laryngoscopes can improve the care of patients with difficult airways. Video laryngoscopes can significantly improve airway management and improve patient safety when used in the difficult airway algorithm.[4]

Despite the attractiveness of video laryngoscopy, the technique does have disadvantages. The acute angle on the video laryngoscope blade is difficult to insert into a decreased mouth opening and the endotracheal tube can be challenging to direct into the trachea because of the lack of space in the oropharynx. Moreover, a bloody oropharynx and/or fogging may obscure the view of the glottis and a secondary rescue device must be used. Typically, the video laryngoscope is more expensive than the direct laryngoscope, but can offer a better view of the glottis.[5] Although the video laryngoscope does have these disadvantages, it appears to be quickly evolving in the difficult airway algorithm.

In this case study, several factors made intubation difficult. These factors included an unanticipated poor glottic visualization, multiple unsuccessful intubation attempts, and edematous oropharynx tissue. The poor

glottic view obtained did not improve with increased neck extension or external manipulation. These factors contributed to an unanticipated difficult airway after induction. There was no indication that a difficult airway would be encountered during the preoperative evaluation, and this unanticipated situation likely could have been avoided if a video laryngoscope was used as an earlier adjunct to the difficult airway scenario. The video laryngoscope provided a Grade I view and allowed for a successful intubation of the airway. Multiple attempts could have been avoided if an alternative approach such as an intubating stylet, gum elastic bougie, or the video laryngoscope were utilized with earlier intubation attempts.

In summary, video laryngoscopy is a relatively new technology that has been proven to be beneficial in the airway management of patients with difficult airways. The literature also shows that video laryngoscopy may be beneficial if used as an early adjunct to the difficult airway when direct laryngoscopy fails. Video laryngoscopy can aid in these unanticipated difficult airway situations and it is the latest advancement in airway management techniques.

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Thyrotoxic Storm

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Keywords: Thyroid storm, thyrotoxicosis, hyperthyroidism, diagnosis, management, anesthesia

Thyrotoxicosis is the second most common endocrine disease encountered perioperatively.[1] Thyrotoxic storm, or thyroid crisis, is a life threatening condition characterized by a severely exaggerated manifestation of thyrotoxicosis.[2] The incidence of thyroid storm has been noted to be less than 1-2% of patients hospitalized for thyrotoxicosis; however, the mortality rate due to thyroid storm ranges from 20 to 30%.[3,6] The most common etiologies of thyrotoxicosis include Graves disease and

toxic multinodular goiter.[2] Recognition and appropriate anesthetic management of life-threatening thyrotoxicosis is vital to prevent the high mortality that may accompany this disorder.

Case Report

A 56 year-old, 40.4 kg, 142 cm female Nepalese immigrant presented to the hospital for thyroidectomy following a diagnosis of a large toxic multinodular goiter. Medical history wasobtained through an interpreter and a limited electronic health record. Past medical history included asthma, microcytic anemia, and a large goiter, which had recently increased in size. The patient reported no prior surgeries and no awareness of personal or family difficulties with anesthesia. The patient had no known medication allergies. Preoperative vital signs were blood pressure 142/88 mm Hg, heart rate 92 beats/min, respiratory rate 16 breaths/min, and SpO_2 98%. Preoperative lab values included a thyroid stimulating hormone level of 0.1 mIU/L, and a total T4 level of 13.1 μg/dL. The patient had received methimazole 5 mg two times daily and propranolol 10 mg three times daily for tachycardia for the past four weeks.

Airway examination revealed a Mallampati grade II airway, full neck range of motion, and poor dentition with many missing and loose teeth. A large goiter was noted on physical examination with minimal tracheal deviation. The patient's lungs were clear to bilateral auscultation, with adequate and equal chest movement, and heart sounds were normal. A 20 gauge peripheral intravenous (IV) catheter was placed.

Preoperative midazolam 2 mg IV was administered. Standard monitors were applied in the operating room and the patient was preoxygenated with 10L/min oxygen via facemask for five minutes. Anesthesia was induced via facemask with sevoflurane and fentanyl 150 mcg IV. Manual mask ventilation was verified prior to laryngoscopy. Direct laryngoscopy was performed with video laryngoscopy , and a 6.0 nerve integrity monitoring endotracheal tube (Medtronic, Minneapolis, MN) was placed without difficulty. Endotracheal tube placement was confirmed by the auscultation of bilateral breath sounds and end tidal carbon dioxide detection. General anesthesia was maintained with sevoflurane 2.9% inspired concentration in a mixture of oxygen 1 L/min and air 1 L/min. hydromorphone 2 mg IV was given throughout case in 0.5 mg increments. Postinduction vital signs were blood pressure 130/81 mm Hg, heart rate 95 beats/minute, and SpO_2 100%. Prior to incision the patient received cefazolin 1,000 mg, dexamethasone 8 mg, and fentanyl 50 mcg IV; and a timeout was performed by surgical staff verifying correct patient identifiers.

The surgeon began resection of thyroid tissue during the second hour of the case. Shortly after, the patient's heart rate increased to 154 beats/min, the blood pressure increased to 188/104 mmHg, and the temperature rose to 38.1 despite adequate anesthesia and analgesia. Room temperature was decreased and acetaminophen 1000mg was given intravenously. Intra-operative beta blockade with metoprolol 2.5 mg IV was given three times for tachycardia and hypertension.

Total surgical time was 2.5 hours and the decision was made to transfer the patient to the intensive care unit for closer monitoring and management by an endocrinologist. The patient's transfer to the intensive care unit with O_2 10 L/min via ambubag was without incident with stable vital signs and a patent

airway. The patient was extubated three hours after arrival in the intensive care unit when cleared by the endocrinologist. The remainder of her postoperative course was uneventful and no anesthesia complications were noted. The patient was discharged home four days later.

Discussion

Thyroid storm ranks as one of the most critical endocrine emergencies with a mortality rate ranging from 20-30%.[4] Thyroid storm is a life-threatening exacerbation of hyperthyroidism which may be triggered by trauma, infection, medical illness, or surgery and may have poor outcomes even with aggressive medical treatment.[3,5] This syndrome has become less common today than in the past because of earlier diagnosis and treatment of thyrotoxicosis, as well as the increasing knowledge of the importance of ensuring a euthyroid state prior to surgery.[2]

The pathophysiological mechanisms of thyroid storm have not yet been clearly identified, therefore the diagnosis is based on clinical manifestations.[4] Due to the high mortality of this condition, it is of vital importance to initiate treatment when the diagnosis is strongly suspected, whether objective evidence is available or not.[1,2,5]

This patient had multiple factors during her intraoperative phase of surgery, which made the diagnosis of thyroid storm difficult. Being a recent immigrant from India, a diet deficient in iodine was thought to be responsible for her large toxic multinodular goiter. Through the interpreter the patient reported that the large goiter caused her intermittent pain, swallowing difficulties, and difficulty breathing while in the supine position. This goiter had grown significantly larger while in India due to lack of pharmacologic management. Her preoperative pharmacologic treatment consisted of four weeks of methimazole and propranolol. Current literature recommends waiting 6-8 weeks for antithyroid drugs to become effective prior to elective cases.[2] Goiters of this size have become less common today due to earlier diagnosis and treatment. Based on the size of her goiter a longer time may have been more beneficial for ensuring a euthyroid state prior to her operation.

Signs and symptoms of thyrotoxicosis normally manifest during the postoperative period, however they may appear intraoperatively in untreated or inadequately treated patients presenting for surgery.[5] When encountering patients with uncontrolled or poorly controlled thyroid disease presenting for surgery, anesthesia professionals must be prepared to manage thyroid storm. Signs and symptoms of thyroid storm can vary, but include extreme anxiety, fever, tachycardia, cardiovascular instability, and altered consciousness.[3] Symptoms of thyroid storm, such as anxiety and altered consciousness, can be masked by general anesthesia making correct diagnosis more challenging.

Anesthetic management includes supportive care and four primary and specific measures. These measures include: inhibiting hormone production and release with antithyroid drugs through nasogastric, oral or rectal routes; counteracting ongoing effects of thyroid hormones in the hyperadrenergic state with β-adrenergic blockers; managing high metabolic demand with aggressive fluid management and corticosteroids if large fluid losses occur due to sweating, diarrhea, or vomiting; and addressing the precipitating illness, which in this patient was relatively clear due to her presenting diagnosis.[1,5]

Propranolol is the β-blocker of choice for counteracting the hyperadrenergic effects of thyroid storm. Propranolol limits cardiac complications and is the only β-blocker to inhibit peripheral conversion of T_4 to T_3.[3] Glucocorticiods, including IV hydrocortisone or dexamethasone, block the conversion of T_4 to T_3 and are also beneficial if adrenal insufficiency is suspected.[2] Cooling measures to counter the fever, decrease metabolic demands, and decrease the percentage of free T_4 may include cooling blankets, ice packs, cool IV fluids, and antipyretics.[4,5] Salicylates should be avoided due to their inhibition of thyroid hormone binding which could increase free hormone and worsen the crisis.[1]

This patient was treated based on clinical manifestations encountered during the case. The patient was followed postoperatively in the intensive care unit. There she received propylthiouracil via nasogastric tube every four hours for 24 hours, as well as acetaminophen IV every six hours.

This case serves to review the need to establish a euthyroid state preoperatively, which may mean waiting a substantial amount of time. In this particular case, the recommendation of eight weeks of treatment may have been more effective due to the abnormally large goiter not often encountered in the United States today. The case also raises awareness of the constellation of signs and symptoms of a thyroid storm and that a diagnosis must be made on the basis of suspicious and non-specific clinical findings rather than thyroid function testing.

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Risks Associated with Positioning During Laparoscopic Robotic Prostatectomy

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Keywords: robotic-assisted, laparoscopic, prostatectomy, positioning, anesthesia

Robotic-assisted laparoscopic prostatectomies (RALP) are becoming more widely utilized for removal of the prostrate. The evolving technique is proving to be very

beneficial to patients in terms of decreased blood loss and decreased pain requirements in the recovery room, but offers several challenges for the anesthesia provider. [1] For the robot to be in the proper position for surgery the patient must be placed in lithotomy and steep trendelenburg position.[1] With this required positioning an understanding of physiologic changes associated is paramount to patient care during this procedure. This case report will focus on the positioning challenges involved in RALP and the strategic interventions of the anesthesia provider that promote patient safety.

Case Report

A 56-year-old male, 165 cm, 79.4 kg patient presented for a laparoscopic robotic radical prostatectomy with bilateral pelvic lymph node dissection. His past medical history included hypothyroidism, osteoarthritis, and prostate cancer. His preoperative blood pressure was 135/77 mmHg, heart rate 67 beats/min, and SpO_2 was 97% on room air. His preoperative electrocardiogram showed normal sinus rhythm. Preoperative labs included a complete blood count and a basic metabolic panel with all values within normal limits.
An 18 gauge peripheral intravenous (PIV) catheter was placed preoperatively. In the operating room, the patient was assisted onto the operating table in a supine position. Monitors were applied and pre-oxygenation initiated. An intravenous induction of general anesthesia was performed with lidocaine 100 mg, fentanyl 100 mcg, propofol 200 mg, and rocuronium 50 mg. Direct laryngoscopy was performed utilizing a MacIntosh 3 blade that revealed a grade 1 view. The trachea was intubated with a cuffed 7.0 oral endotracheal tube (ETT). End tidal CO_2 ($EtCO_2$) was confirmed and bilateral breath sounds (BBS) were auscultated. General anesthesia was maintained with 1.2% isoflurane.

A second 18 gauge PIV was placed. The patient's arms, fingers, and elbows were padded with foam and then tucked in a neutral position at his side with thumbs pointing up. His head was in a neutral position supported by a blue foam head cradle, and his face was protected by placing a Mayo stand several inches above. Shoulder supports were placed with padding against the patient and secured onto the bed frame. The patient was placed in the lithotomy position and secured in padded surgical stirrups while ensuring that both legs were raised at the same time with the hips extended < 90 degrees. Padding was also placed behind the knees to prevent peroneal nerve injury. Before surgery was initiated, the patient's position was tested in steep trendelenburg to ensure there would be no patient movement for the robotic portion of the case.
Bilateral breath sounds and $EtCO_2$ were reconfirmed after the patient was positioned in steep trendelenburg. Fluids were monitored and minimized during surgery to avoid excessive facial edema and fluid overload, as well as to minimize fluid in the surgical field. The ventilator was set on volume control mode with a tidal volume of 600 mL and frequency of 10 breaths/min. Ventilator settings were manipulated while in steep trendelenburg to maintain a normal $EtCO_2$ and peak airway pressures. No ventilation problems were noted. The surgery was uneventful with minimal fluctuations in vital signs.

Upon completion of the case, neurmomuscular blockade was antagonized; the patient began spontaneously breathing with appropriate tidal volumes and respiratory rate and began following commands. A noneventful extubation

ensued and the patient was placed on oxygen10 L/min via face mask. Overall, the patient received 1100 mL of lactated ringers, had an estimated blood loss of 75 mL, and 150 mL of urine output. The patient was transferred to the post anesthesia care unit, vital signs were stable, he denied any pain or other problems and only a minimal amount of edema was noted around the patient's eyes.

Discussion

Until recently, the standard of care for a prostatectomy consisted of either a retropubic or perineal open surgical approach, both of which involve a large incision with potential for large blood loss.[1] The RALP was introduced in 1999 and is becoming a popular surgical choice due to decreased blood loss, decreased pain after surgery, and shorter hospital stays.[1] Unfortunately, due to the robotic docking system, the patient must be placed in lithotomy and steep trendelenburg positions under general anesthesia. This positioning presents the potential for patient injury such as increased intra-ocular pressure, lower extremity nerve damage, displacement of the ETT, and difficulty with ventilation.

Increased intra-ocular pressure (IOP) is a concern with the RALP procedure, especially for elderly patients who may already have increased IOP and multiple comorbidities. Increased IOP has been linked to ischemic optic neuropathy, which may cause blindness.[2] The results of one study showed that, on average, IOP increased 13mmHg during the RALP procedure.[2] High $EtCO_2$ and prolonged surgical time in trendelenburg were two significant contributors to the increased IOP.[2] For this case, the $EtCO_2$ was kept below 35 mmHg until the end of the case when it was allowed to rise to 38 mmHg to initiate spontaneous respirations. The time in trendelenburg was less than 2 hours, which is below the average of 4 hours.[2]

When any patient is placed in the lithotomy position, there is the chance of nerve injury. The peroneal nerve runs lateral to the knee and the saphenous nerve medial to the knee.[3] Both nerves have the potential for injury if excessive pressure is applied. Scrupulous attention was paid when the patient was positioned. Both lower extremities were raised simultaneously and placed in padded leg holders. The legs were ensured to be symmetrical and excessive flexion or extension was avoided. Both sides of the knee were padded to avoid nerve damage since the patient was in this position for a prolonged period of time.

Placing the patient in steep trendelenburg combined with insufflating the abdomen have the potential to displace the ETT. One study determined that it was the pneumoperitoneum rather than the positioning that actually moves the tube. This study noted significant shortening of the distance between the carina and the ETT tip with pneumoperitoneum and steep trendelenburg, which could potentially result in endobroncial intubation.[4] The recommendation, from the authors of this particular study, is to place the ETT in the mid-trachea and to confirm tracheal tube placement not only after moving, but also after pneumoperitoneum.[4] Placement was confirmed by positive $EtCO_2$ and positive bilateral breath sounds before and after the patient was moved. There were no changes in oxygenation status to alert the team that the tube had possibly moved during the procedure.

Pneumoperitoneum and steep trendelenburg causes the abdominal contents to push the diaphragm upwards into the chest cavity.

This restriction decreases the lung's functional reserve capacity and pulmonary compliance and results in as much as a 50% increase in peak airway pressures. Possible strategies to lower the potential risk of barotrauma are reducing the tidal volume, increasing the respiratory rate, and allowing permissive hypercarbia.[6] During the procedure the tidal volume was dropped to 525 mL and respiratory rate increased to 14 to maintain an $EtCO_2$ lower then 40mmHg and peak pressures less than 40 cmH_2O.

In conclusion, the RALP procedure is proving to have many advantages over the more invasive older techniques. A shorter recovery period, smaller incisions, less blood loss, and decreased postoperative pain are a few incentives to the RALP.[5] Unfortunately, the RALP still requires the patient to be positioned in lithotomy and steep trendelenburg. This unnatural position and pneumoperitoneum predispose the patient to a number of complications, such as increased intraocular pressure, lower leg nerve injury, displacement of the ETT, and difficulty ventilating intraoperatively. These side effects can be minimized with educated planning in relation to careful positioning and diligent monitoring.

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Cricoid Pressure in Prevention of Aspiration

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Keywords: cricoid pressure, newton, rapid sequence induction, Sellick maneuver, pediatric airway

As described by Dr. Sellick in 1961, cricoid pressure (CP) is the application of backward pressure to the cricoid cartilage in order to compress the esophagus against the vertebral bodies.[1,2] Cricoid pressure is applied while the patient is awake, at a force of 10 newtons (N), and gradually increased to 40 N with loss of consciousness. This maneuver aims to minimize

the risk of aspiration of gastric contents during tracheal intubation. Disadvantages of CP include partial or complete airway obstruction during mask ventilation, difficulty inserting laryngoscope, impaired glottic opening, and difficulty passing the endotracheal tube (ETT).[3]

Case Report

A 3-year-old male, 14.9 kg, 83 cm, presented for colonoscopy and excision of rectal polyp. The patient's history of present illness was notable for 2 episodes over 3 months of prolapsed rectal polyp. Parents reported the polyp was easily reducible, without pain or bleeding. No birth, medical or surgical history, no medications, or familial anesthesia problems were reported. No lab work or pre-op imaging was necessary. A clear liquid diet was initiated 48 hours prior to the scheduled procedure, a bowel prep with polyethylene glycol was initiated 24 hours before, and reported last clear liquid intake was 4 hours prior.

The child was examined in the pre-operative area while sitting with his parents. He was introduced to the scented facemask and playfully demonstrated deep breathing technique with the mask to his face. Physical exam was within normal limits. The child refused airway exam and parents reported no history of snoring, loose or broken teeth.

The anesthesia team, patient and mother proceeded to the operating room (OR) for a planned mask induction. En route the child vomited a small amount of clear liquid. In the OR the child sat with the mother next to the OR table. The facemask was introduced with a primed anesthesia circuit of nitrous oxide 70% measured inspired concentration (flow rate of 5 L/min) and oxygen at 2 L/min. Introduction of sevoflurane 2% inspired concentration was added to the mixture, and titrated to effect until loss of lid reflex. Nitrous oxide was discontinued, oxygen flow increased to 6 L/min and sevoflurane 5% inspired concentration maintained. An anesthesia practitioner provided head support and CP while the child was upright and positioned supine with the head of the bed slightly elevated. A 60 mm oral airway was placed and spontaneous respirations were assisted via mask ventilation with the head maintained in the sniffing position.

Standard monitors were applied and a 22 gauge intravenous (IV) catheter was inserted, followed by administration of fentanyl 25 mcg, rocuronium 10 mg, and propofol 30 mg. A #2 Miller blade was used for direct laryngoscopy, revealing a grade IV glottic view. The view was communicated to the assisting anesthesia practitioner and believed to be due to cricoid force. It was requested to maintain CP but use less pressure. With slight release, a grade I view was obtained and a 4.5 cuffed ETT was placed. Cuff inflation pressure was measured at 20 cm H_2O, and leak occurred at 15 mm Hg. Controlled respirations were maintained with pressure control ventilation. Rapid establishment of an orogastric tube drained 50 mL of clear fluid. Dexamethasone 6 mg and ondansetron 1.5 mg were administered in addition to a fluid bolus of 300 mL of lactated Ringer's solution. Upon completion of the procedure, neuromuscular blockade was antagonized, and spontaneous respirations were established. When extubation criteria were met the child's trachea was extubated, 8 L/min oxygen facemask applied, and the child was placed in the recovery position.

Discussion

The efficacy of CP in anesthesia is controversial. Recommendations for its use originate from Dr. Sellick's observational studies of his practice, small sample size, and undefined cricoid force.[4] Since then, two systematic reviews neither support nor negate its value.[4] Current research and case reports have observed the failure of CP in preventing passive

regurgitation and aspiration, as well as its success when regurgitation is witnessed upon its release. Circumstances related to its failure include inconsistent technique, application of inadequate or excessive pressure, release of pressure before intubation, and anatomic variations between individuals.[4,5] The cornerstone for use in pediatric anesthesia is derived from a single study of 8 cadavers in which firm pressure prevented reflux.[6]

Despite lack of strong evidence to support its use, CP remains a standard of practice in pediatric and adult at-risk patients: those inadequately fasted, trauma, emergency, bowel obstruction, delayed gastrointestinal motility, diabetes, and pregnancy. Contraindications include active vomiting and injury to the cervical spine or cricotracheal structure.[5] Risk of regurgitation from the stomach to the esophagus may be increased with CP due to reduced tone of the lower esophageal sphincter.[3]

In anesthesia, CP is an integral component to rapid sequence induction (RSI). Preoxygenation, application of CP, IV induction, and neuromuscular blockade precede rapid placement of an ETT without attempting to ventilate. The method of application is not standardized for clinically referred to "modified rapid sequence", meaning some part of the sequence will deviate to meet the needs of the patient and situation. When this patient vomited, the anesthetic plan changed from routine inhalation induction to modified RSI. The anesthetic goals were to minimize the child's discomfort, separation anxiety, and optimize intubating conditions while minimizing aspiration risk. Establishing an IV prior to induction would likely cause emotional distress and increase the likelihood of vomiting. Had retching ensued after vomiting, CP would not have been used due to the risk of increased esophageal pressures and possible rupture.[3] For this child, parent presence was calming and inhalation induction was smooth. Application of CP in the upright position with loss of lid reflex was key to reducing emotional distress in this child, and minimizing the risk of regurgitation and aspiration. Magnetic Resonance Imaging (MRI) demonstrates in 95% of test subjects, the cricopharyngeal muscle was posterior to the cricoid ring, and in 50% of test subjects the esophagus was lateral to the cricoid cartilage, on average 1cm inferior.[7] The efficacy of CP is not affected by esophageal position because muscular attachments between the cricoid and postcricoid hypopharynx permit movement as a unit when compressed to seal the hypopharynx.[8]

This patient maintained spontaneous respirations with gentle assist while IV access was obtained. Consistent results regarding the effects of CP on ventilation report reduced tidal volumes, increased peak inspiratory pressures, and up to 50% functional airway occlusion.[2] This may account for the partial obstruction noted with spontaneous respirations, thus requiring an oral airway to improve ventilation.

Correct application and pressure are key variables cited for failure of the Sellick maneuver. Studies report that physicians, nurses and other OR personnel were unable to correctly apply the proper pressure of 40 N, and often misidentified the cricoid cartilage, and mistakenly applied pressure to the thyroid cartilage.[4,5] Training demonstrates improved provider skills after education, however a single study follow up at 3 months reported most providers failed to retain improved skills.[5]

Although pediatric application of CP mirrors that recommended for adults, intuitively

children have smaller more pliable airways, and should require less force. In adults, airway distortion occurs up to 90% at CP of 44 N, 43% at 30 N and 23% at 20 N.[6] Limited data exist regarding the effect on pediatric airways. One such study measured CP and airway distortion in children using a gauge apparatus and airway caliber with a rigid bronchoscope attached to a camera and monitor. Subject's age ranged from 3 months to 15 years. Results found a linear relationship between age, weight and CP at which airway distortion >50% occurred.[5] The distorting force in 4-5 kg was 5-7.5 N, 10 kg at 10 N, and in teenagers 15-25 N.[5]

MRI supports functional occlusion of the esophageal opening with CP.[8] Our patient vomited en route to the OR. The decision to use CP in this scenario was appropriate to prevent regurgitation, and as current recommendations suggest, CP should be released if difficulty securing an airway is encountered.[5] In this case report, excessive CP obstructed the glottic view, necessitating reduced pressure. Based on the recommendations from the above reference in children, CP between 10-15 N would have been adequate for this 14.9 kg child. However, research does not support abandoning the technique and its application to high-risk patients.
Evidence suggests education and frequent evaluation of proper technique are necessary to ensure success of CP and avoid complications.[5]

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Mentor: Janet Dewan, CRNA, MS

Emergence Delirium in the Pediatric Patient

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Keywords: anesthesia, emergence delirium, agitation, pediatrics

Emergence delirium (ED) is a well-known phenomenon affecting children in the immediate postoperative period. It is a condition in which the patient appears to be awake, but experiences alterations in orientation and mental status including confusion, lethargy, and violent or harmful behavior.[1] Emergence delirium has also been defined as "a disturbance in a child's awareness of and attention to his/her environment with disorientation and perceptual alteration including hypersensitivity to stimuli and hyperactive motor behavior in the immediate post anesthesia period".[2] Despite attention in the pediatric anesthesia literature, ED remains a poorly understood phenomenon.

Case Report

A 5-year-old, 24 kg male, presented for a tonsillectomy and adenoidectomy. The patient's past medical history included anxiety and recurrent upper respiratory infections. The patient had no known allergies, no past surgical history, and no current home medications. The preanesthetic evaluation revealed a calm, age appropriate acting child with mild rhinorrhea. Lung sounds were clear to auscultation and no dyspnea was observed. The child life specialist engaged the patient with age appropriate activities throughout the preanesthetic evaluation. Both parents and the child life specialist accompanied the patient to the operating room (OR) where an inhalation mask induction was performed using oxygen 3 liters per minute, nitrous oxide 7 liters per minute, and 8% sevoflurane. The patient remained calm while holding the unscented mask over his mouth and nose with assistance. The parents were escorted out of the operating room when the child lost consciousness.

The patient continued to breathe spontaneously with mask ventilation assistance. A 22 gauge peripheral intravenous (IV) line was placed to the left hand and secured. Propofol 50 mg was administered. The trachea was then intubated using a Miller 2 blade and a 5 mm cuffed endotracheal tube. The patient was repositioned supine and a throat pack was placed in the hypopharynx by the surgeon. Dexamethasone 4 mg, ondansetron 3 mg, fentanyl 25 mcg, and 300 mL lactated Ringer's solution were administered. The induction, anesthetic maintenance and surgery were uneventful. General anesthesia was maintained using 1% sevoflurane, 1 L/min oxygen, and 1 L/min nitrous oxide.

At the end of the procedure, the surgeon removed the throat pack and suctioned the stomach and oropharynx using an orogastric tube. The endotracheal tube was removed when the patient was completely awake and spontaneously ventilating with adequate tidal volumes. A simple face mask was applied with O_2 at 6 L/min and the patient was transferred to a stretcher with padded siderails. Upon wakeup, the patient became extremely agitated and combative. Several OR staff were required to restrain and protect the patient from injury. Upon arrival to the post anesthesia care unit (PACU), the patient pulled out his peripheral IV,

developed a croup-like cough, and remained agitated. The parents were immediately called to the bedside while the PACU nurse administered a 2.25% racemic epinephrine nebulizer treatment. The croup-like cough responded to treatment. Despite constant reassurance from the PACU nurse, parents, and the child life specialist, the patient remained inconsolable, irritable, uncooperative, and agitated for the next 25 minutes.

Discussion

Children emerging from anesthesia often experience disturbances in behavior that may be referred to as postanesthetic excitement, delirium, and agitation.[2] Emergence Agitation (EA) is a mild state of restlessness and mental distress.[3] However, EA does not always cause a significant change in behavior like that of ED.[2] As a patient is recovering from anesthetic agents ED typically presents as disorientation, restlessness, irritability, screaming, and involuntary activity. The degree of agitation varies and often requires additional nursing care along with administration of analgesics and sedation. The agitated behavior can cause discomfort and/or injury to the child, anxiety for the parents, and delayed discharge from the hospital.[4]

The incidence of ED has been reported between 10-80% depending on the definition and scale used to measure.[5] Several factors have been associated in the development of ED including rapid emergence, pain, surgery type, age, preoperative anxiety, child temperament, and anesthetic agent.[4] Sevoflurane has replaced halothane as the pediatric inhalation induction anesthetic of choice. Due to the low blood/gas solubility, sevoflurane offers rapid induction/emergence and is nonirritating to the airway which decreases the risk for bronchospasm and laryngospasm. However, sevoflurane has been associated with a higher incidence of ED due to rapid emergence when compared with halothane.[3] Inadequate postoperative pain relief may be associated with development of ED. Administering 1mg/kg IV ketorolac or 2.5mcg/kg IV fentanyl may help to significantly decrease ED incidence even after sevoflurane anesthesia.[2] ED often accompanies ear, nose, and throat surgeries. Younger children, especially males age 2-5, seem to be more susceptible since they are easily confused and frightened by unfamiliar experiences. Use of anticholinergics, droperidol, barbiturates, benzodiazepines, metoclopramide, and ketamine have all been linked to increased rates of ED.[4]

There are a number of scales that are used to assess and measure ED. Three of the most commonly used measurements include the Pediatric Anesthesia Emergence Delirium (PAED), Watcha, and Cravero scales. Each scale measures such things as crying, ability to be consoled, degree of agitation/thrashing, degree of wakefulness, ability to make eye contact, and awareness of surroundings. A study performed in a pediatric PACU compared each of these scales for assessing presence of ED after recovery from general anesthesia. No scale was shown to be superior to another. Each scale had detection limitations, yet correlated well with one another.[5] Studies have compared different anesthetic techniques directed toward finding techniques that reduce the frequency of ED. One study examined children undergoing adenotonsillectomy compared sevoflurane anesthesia to total intravenous anesthesia (TIVA) using a propofol infusion after a sevoflurane inhalation induction. No difference in PAED scores was observed.[6] Another comparison of preoperative oral

dexmedetomidine to oral midazolam showed no benefit of one over the other.[7]
A third study examined the administration of fentanyl with midazolam, propofol, or ketamine before discontinuing sevoflurane/remifentanyl at the end of the case. Results showed significant reductions in ED for the propofol/fentanyl and midazolam/fentanyl groups when compared to the ketamine/fentanyl group.[8] One possible explanation for these results may be the ED and hallucinations often associated with ketamine. Some authors have advocated conversion to isoflurane or desflurane after sevoflurane induction, yet no scientific evidence has supported this. Delaying emergence by a slow decrease in the inspired concentration of sevoflurane has proved unsuccessful, and preoperative oral midazolam administration use has shown equivocal results. The short half-life of midazolam may not prevent ED in longer cases. Combining midazolam and a small dose of diazepam may extend the effects into the recovery phase.[2]

Management of this case could have included other pharmacologic options. Unfortunately, there is still no ideal pediatric inhalation agent. Perhaps premedicating our patient, who came with a history of anxiety, with small doses of oral midazolam and/or oral diazepam may have helped to prevent the ED. However, upon initial assessment and inhalation induction, our patient did not appear anxious. Another alternative may have been to discontinue the sevoflurane after inhalation induction and convert to a TIVA technique using a continuous propofol/remifentanyl infusion followed by a small dose of IV fentanyl and IV midazolam prior to extubation. Although this patient was administered 25 mcg of fentanyl, this dose fell short of the recommended 2.5 mcg/kg IV dose that might have ameliorated his delirium. However, administering an opioid and a benzodiazepine just before wake up may delay emergence as well as prolong PACU stay. Performing a risk/benefit analysis comparing delayed emergence versus ED may be beneficial in these situations.

Despite research into this frequently reported phenomenon, the etiology and prevention of ED remains poorly understood. Its management can present a challenge to anesthesia professionals and PACU nurses, as well as stress to the parents and potential injury to the child. Further trials and studies need to be performed to accurately predict and prevent ED. No single medication or measure has been shown to prevent ED in children, but perhaps developing detection strategies for those patients at higher risk, then adjusting technique to minimize the risk, may be beneficial.

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Anesthetic Management of a Patient with Myasthenia Gravis

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Keywords: Myasthenia Gravis, acetylcholine receptors, sigmoid colectomy, nAchR

Myasthenia Gravis (MG) is a chronic autoimmune disease characterized by weakness and fatigue of the skeletal muscles. MG is caused by a decrease in functional postsynaptic nicotinic acetylcholine receptors (nAchR) at the neuromuscular junction, due to their destruction or inactivation by circulating antibodies.[1] Seventy to eighty percent of functional acetylcholine receptors can be lost accounting for marked sensitivity to non-depolarizing muscle relaxants in patient's with MG. Regional and local anesthesia with careful monitoring are the preferred anesthetic technique when appropriate.[1]

Case Report

A 74-year-old, 65 kg, 165 cm Caucasian male was scheduled for a sigmoid colectomy. The patient's past medical history was significant for myasthenia gravis, hypertension, benign prostatic hypertrophy, diverticulosis, intestino-vesical fistula, chronic urinary tract infections, anemia, Irritable Bowel Syndrome, and basal cell carcinoma. Surgical history included tonsillectomy and adenoidectomy at age eight, and right inguinal hernia repair five years earlier. The patient was diagnosed with MG 14 years earlier. His current home medication regime included pyridostigmine (120 mg in the morning, 60 mg at noon, and 60 mg in the evening), and azathioprine (100 mg in the morning and 50 mg in the evening). Past MG exacerbations had required intubation. The patient complained of intermittent dysphagia and bilateral upper extremity weakness. Preoperative pulmonary function tests showed a FVC of 4.06 liters, FEV1 of 2.79 liters, with normal TLC, FRC, and RV. Pre-operative laboratory values demonstrated a stable leukopenia (WBC 3.8 K/cmm), macrocytic anemia (MCV 106.4 fL), and normal liver function tests. The patient had no known drug allergies. The patient was evaluated preoperatively by neurology, was admitted twenty-four hours before surgery and received one intravenous immunoglobulin infusion.

The patient consented to epidural anesthesia/analgesia with sedation for intra operative management. General anesthesia was presented as an alternate plan. Complications of general anesthesia were discussed to include prolonged intubation with an intensive care unit stay. All questions were answered and the patient was transferred to the operating room. Standard noninvasive monitors were applied, midazolam 2 mg was administered and the patient was assisted to a sitting position for placement of the epidural. Placement of the epidural was at lumbar 2-3 interspace, and a negative test dose of 1.5% lidocaine with epinephrine 1:200,000 3mL was administered. Oxygen was continuously administered by facemask with continuous end tidal CO_2 monitoring. During the procedure bolus doses of 0.25% bupivicaine in 5mL increments were given through the epidural every 10 minutes. The patient remained hemodynamically stable throughout the case. Total time for the procedure was two hours and forty-five minutes. Total intravenous crystalloid was three liters, estimated blood loss was 300 mL, and total urine output was 550 mL. A patient controlled epidural analgesia (PCEA) infusion was initiated in the operating room prior to transfer to the post anesthesia care unit. The procedure was completed without event and the patient was transferred to the post anesthesia care unit. The patient's postoperative course was uneventful and his pain postoperatively was well management with the PCEA eliminating the need for additional intravenous opioids. His home medications were resumed on postoperative day one, administered through a nasogastric tube.

Discussion

The prevalence of MG is 1 in 7500, with women twenty to thirty years of age most affected. Men are often sixty years of age or older when their disease presents.[2] No single cause is known. There is an association with the thymus and circulating autoantibodies. Onset may be abrupt or insidious with a fluctuating course, with periods of exacerbation and remission.[3] The goal of treatment for MG is to improve the neuro muscular transmission. Symptom reduction is obtained through administration of cholinesterase inhibitors which inhibit the hydrolysis of acetylcholine and increases the neurotransmitter concentration at the receptor deficient neuromuscular junction.[3,4] Immunosuppressive therapy (corticosteroids, azathioprine, cyclosporine, mycophenolate) is indicated when skeletal muscle weakness is not controlled with anticholinesterase drugs.[4] Corticosteroid produces an 80% remission rate by reducing AChR antibody levels.[3] Plasmapheresis and intravenous immunoglobulin has been utilized in patients with MG to provide preparation for surgery and to provide short term strength improvement for MG exacerbations and crises. IVIG is thought to act by down regulation of autoantibodies providing optimal neuromuscular function preoperatively.[1] Surgical treatment includes a thymectomy which is intended to induce remission or allow for dose reduction of immunosuppressive medications.[4]

Myasthenia Gravis is marked by periods of exacerbation and remission. Ptosis and diplopia from weak extra-ocular muscles are the most common initial complaints. Weakness of pharyngeal and laryngeal muscles results in dysphagia, dysarthria and difficultly handling saliva, placing the MG patient at high risk for pulmonary aspiration of gastric contents.[5]

Individuals with MG have a diminished number of normal nAChR, which will present as sensitivity to neuromuscular

blocking agents and can be profound. Patients taking cholinesterase inhibitors will have inhibited plasma cholinesterase, and if given succinylcholine will be at risk for enhanced duration of block. Patients with a diminished number of receptors, however, who are not taking cholinesterase inhibitors, may show a resistance to depolarization and appear resistant to succinylcholine because of the lack of nAChRs. Myasthenia Gravis patients taking cholinesterase inhibitors are maximally inhibited; therefore reversal with acetylcholinesterase inhibitors at surgical end may be unsuccessful.[1] If necessary, tracheal intubation of the MG patient can be accomplished without neuromuscular blockers because of the combination of intrinsic muscle weakness and the relaxant effect of volatile anesthetics on the skeletal muscle. [2]

If general endotracheal anesthesia is utilized for major surgery, patients with MG may require ventilatory support postperatively. It is important to discuss this implication with patients preoperatively.[2] Predicting patients at risk for developing post-surgical myasthenic crisis is difficult, however a scoring system has been developed to aid in predicting higher risk patients.[2] Patients at higher risk were found to have the disease greater than six years, with the presence of previous respiratory problems or co-existing lung disease, requiring a pyridostigmine doses > 750 mg a day and a pre-operative FVC < 2.9 L.[1] The scoring system has not predicted postoperative outcome for all patients.

This case provides an example of the management of a MG patient with regional anesthesia for intra abdominal surgery. Preoperative patient preparation with a detailed review of the disease process in a MG patient is essential for providing a safe anesthesia care. The anesthetic management for the MG patient is focused on optimizing the patient preoperatively which can markedly decrease the risk of surgery and improve patient outcomes.[1,3] If general anesthesia is needed, the respiratory depressant effects of the anesthetic agents compounded by an already weakened respiratory system may require post operative ventilation.[4] Based on the literature, preferred techniques for the management of MG patients includes the use of regional or local anesthesia, avoidance of non depolarizing relaxants and limiting large doses of opioids. Regional anesthesia may eliminate the need for muscle relaxants during abdominal surgery. Benefits of epidural analgesia include better post-operative pain control and respiratory function, faster return of gastrointestinal function, allowing for resumption of oral medication regime, and also decreasing the need for post-operative opioids.[2] In the MG patient, optimal pain management is essential because the stress caused by pain can lead to a myasthenic crisis. If opioids are necessary, small doses of short acting drugs are recommended augmented with non-steroidal anti-inflammatory drugs.[2]

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Mentor: Janet Dewan, CRNA, MS

Partial versus Open Sternotomy for Aortic Valve Replacement

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Keywords: aortic, cardiac, anesthesia, valve replacement

Aortic valve replacements (AVR) have traditionally been performed with a full sternotomy incision. More recent techniques have been developed to allow for valve replacement through a partial or "mini" sternotomy. The advantages of the partial sternotomy AVR are smaller incision, less respiratory support time and less blood loss. It is suggested that a partial sternotomy can decrease morbidity and hospital lengths of stay as compared with a full sternotomy AVR.[1] However, when a procedure must be converted emergently from a planned partial to a full sternotomy, research suggests these patients may have worse outcomes related to the increased surgical duration.[2]

Case Report

A 78-year-old, 129 kg, 178 cm Caucasian male presented for a scheduled partial sternotomy AVR for severe aortic stenosis (AS). Medical history was otherwise significant for hypertension, type 2 diabetes mellitus, obstructive sleep apnea, gout, degenerative joint disease (DJD), benign prostatic hypertrophy, hypothyroidism, and obesity. His medical management included metformin, glipizide, valsartan, atenolol, terazosin, furosemide, levothyroxine, and allopurinol. The patient had no significant surgical history or anesthetic events. on echocardiogram, the patient exhibited severe AS with an aortic valve area of 0.7 cm^2 and an ejection fraction of 40-45%. The patient's hemoglobin and hematocrit were 13.4 mg/dL and 40.6 mg/dL, respectively. On physical exam the patient was neurologically intact, and pain free with no complaints of shortness of breath or chest pain. The patient's metabolic equivalent of task (METs) level was difficult to determine secondary to pain from chronic DJD limiting his activity. Assessment of the patient's airway revealed a Mallampati score of 3, small mouth opening and a thyromental distance of 5 cm.

Preoperatively, a left radial arterial catheter, a right internal jugular large bore catheter and pulmonary artery catheter were placed. The patient was transferred to the operating room where hemodynamic monitoring and preoxygenation were initiated. Medications administered for induction of general anesthesia included midazolam 10 mg, fentanyl 500 mcg, and propofol 50 mg. The Glidescope (Verathon, Inc. Bothell, WA) was used for laryngoscopy and a 9.0mm endotracheal tube (ETT) was placed. The ETT placement was verified and a bronchial blocker was placed in the right bronchus

under visualization with a fiberoptic bronchoscope. Transesophageal echocardiogram examination (TEE) demonstrated an extremely dilated ascending aorta requiring an aortic root repair in addition to the planned AVR. Access via partial sternotomy was aborted and a full sternotomy was performed. The right bronchial blocker was removed and two-lung ventilation was reinstituted. Prior to the initiation of cardiopulmonary bypass (CPB), the patient required multiple doses of phenylephrine for hypotension and the TEE exam demonstrated intracardiac hypovolemia. A total of 500 ml of 5% albumin was administered immediately prior to CPB. Total CPB time was 138 minutes, and 4 units of packed red blood cells were administered during CPB. Upon discontinuation of CPB, a milrinone infusion was started at 0.5mcg/kg/min. Atrial and ventricular pacing was instituted at 80 beats per minute (bpm). Increasing doses of phenylephrine were required to maintain systolic blood pressure greater than 90mmHg and an epinephrine infusion was initiated at 5mcg/min. A total of 4 units of fresh frozen plasma, one pack of platelets, and an additional 100 ml of 5% albumin were given post-bypass. A total of 3 L of crystalloid was administered. The patient was transferred intubated and on milrinone and epinephrine infusions to the intensive care unit (ICU) post-procedure. Upon arrival to the ICU, the patient remained hypotensive and a phenylephrine infusion was started. The patient's vital signs immediately prior to transfer of care were: blood pressure 98/47, SpO_2 100%, heart rate 80 bpm via pacing wires and temperature 96.8^{o} F.

Discussion

Aortic stenosis (AS) is a narrowing of the aortic valve lumen between the left ventricle of the heart and the aorta. Aortic stenosis is the most common reason employed for an aortic valve replacement. It is estimated that approximately 2% of the population aged 65 and over have AS.[3] Aortic stenosis may develop asymptomatically, although the condition will eventually result in a decreased cardiac output secondary to ventricular outflow obstruction and concentric ventricular hypertrophy. Contractility and ejection fraction are maintained until the aortic valve area has narrowed to approximately less than 1cm^2.[3]

The gold standard for the diagnosis of AS is echocardiography. This patient underwent a transthoracic echocardiogram (TTE) preoperatively, which did not provide enough data to allow the sonographer to diagnose the extent of aortic disease resulting from the AS. Transesophageal echocardiography (TEE) has demonstrated better visualization of cardiac structures including valves and the thoracic aorta. The improved imaging could warrant the small risk and mild discomfort of a slightly more invasive exam.[4] Potentially, TEE, may have allowed for better diagnosis in this case.

Knowledge of the full extent of the patient's disease process preoperatively would likely have resulted in a planned full sternotomy. Evidence suggests that conversion from a partial sternotomy to a full sternotomy intraoperatively has more postoperative complications.[2] One review examining pulmonary complications following both partial and full sternotomies found that total time on CPB and aortic cross clamp time were significantly longer for patients who had a partial sternotomy converted to full sternotomy intraoperatively, compared with those patients that had either a partial sternotomy or a full sternotomy.[5] Additional risk factors that may lead to an increased likelihood of conversion from partial to full sternotomy might include: advanced patient

age, fragility of the aorta, coronary disease and chronic renal failure.[6]

An article published in the Annals of Thoracic Surgery suggests that the mini sternotomy approach not only allows for superior cosmetic advantages, but also for increased sternal stability, less postoperative pain and decreased need for blood transfusions. Additionally, mechanical ventilation and respiratory support were longer in the group that received the full sternotomy. The study indicated, however that a conversion from mini to full sternotomy resulted in an increased risk of death as a result of massive myocardial infarction. Although the likelihood of sternotomy conversion is low, it is a risk nonetheless because of the potential need for better surgical exposure.[7]

Based on the pathophysiology of AS, patients become dependent on preload and heart rate to maintain adequate cardiac output. This patient's aortic valve gradient was $0.7cm^2$ which is highly indicative of left ventricular hypertrophy requiring higher filling pressures to produce the same amount of ventricular output. Knowing this, the patient's preoperative fluid status could have been managed more optimally. In accordance with the patient's left ventricular end diastolic pressure and cardiac index, preoperative fluid resuscitation should have been instituted to acquire appropriate hemodynamics for a patient with aortic stenosis.[3] Specifically, a preoperative fluid bolus of 1-2L of crystalloid to obtain adequate filling pressures could have been given. A more aggressive preoperative intravenous fluid resuscitation plan could have lessened the patient's negative hemodynamic response to vasodilation and decreased venous return under anesthesia.

Isoflurane was the inhalation agent selected for general anesthesia in this case. However, Cromheecke et al. suggests that sevoflurane demonstrates cardioprotective properties in patients undergoing aortic valve replacement with cardiopulmonary bypass.[8] Of the patients who received a volatile anesthetic regimen, the sevoflurane group had better recovery of myocardial function and less postoperative release of troponin I. Myocardial recovery was based on intraoperative trends of the dP/dt_{max} value, which represents inotropic function of the left ventricle based on change in maximum rate of systolic pressure rise. The data suggests that the choice of volatile anesthetic may have hastened the return of improved cardiac output after the myocardial ischemia caused by cardiopulmonary bypass.[8] Potentially, there may have been advantages to utilizing sevoflurane for this patient.

A consensus has not yet been reached on the merits and challenges related to minimally invasive aortic valve surgery for AS. What is important is a thorough preoperative assessment that allows providers to fully appreciate a patient's disease process. This preoperative assessment is imperative to ensure a successful intraoperative plan.

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Analgesia for Chronic Pain in a Patient Undergoing Orchiectomy

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Keywords: keywords orchiectomy, pain, tolerance, analgesia

Optimal pain management for patients with atypical pain tolerance presents a unique set of challenges to anesthesia providers. The variables responsible for these challenges include but are not limited to the type of surgery, current medication regimen, and history of chronic pain. It is important to recognize the uniqueness of individuals with respect to their risk factors for pain and responsiveness to analgesia. Understanding specific physiological principles will assist anesthesia professionals in providing optimal analgesia for patients who may otherwise be at risk for under-treatment of pain due to misperceptions or a lack of knowledge held by anesthesia providers.

Case Report

A 26-year-old, 170 cm, 75 kg, male patient presented for a left orchiectomy. His history included two previous motor vehicle crashes that resulted in intermittent episodes of lower back pain, for which he was prescribed oxycodone as needed. The patient reported taking 100 mg of controlled release oxycodone twice a day for the past two years. The patient also admitted to drinking alcohol socially and smoking marijuana monthly. He denied any surgical history.

The patient appeared very anxious while in the holding area prior to surgery. After consents were obtained, the patient received midazolam 5mg intravenously (IV). After approximately ten minutes, the patient remained anxious and was administered an additional 5 mg IV midazolam. The patient continued to express anxiety and agitation and was administered ketamine 50 mg IV with minimal change in the patient's anxiety. Finally, the patient was administered dexmedetomidine 30 mcg IV and was transported to the operating room, appearing relaxed and cooperative.

Upon arriving in the operating room, standard monitors were applied to the patient. His vital signs were within normal limits. For induction and tracheal intubation, the patient received IV fentanyl 200 mcg, diprivan 200 mg, and rocuronium 60 mg. General anesthesia was maintained with sevoflurane 2.5% inspired concentration in a mixture of oxygen 1L/min and air 1L/min. Ten minutes after induction, the patient's neuromuscular blockade was assessed via peripheral nerve stimulator train-of-four monitoring. He exhibited four out of four, equal twitches and was noted to be breathing asynchronously with the ventilator. The ventilator mode was discontinued, and the patient was allowed to spontaneously breathe for the duration of the case at a rate of 18-24 breaths per minute with tidal volumes greater than 500 ml. The surgery lasted one hour and ten minutes and the patient's vital signs remained stable for the duration of the case. Throughout the case, the patient received a total of midazolam 10 mg, hydromorphone 2.4 mg, fentanyl 400 mcg, and dexmedetomidine 100 mcg.

The patient emerged smoothly from anesthesia and was extubated without complication. Upon arrival to the post anesthesia care unit (PACU), the patient rated his pain as a nine out of ten. He continued to receive supplemental doses of IV hydromorphone in the PACU until his pain score decreased to 3 out of 10. The patient required a total hydromorphone dose of 1.6 mg in the PACU in addition to the 2.4 mg administered intraoperatively. Surgeon preference prevented the use of regional anesthesia or field block.

Discussion

In order to provide optimal analgesia for patients with atypical pain tolerance, it is imperative that anesthesia providers understand risk factors likely to influence a patient's opioid and/or sedative requirements. Specifically, these variables include the type of surgical procedure, non-prescription drug use, and prescribed opioid usage. Each of these variables will be discussed, along with specific implications for analgesic requirements.

One of the first considerations when evaluating analgesic requirements is the anticipated level of discomfort resulting from the surgical procedure. The average pain score on a numbered scale of zero to ten for an orchiectomy is a seven, indicating a significant amount of pain can be anticipated without the use of pain medications.[1] This scale reflects a zero when the patient reports having no pain and a ten when the patient reports experiencing the most severe pain ever experienced. The severity of pain in the postoperative phase following this procedure is related to the significant nerve innervation of the testicular and scrotal regions by afferent nerve fibers of the spermatic cord, iliohypogastric, ilioinguinal nerves, and genitofemoral nerves, along with a branch of the pudendal nerve on the posterior surface of the scrotal sac.[2] Therefore, it is likely that the patient will require potent or higher dose opioids for

optimal analgesia. The analgesic requirements in this particular case appear to extend beyond the scope of discomfort that would reasonably be attributed to orchiectomy.

Research studies examining the concomitant use of marijuana and analgesics suggest a cross-tolerance between cannabis and alcohol, barbiturates, opioids, benzodiazepines, and phenothiazines.[3] This cross-tolerance may, at least partly, account for the patient's tolerance to midazolam, fentanyl, and hydromorphone. Furthermore, individuals who habitually smoke marijuana have been noted to have an increased incidence of anxiety, fear, depression, delusions, violent behavior, and hallucinations.[3] The patient discussed in this case study demonstrated high levels of anxiety and fear.

High anxiety levels have been associated with an increase in sympathetic nervous system activity and increased efflux of substance P in specific limbic structures such as the amygdala and septum.[4] Substance P is a neurotransmitter that regulates the excitability of dorsal horn nociceptive neurons, which plays a significant role in the sensation of pain.[5] This physiological understanding may explain the increased doses of midazolam and supplemental ketamine and dexmedetomidine required to attenuate the patient's pre-operative anxiety. Furthermore, this knowledge may, at least partly, explain the increased cumulative analgesic requirements for this patient. That is to say, the high anxiety of the patient would likely have resulted in increased release of substance P, thereby increasing the excitability of the dorsal horn nociceptive neurons and sensation of pain. Logically, this could likely result in increased opioid requirements for adequate analgesia.

The patient's chronic low back pain required oxycodone for relief. The long-term use of oxycodone may have resulted in a down regulation of his mu receptors.[6] As such, the patient would require a higher opioid dose to achieve analgesia.[6] Therefore, it is reasonable to surmise that, in this case, the down regulation of the patient's mu receptors may have negated the normal side effect of respiratory depression anticipated with high dose opioid administration.

Finally, many studies have indicated decreased opioid requirements when ketamine is administered.[7-10] Ketamine acts on the central nervous system. Its effects are primarily mediated by non-competitive antagonism at the *N*-methyl-*D*-aspartate receptor calcium channel pore, and it also reduces the presynaptic release of glutamate.[11] Administration of ketamine in this case likely decreased the overall opioid requirements for this patient. However, it is notable that the patient required significant doses of opioids despite the concomitant administrations of other analgesics.

This case study highlights important variables to consider when formulating a plan of care to provide optimal analgesia for patients with decreased pain tolerance. This patient required substantial analgesic intervention both intraoperatively and postoperatively. Rather than one particular factor being primarily responsible for his significant analgesic requirements, a cumulative appreciation of the various factors discussed may be helpful in understanding the physiologic complexity surrounding atypical pain tolerance. It is crucial for anesthesia providers to understand physiologic principles relating to pain. This knowledge empowers anesthesia providers to recognize patients with atypical

pain tolerance: a first step in providing these patients adequate analgesia.

References

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Mentor: Kelly Wiltse Nicely, CRNA, PhD

Editorial

With a New Year and spring well upon us I would like to welcome our new Editorial Board members.

Kären K. Embrey CRNA, EdD; University of Southern California
Ilene Ottmer, CRNA, MSN; University of Wisconsin Medical School & Medical Foundation
Sarah Perez, CRNA, MSN; Washington University School of Medicine

These individuals have graciously agreed to volunteer their time to support the ISJNA in its mission to facilitate and encourage scholarly writing by graduate students enrolled in nurse anesthesia educational programs. Actually, I should say 'continue to volunteer their time', as each of these CRNAs have been involved with the journal as reviewers and mentors. I am also particularly pleased to point out that two of our new editors are former authors! This truly demonstrates the spirit of the journal and is a tribute to those who have served on the editorial board since its inception by Ron Van Nest, CRNA, MA, JD back in 2002.

We have had many distinguished CRNAs who have served the student journal, and at this time I would like to thank Michele Gold, CRNA, PhD (University of Southern California), who is retiring from the Editorial Board. In another example of renewal, Dr. Gold recruited and mentored Dr. Embrey to take her place, so I leave you with this springtime quote:

"*From the end spring new beginnings*" Gaius Plinius Secundus

Best,

Vicki C. Coopmans, CRNA, PhD
Editor

> "***The International Student Journal of Nurse Anesthesia*** **is produced exclusively for publishing the work of nurse anesthesia students. It is intended to be basic and introductory in its content. Its goal is to introduce the student to the world of writing for publication; to improve the practice of nurse anesthesia and the safety of the patients entrusted to our care.**"

To access prior issues of the ISJNA visit the following link:

www.aana.com/studentjournal

INTERNATIONAL STUDENT JOURNAL OF NURSE ANESTHESIA
GUIDE FOR AUTHORS

MISSION STATEMENT

The International Student Journal of Nurse Anesthesia *is produced exclusively for publishing the work of nurse anesthesia students.* It is intended to be basic and introductory in its content. Its goal is to introduce the student to the world of writing for publication; to improve the practice of nurse anesthesia and the safety of the patients entrusted to our care.

ITEMS ACCEPTED FOR PUBLICATION

Case reports, research abstracts, evidence-based practice (EBP) analysis reports, and letters to the editor may be submitted. These items must be authored by a student under the guidance of an anesthesia practitioner mentor (CRNA or physician). The mentor must submit the item for the student and serve as the contact person during the review process. Items submitted to this journal should not be under consideration with another journal. We encourage authors and mentors to critically evaluate the topic and the quality of the writing. If the topic and the written presentation are beyond the introductory publication level we strongly suggest that the article be submitted to a more prestigious publication such as the *AANA Journal.*

ITEM PREPARATION & SUBMISSION

Student authors prepare case reports, abstracts, EBP analysis reports, and letters to the editor with the guidance of a mentor. Only students may be authors. Case and EBP analysis reports must be single-authored. Abstracts may have multiple authors. **Mentors should take an active role** in reviewing the item to ensure appropriate content, writing style, and format prior to submission.

The original intent of this journal was to publish items while the author is still a student. In order to consistently meet this goal, all submissions must be received by the editor at least **3 months prior** to the author's date of graduation.

PEER REVIEW

Items submitted for publication are initially reviewed by the editor. Items may be rejected, or returned to the mentor with instructions for the author to revise and resubmit prior to initiation of the formal review process. All accepted submissions undergo a formal process of blind review by at least two ISJNA reviewers. After review, items may be accepted without revision, accepted with revision, or rejected with comments.

General guidelines

1. Items for publication must adhere to the *American Medical Association Manual of Style* (AMA, the same guide utilized by the *AANA Journal* and such prominent textbooks as *Nurse Anesthesia* by Nagelhout and Plaus). The review process will not be initiated on reports submitted with incorrect formatting and will be returned to the mentor for revision. Please note the following:
    a. Use of abbreviations is detailed in Section 14. Spell out acronyms/initialisms when first used. If you are using the phrase once, do not list the acronym/initialism at all.
    b. Instructions regarding units of measure can be found in Section 18. In most cases The International System of Units (SI) is used. Abbreviations for units of measure do not need to be spelled out with first use. Some examples: height/length should be reported in cm, weight in kg, temperature in ^{o}C, pressure in mm Hg or cm H_20.
    c. In general, first use of pulmonary/respiratory abbreviations should be expanded, with the following exceptions: O_2, CO_2, PCO_2, $PaCO_2$, PO_2, PaO_2. Please use SpO_2 for oxygen saturation as measured by pulse oximetry.
    d. Use the nonproprietary (generic) name of drugs - avoid proprietary (brand) names. Type generic names in lowercase. When discussing dosages state the name of the drug, *then* the dosage (midazolam 2 mg).
    e. Use of descriptive terms for equipment and devices is preferred. If the use of a proprietary name is necessary (for clarity, or if more than one type is being discussed), give the name followed by the manufacturer and location in parenthesis:
        "A GlideScope (Verathon Inc., Bothell, WA) was used to . . . ."
    Please note, TM and ® symbols are not used per the AMA manual.

f. Examples of referencing are included later in this guide.

2. Report appropriate infusion rates and gas flow rates:
   a. When reporting infusion rates report them as mcg/kg/min or mg/kg/min. In some cases it may be appropriate to report dose or quantity/hr (i.e. insulin, hyperalimentation). If a mixture of drugs is being infused give the concentration of each drug and *report the infusion rate in ml/min*.
   b. Keep the gas laws in mind when reporting flow rates. Report the liter flows of oxygen and nitrous oxide and the percent of the volatile agent added to the gas mixture. Statements such as "40% oxygen, 60% nitrous oxide and 3% sevoflurane" do not = 100% and are thus incorrect. For example, "General anesthesia was maintained with sevoflurane 3% inspired concentration in a mixture of oxygen 1 L/min and air 1 L/min".
3. Only Microsoft Word file formats will be accepted with the following criteria:
   a. Font - 12 point, Times New Roman
   b. Single-spacing (except where indicated), paragraphs separated with a double space (do not indent)
   c. One-inch margins
   d. Place <u>one</u> space after the last punctuation of sentences. End the sentence with the period before placing the superscript number for the reference.
   e. Do not use columns, bolds (except where indicated), or unconventional lettering styles or fonts.
   f. Do not use endnote/footnote formats.
4. Do not use Endnotes or similar referencing software. Please remove all hyperlinks within the text.
5. Avoid jargon.
   a. *'The <u>patient</u> was reversed'* - Did you physically turn the patient around and point him in the opposite direction? "Neuromuscular blockade was antagonized."
   b. *The patient was put on oxygen.* "Oxygen was administered by face mask."
   c. *The <u>patient</u> was intubated and put on a ventilator*. "The trachea was intubated and respiration was controlled by a mechanical ventilator.
   d. *The patient had been on Motrin for three days.* "The patient had taken ibuprofen for three days."
   e. Avoid the term "MAC" when referring to a sedation technique - the term sedation (light, moderate, heavy, unconscious) sedation may be used. Since all anesthesia administration is monitored, the editors prefer to use specific pharmacology terminology rather than reimbursement terminology.
6. Use the words "anesthesia professionals" or "anesthesia practitioners" when discussing all persons who administer anesthesia (avoid the reimbursement term "anesthesia providers")
7. References
   a. Again, the **AMA Manual of Style** must be adhered to for reference formatting.
   b. All should be within the past 8 years, except for seminal works essential to the topic being presented.
   c. Primary sources are preferred.
   d. All items cited must be from peer-reviewed sources – use of internet sources must be carefully considered in this regard.
   e. Numbering should be positioned at the one-inch margin – text should begin at 1.25".
8. See each item for additional information.
9. **Heading** for each item (Case Report, Abstract, EBPA Report) must adhere to the following format:

Title (bold, centered, 70 characters or less)
[space]
Author Name (centered, include academic credentials only)
Name of Nurse Anesthesia Program (centered)
[space]
Anticipated date of graduation (italics, centered, will be removed prior to publication)
E-mail address (italics, centered, will be removed prior to publication)
[space, left-justify from this point forward]
Keywords: ('Keywords:' in bold, followed by keywords (normal font) that can be used to identify the report in an internet search.)

<u>Case Reports</u>

The student author must have had a significant role in the conduct of the case. The total word count should be between 1200 – 1400 words. References do not count against the word count. Case reports with greater than 1400

words will be returned to the mentor for revision prior to initiation of the review process. The following template demonstrates the required format for case report submission.

Heading (see #9 above in General Guidelines)

[space]

A brief introductory paragraph of less than 100 words to focus the reader's attention. This may include historical background, demographics or epidemiology (with appropriate references) of the problem about to be discussed. It is written in the *present tense*. Although it is introductory, the heading word '***Introduction'*** is not used. Be certain to cite references in this section, especially statistics and demographics pertaining to your topic.

[space]

Case Report (bold, 400-500 words)

[space]

This portion discusses the case performed in *400 words or less*, and is written in the *past tense*. Do not justify actions or behaviors in this section; simply report the events as they unfolded. Present the case in an orderly sequence. Some aspects need considerable elaboration and others only a cursory mention.

- Patient description: height, weight, age, gender.
- History of present illness
- Statement of co-existing conditions/diseases
- Mention the current medications, generic names **only**. (Give dosage and schedule only if that information is pertinent to the consequences of the case.)
- **Significant** laboratory values, x-rays or other diagnostic testing pertinent to the case. Give the units after the values (eg. Mmol/L or mg/dL).
- Physical examination/Pre-anesthesia evaluation - **significant** findings only. Include the ASA Physical Status and Mallampati Classification **only** if pertinent to the case.
- Anesthetic management (patient preparation, induction, maintenance, emergence, post-operative recovery).

Despite the detail presented here it is only to help the author organize the structure of the report. Under most circumstances if findings/actions are normal or not contributory to the case then they should not be described. Events significant to the focus of the report should be discussed in greater detail. The purpose of the case report is to set the stage (and 'hook' the reader) for the real point of your paper which is the discussion and teaching/learning derived from the case.

[space]

Discussion (bold, 600-800 words)

[space]

Describe the ***anesthesia*** implications of the focus of the case report citing current literature. Describe the rationale for your actions and risk/benefits of any options you may have had. This section is not merely a pathophysiology review that can be found in textbooks. *Relate the anesthesia literature with the conduct of your case noting how and why your case was the same or different from what is known in the literature.* Photographs are discouraged unless they are essential to the article. Photos with identifiable persons must have a signed consent by the person photographed forwarded to the editor via first class mail. Diagrams must have permission from original author. This is the most important part of the article. In terms of space and word count this should be longer than the case presentation. End the discussion with a summary lesson you learned from the case, perhaps what you would do differently if you had it to do over again.

[space]

References (bold)

[space]

A minimum of 5 references is recommended, with a maximum of 8 allowed. No more than 2 textbooks may be included in the reference list, and all references should be no older than 8 years, except for seminal works essential to the topic. This is also an exercise in evaluating and using current literature.

[space]

Mentor: (bold, followed by mentor name and credentials in normal text)

E-mail address (italics, will be removed prior to publication)

Research Abstracts

Research abstracts are limited to 500 words. References are not desired but may be included if considered essential. Note that this abstract is different from a research proposal. This abstract reports the *outcome* of your study. Use the same format described for the case report with the exception of the section headings:

Heading (see #9 above in General Guidelines)
[space]
Introduction (bold)
[space]
A brief introductory paragraph including purpose and hypotheses.
[space]
Methods (bold)
[space]
Include research design and statistical analyses used
[space]
Results (bold)
[space]
Present results – do not justify or discuss here.
[space]
Discussion (bold)
[space]
Discuss results
[space]
References (bold)
[space]
Not required, but a maximum of 5 references is allowed.
[space]
Mentor: (bold, followed by mentor name and credentials in normal text)
E-mail address (italics, will be removed prior to publication)

EBP Analysis Reports
Evidence-based practice analysis reports are limited to 3000 words. Please do not include an abstract. The report should provide a critical evaluation of a practice pattern in the form of a clinical question about a specific intervention and population. The manuscript should:

1. Articulate the practice issue and generate a concise question for evidence-based analysis. A focused foreground question following either the PICO or SPICE format should be used.
2. Describe the methods of inquiry used in compiling the data.
3. Critically analyze the quality of research reviewed and applicability to different practice settings.
4. Draw logical conclusions regarding appropriate translation of research into practice.

The same general format guidelines apply with the exception of the section headings as below. Please note that text books and non-peer reviewed internet sources should be avoided, and sources of reference should be less than 8 years old unless they are seminal works specifically related to your topic of inquiry:

Heading (see #9 above in General Guidelines)
[space]
Introduction (bold)
[space]
Briefly introduce the reader to the practice issue or controversy, describe the scope or significance or problem, and identify the purpose of your analysis. Describe the theoretical, conceptual, or scientific framework that supports your inquiry.
[space]
Methodology (bold)
[space]
Include the format used for formulating the specific question you seek to answer, search terms and methods used, and levels of evidence.
[space]
Literature Analysis (bold)
[space]

Review and critique the pertinent and current literature, determining scientific credibility and limitations of studies reviewed. Your synthesis table would be included in this section. Your review and discussion of the literature should logically lead to support a practice recommendation. Subheadings may be used if desired.
[space]
Conclusions (bold)
[space]
Summarize the salient points that support the practice recommendation and make research-supported recommendations that should improve the practice issue, while also acknowledging any limitations or weaknesses
[space]
References [bold]
[space]
A minimum of 8 references is recommended, with a maximum of 12 allowed.

Letters to the Editor
Students may write letters to the editor topics of interest to other students. Topics may include comments on previously published articles in this journal. Personally offensive, degrading or insulting letters will not be accepted. Suggested alternative approaches to anesthesia management and constructive criticisms are welcome.
The length of the letters should not exceed 100 words and must identify the student author and anesthesia program.

AMA MANUAL OF STYLE

The following is brief introduction to the *AMA Manual of Style* reference format along with some links to basic, helpful guides on the internet. The website for the text is http://www.amamanualofstyle.com/oso/public/index.html. It is likely your institution's library has a copy on reserve.
http://www.docstyles.com/amastat.htm#Top
http://healthlinks.washington.edu/hsl/styleguides/ama.html

Journal names should be in *italics* and abbreviated according to the listing in the PubMed Journals Database. The first URL below provides a tutorial on looking up correct abbreviations for journal titles; the second is a link to the PubMed where you can perform a search.
http://www.nlm.nih.gov/bsd/viewlet/search/journal/journal.html
http://www.ncbi.nlm.nih.gov/pubmed

The International Student Journal of Nurse Anesthesia (ISJNA) is not listed in the PubMed Database. For the purpose of citing the ISJNA *in this Journal* use "**Int Student J Nurse Anesth**" as the abbreviation. The titles of text books are also printed in *italics*. Please pay close attention to ensure correct punctuation.

Journals
Note there is a comma after the first initials until the last author, which has a period. If there are six or less authors **cite all six**. If there are more than six authors **cite only the first three** followed by "et al." Only the first word of the title of the article is capitalized. The first letters of the major words of the journal title are capitalized. There is no space between the year, volume number, issue number, and page numbers. If there is no volume or issue number, use the month. If there is an issue number but no volume number use only the issue number (in parentheses). The pages are inclusive - **do not omit digits.**

Some journals (and books) may be available both as hard copies and online. When referencing a journal that has been accessed online, the DOI (digital object identifier) or PMID (PubMed identification number) should be included (see example below).

Journal, 6 or fewer authors:
Hamdan A, Sibai A, Rameh C, Kanazeh G. Short-term effects of endotracheal intubation on voice. *J Voice.* 2007;21(6):762-768.

Journal, more than 6 authors:
Chen C, Nguyen MD, Bar-Meir E, et al. Effects of vasopressor administration on the outcomes of microsurgical breast reconstruction. Ann Plast Surg. *2010;65(1):28-31. PMID: 20548236.*

Texts
There is a difference in citing a text with one or more *authors* from a text with one or more *editors*. Texts that are *edited* give credit to the authors of the chapters. They must be annotated and the **inclusive** pages of the chapter are noted. Texts that are *authored* do not have different chapter authors, the chapter is not cited by heading **but the inclusive pages where the information was found are cited**, unless the entire book is cited.

Text:
Stoelting R, Dierdorf S. *Anesthesia and Co-Existing Disease*. 3rd ed. Philadelphia: Churchill Livingstone; 1993:351-354.

Chapter from a text:
Burkard J, Olson RL, Vacchiano CA. Regional anesthesia. In Nagelhout JJ, Plaus KL, eds. Nurse Anesthesia*. 4th ed. St. Louis:Elsevier; 2010:977-1030*

Each chapter was written by a different author. Note the chapter's author gets the prominent location. The chapter title is cited; "editor" is abbreviated in a lowercase. The word "edition" is also abbreviated and in lower case. The inclusive pages of the chapter are cited.

Electronic references
Only established, peer-reviewed sources may be referenced. Please do not reference brochures or informational websites where a peer-review process cannot be confirmed. Authors are cautioned to not copy and paste from these without full credit and quotation marks where appropriate. Electronic references are cited using the following format:

Author (or if no author, the name of the organization responsible for the site). Title. *Name of journal or website*. Year;vol(issue no.):inclusive pages. doi: or URL. Published [date]. Updated [date]. Accessed [date].

For online journals, the accessed date may be the only date available, and in some cases no page numbers.

Examples:
Kamangar N, McDonnell MS. Pulmonary embolism. *eMedicine*. http://www.emedicine.com/med/topic1958.htm. Updated August 25, 2009. Accessed September 9, 2009.

Gupta A, Aggarwal N, Sharma D. Ultrasound guided ilioinguinal block. *The Internet Journal of Anesthesiology.* 2011;29(1).
http://www.ispub.com/journal/the_internet_journal_of_anesthesiology/volume_29_number_1/article/ultrasound-guided-ilioinguinal-block.html. Accessed August 1, 2011.

ACADEMIC INTEGRITY
Issues of academic integrity are the primary responsibility of the author and mentor. Accurate and appropriate acknowledgement of sources is expected. **Any violation will be cause for rejection of the article.**

"Plagiarism is defined as the act of passing off as one's own the ideas, writings, or statements of another. Any act of plagiarism is a serious breach of academic standards, and is considered an offense against the University subject to disciplinary action. Any quotation from another source, whether written, spoken, or electronic, must be bound by quotation marks and properly cited. Any paraphrase (a recapitulation of another source's statement or idea in one's own words) or summary (a more concise restatement of another's ideas) must be properly cited."
http://grad.georgetown.edu/pages/reg_7.cfm

HOW TO SUBMIT AN ITEM
Manuscripts must be submitted by the mentor of the student author via e-mail to **INTSJNA@aol.com** as an attachment. The subject line of the e-mail should be "Submission to Student Journal". The item should be saved in the following format – two-three word descriptor of the article_author's last name_school abbreviation_mentor's last name_date (e.g. PedsPain_Smyth_GU_Pearson_5.19.09)

REVIEW AND PUBLICATION

If the editor does not acknowledge receipt of the item within one week, assume that it was not received and please inquire. Upon receipt, the Editor will review the submission for compliance with the Guide to Authors. If proper format has not been following the item will be returned to the mentor for correction. This is very important as all reviewers serve on a volunteer basis. Their time should be spent ensuring appropriate content, not making format corrections. It is the mentor's responsibility to ensure formatting guidelines have been followed prior to submission.

Once the item has been accepted for review the Editor will send a blinded copy to a Section Editor, who will then coordinate a blinded review by two reviewers who are not affiliated with the originating program. The reviewers recommend publication to the Section Editor or make recommendations for changes to be addressed by the author. The Section Editor will return the item to the Editor, who will return it to the mentor for appropriate action (revision, approval to print). If the article is returned to the author for repair it is usually to answer a specific question related to the case that was not clear in the narrative or it asks the author to provide a reference for a statement. Every effort is made to place the returned article in the earliest next issue.

The goal is for all articles submitted by students to be published while the author is still a student. Therefore, deadlines must be met and the entire process must be efficient. If an item is not ready for publication within 3 months after the student author has graduated it will no longer be eligible for publication. For this reason it is recommended that case reports be submitted at least 4-6 months prior to the student author's anticipated graduation date.

Mentors of the papers may be asked to serve as reviewers of case reports by student authors from other programs and will be listed as contributing editors for the issue in which the item is published.

PHOTOS

Photos of students for the front cover of the Journal are welcome. Include a legend describing the activity and who is in the photo and identify the photographer. Only digital photos of high quality will be accepted via email to INTSJNA@aol.com. There must be a follow up hard copy signed by all present in the photo, as well as the photographer/ owner of the original photo, giving consent to publish the photo. Mail that consent to:

Vicki C. Coopmans, CRNA, PhD
Goldfarb School of Nursing at Barnes-Jewish College
4483 Duncan Ave., Mailstop 90-36-697
St. Louis, MO 63110

SUBMISSION CHECK LIST

___ **AMA Manual of Style and other format instructions are adhered to**.
___ Total word count not exceeded (1400 for case report, 500 for abstract, 3000 for EBPA).
___ The item is one continuous Word document without artificially created page breaks.
___ Verbatim phrases and sentences are quoted and referenced.
___ All matters that are not common knowledge to the author are referenced.
___ Generic names for drugs and products are used throughout and spelled correctly in lower-case.
___ Units are designated for all dosages, physical findings, and laboratory results.
___ Endnotes, footnotes not used.
___ Jargon is absent.

Heading
___ Concise title less than 70 characters long
___ Author name, credentials, nurse anesthesia program, graduation date and email are included.
___ Five **Keywords** are provided

Case Report
___ Introduction is less than 100 words.
___ Case Report section states only those facts vital to the account (no opinions or rationale)
___ Case report section is 400-500 words and not longer than the discussion.
___ Discussion section is 600-800 words.
___ Discussion of the case management is based on a review of current literature
___ Discussion concludes with lessons learned and how the case might be better managed in the future.

Abstract
___ The 500 word count maximum is not exceeded.
___ Abstract reports the *outcome* of your study.
___ Includes Introduction, Methods, Results, and Conclusion sections.

EBPA Report
___ The 3000 word count maximum is not exceeded.
___ A critical evaluation of a practice pattern in the form of a precise clinical question about a specific intervention and population is presented.
___ A focused foreground question following either the PICO or SPICE format is used.
___ Includes Introduction, Methodology, Literature Analysis, and Conclusion sections.

References
___ AMA Style for referencing is used correctly.
___ Reference numbers are sequenced beginning with one and superscripted.
___ References are from anesthesia and other current primary source literature.
___ All inclusive pages are cited, texts as well as journals.
___ Journal titles are abbreviated as they appear in the PubMed Journals Database.
___ Number of references adheres to specific item guidelines.
___ Internet sources are currently accessible, reputable, and peer reviewed.

Transmission
___ The article is sent as a attachment to **INTSJNA@AOL.COM**
___ The file name is correctly formatted (e.g. PedsPain_Smyth_GU_Pearson_5.19.09)
___ It is submitted by the mentor with cc to the student author
___ The words "Submission to Student Journal" are in the subject heading.