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TOPICS IN THIS ISSUE

Sickle Cell Disease
Autistic Spectrum Disorder
Pediatric Emergence Agitation
Supraventricular Tachycardia
Tonsillectomy Complications
Difficult Extubation
Organ Procurement
BIS Monitoring
Nasal Intubation
Aortic Stenosis



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Front Cover: Jennifer Willard, RN, BSN (foreground) and Sara Miller, RN, BSN, graduate students in the Wake Forest University Baptist Medical Center Nurse Anesthesia Program, learn to recognize the epidural “loss of resistance” on spine specimens in the clinical skills lab.

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Anesthetic Considerations for Sickle Cell Disease

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Keywords: Sickle Cell Disease, Transfusion Therapy, Hemoglobin S, Anesthesia

Sickle cell disease (SCD) is a genetic disorder primarily affecting people whose ancestors resided in malaria-stricken areas in the world. The primary defect of SCD is a homozygous abnormal hemoglobin S (Hgb SS) that comprise up to 70- 98% of hemoglobin. In sickle cell trait (SCT), a predominantly benign disease, the heterozygous Hgb SA, the abnormal hemoglobin S may contain 40% of the total hemoglobin.¹ Sickle cell disease is a structural disorder in which the glutamine acid in the sixth residue of the B chain of hemoglobin is substituted with valine. In the United States, 8% of African-Americans have the heterozygous SCT and 2.8% are affected by SCD.² Sickle cell disease is prevalent in other ethnic groups including Mediterranean countries, Arabian countries, Turkey, India, the Caribbean and South and Central America.³

Hemoglobin S, when deoxygenated at PaO₂ < 20mmHg for SCT and PaO₂ < 40 mmHg for SCD, can change shape because of polymerization of the abnormal sickle hemoglobin S. Instead of the normal round discoid shape, the hemoglobin S proteins adhere to each other forming a rigid sickle shape and subsequently become embedded in blood vessels restricting blood flow. This restriction deprives the downstream tissue of oxygen leading to ischemia of the organs, which may cause organ damage resulting in sickle cell crisis and severe painful episodes for the patient.² Additionally, this restriction causes mechanical damage of the RBCs during passage in the vasculature resulting

in a chronic hemolytic anemia and activation of the coagulation cascade.²

The initiation of sickle cell crisis can be caused by a variety of factors including acidosis, hypothermia, increased blood viscosity, dehydration, acute pain, trauma, and infection. Vaso-occlusion of blood vessels can affect multiple organs systems resulting in cerebrovascular accidents (CVAs), trans-ischemic accidents (TIAs), acute chest syndromes, renal insufficiency, liver disease, retinopathy, priapism, spontaneous abortions, leg ulcers, osteonecrosis, and splenic sequestration leading to splenectomy.⁴ Patients may be at higher risk for developing these complications during the peri-operative period in conjunction with general anesthesia.

Case Report

A 40 year old, 81 kg, 170 cm, ASA III African-American female presented for incision and drainage of hematoma of left hip and possible left total hip arthroplasty. The patient was initially diagnosed with SCT in boot camp in 1989, and asymptomatic for 19 years until after her second pregnancy following a complicated childbirth at age 33. The patient reported the fetus heart rate decreased necessitating an emergent cesarean section requiring general anesthesia. Thereafter, the patient became symptomatic with sickle cell manifestations including orthopedic, cardiovascular, and pulmonary complications.

Her surgical history includes multiple inner ear surgeries, a left hip core decompression with a post-operative TIA complication, and

a right hip core decompression also with a vaso-occlusive complication of a CVA with no sequelae of symptoms. Subsequently the patient was electively admitted for left hip arthroplasty due to avascular necrosis. During this admission, the patient suffered multiple post-operative complications including pulmonary embolism to bilateral lungs requiring anticoagulants. Complications from anticoagulant therapy resulted in multiple hematoma evacuations to the left hip with incision and drainage with washouts, IVC filter placement, and peri-rectal abscess with rectal drain.

Her medical history included avascular necrosis of hip, shoulders and left knee, which resulted in difficulty ambulating, requiring cane use. The patient also suffered sensory and conductive hearing loss requiring hearing aids and sickle cell retinopathy, and an episode of pericarditis that resolved with antibiotics. During her current admission, the patient had been treated for a urinary tract infection, nausea, vomiting, hemolytic anemia and chronic pain requiring high dose opioids. Throughout her current and past admissions, the patient received multiple blood transfusions without transfusion reactions.

Medications administered on the inpatient unit include docusate sodium twice daily, MS Contin 30mg three times daily, ciprofloxican 250 mg twice daily, promethazine 12.5 mg, diazepam 5 mg, morphine 2-4 mg IV and oxycodone/acetaminophen 5 mg/325 mg as needed for pain. Drug allergies included penicillin ("hives"), aspirin, and metoclopramide "numbness". Preoperative labs were as follows: Hgb 8.0 g/dl, Hct 24.4 % WBC- $6.9 \times 1000/\text{mm}^3$ PLT $698 \times 1000/\text{mm}^3$, PT- 18 seconds, PTT 34.5 seconds, INR 1.4, chemistry results normal. The chest x-ray showed significant changes

of bilateral humeral heads, stable and no evidence of cardiopulmonary disease. The EKG showed sinus tachycardia at heart rate of 105.

In the pre-operative holding area, the patient complained of significant back pain 10/10, in which diazepam 10 mg and hydromorphone 0.4 mg titrated intravenously (IV). After preoxygenation, induction medications included Fentanyl-300 mcg titrated, Lidocaine-80 mg, Propofol-100 mg, and Rocuronium-50 mg given IV push. The trachea was intubated orally with 7.5mmID endotracheal tube, an esophageal temperature probe inserted, and a warming blanket attached to the patient. The patient's temperature was maintained between 36.5-37.3 degree celcius. Clindamycin 600 mg IV was given slowly prior to the start of surgery.

An arterial line was inserted in the right radial artery and anesthesia was maintained using 6% desflurane, nitrous oxide 0.5 L/min, and oxygen 0.5 L/min and titrating Fentanyl 50 mcg and Dilaudid 0.2 mg intravenously. During mid-procedure, the estimated blood loss (EBL) was 200 ml and blood was drawn and evaluated using portable laboratory analysis (ISTAT) for Hgb and Hct, which were 6.8g/dl and 21% respectively. The orthopedic surgeons anticipated replacing hardware of the total hip arthroplasty, which would cause additional blood loss. Thus, the patient was transfused with one unit PRBC without complications.

Prior to emergence, the patient received ondansetron 4mg and the neuromuscular blockade fully reversed using neostigmine 4mg with glycopyrrolate 0.8 mg. The patient received a total of 3000 ml of lactated ringers, one unit of PRBC with EBL of 250 ml, urine output of 500 ml, hydromorphone

4 mg, and fentanyl 750 mcg. The patient's trachea was extubated without complications and subsequently transported via gurney to the ICU step-down unit for closer observation. The one hour Hgb and Hct post-transfusion were 8.0g/dl and 24%. The patient was transferred to the orthopedic ward after 2 days and subsequently discharged after two weeks.

Discussion

Blood transfusion management for patients with SCD can be challenging. Prevention of circulatory stasis requires maintaining the intravascular volume to optimum levels. Blood transfusions can be life saving to correct anemia so that oxygen carrying capacity can be optimized to prevent hypoxia. Alternatively, blood products have inherent immunologic and non-immunologic complications such as risk of infection, hemoconcentration of blood, which may lead to circulatory stasis of blood resulting in microthrombi, clots and sickling. The goals for transfusion in sickle cell patients are two fold: to increase oxygen carrying capacity and to reduce the Hgb S to 30% of circulating blood. This can be accomplished by either simple transfusions or exchange transfusions. Simple transfusions reduce the Hgb S concentrations by hemodiluting the blood with PRBC and increase the Hgb A levels to 60-70%.^{1,3,5} Although simple transfusions are more common, the risk of hyperviscosity and possible stasis of blood must be considered. Alternatively exchange transfusions replace the Hgb S cells with HgbA cells without decreasing the viscosity of the blood, reduces iron overload, while decreasing the concentration of Hgb S. Both modalities decrease the risk of occlusive damage to end organs.¹ Preoperatively, the hematology oncology practitioner was consulted and recommended to maintain the patient's Hgb levels between 6-10 g/dl.

Since the patient Hgb was already at 6.8 g/dl with additional anticipated blood loss, it was prudent to prospectively transfuse the patient before any symptoms started.⁶

Simple and exchange transfusions are only part of the treatment regimen for sickle cell patients. Peri-operative hydration is a critical component in maintaining blood viscosity and preventing sickling. The patient was adequately hydrated with lactated ringers at 125 ml /hr for 12 hours preoperatively, optimized intra-operatively with 3000 ml of lactated ringers for the 3-hour procedure, and maintained post-operatively at 100 ml/hr until the patient was able to tolerate fluids by mouth. In addition to hydration, pre-operatively, patients should be treated with bronchodilators and anti-infectives if indicated.² The patient was currently being treated with ciprofloxacin for a UTI. Additionally, all blood products administered were specifically matched with the patient to prevent alloimmunization. Intra-operatively, arterial oxygenation and body temperature should be optimized to prevent sickling.² The patient was adequately oxygenated and warmed as evidenced by pulse oximetry readings between 99-100% with esophageal temperature varying from 36.4-37.3 °C. Post-operatively, sickle cell patients should receive adequate analgesia, aggressive pulmonary toilet and monitored for post-operative vaso-occlusion crisis.² The patient received a patient controlled analgesia of hydromorphone, referred to the Acute Pain Service for management of post-operative pain. She was instructed pre-operatively to use the incentive spirometry, cough and deep breath in addition to frequent hydration. As a result, the patient suffered no post-operative vaso-occlusive complications. In conclusion, sickle cell patients must be closely monitored throughout the peri-operative period and

transfused only when indicated to minimize potential complications.

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Premedication for the patient with Autistic Spectrum Disorder

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Keywords: autistic spectrum disorder, anesthesia, premedication, autism, preoperative assessment

In 2007, according to the Centers for Disease Control and Prevention, the prevalence of autistic spectrum disorders (ASD), was about 1 in 500 children. This data suggests that the chance of a child having an ASD is more common than childhood cancer.¹ Autistic children are appearing more frequently in the operative setting as advances in medicine allow treatment for this special needs population. For anesthesia practitioners the initial interaction with the patient is the preoperative assessment. This initiation of the anesthetic plan proves to be challenging when confronted with an autistic patient. The practitioner should be aware that the diagnosis of ASD is broad in definition and varies in severity. Along with underlying co-

morbidities that can be associated with ASD, the psychiatric and emotional challenge the patient is confronted with during preoperative preparation warrants special attention to the anesthetic plan.

Case Report

A 20-year-old male patient diagnosed with dental disease presented for dental treatment under general anesthesia. The patient's medical history included autism, seizures, and reflux. His past surgical history included dental treatment under general anesthesia and bilateral tympanostomies. He experienced postoperative nausea with his last treatment, but no other anesthetic complications. The patient's medications included risperdal, escitalopram oxalate, benztropine mesylate, lorazepam, omeprazole, and amoxicillin.

The patient weighed 79 kilograms and was 68 inches tall. His preoperative blood pressure was 135/87, heart rate 74, respiratory rate 18 breaths per minute, and oxygen saturation 99% on room air. No preoperative laboratory work, x-rays, or ECG were obtained. On arrival to the holding room suite a young man, who was fully dressed and sitting in a chair was being comforted by his mother. The patient was uncommunicative, maintained little eye contact and could only follow some commands when prompted by his mother. The patient resisted the holding room nurse's request to don a hospital gown and have an intravenous (IV) catheter placed. Physical exam was unattainable due to the patient's lack of cooperation related to his developmental delay. His physical status was classified as ASA II. The patient, while distracted by his mother showing him some empty bottles, was administered ketamine 300 mg dose mixed with atropine 0.2 mg intramuscularly, which facilitated moving the patient to a stretcher. The patient's mother was then able to dress him into a hospital gown. An IV catheter was placed and midazolam 2mg IV was administered.

Once in the operating room, monitors were applied. The patient was pre-oxygenated by face mask. Fentanyl, propofol, and rocuronium IV were administered for induction of general anesthesia. The patient was intubated via the left naris with a 7.0 nasal RAE under direct visualization. Isoflurane and nitrous oxide were administered. Muscle relaxation was maintained with vecuronium. The patient's procedure was uneventful and vital signs remained stable throughout the case. Ondansetron IV and droperidol IV were administered. The procedure ended and the patient was given neostigmine and glycopyrrolate IV to reverse muscle paralysis. The patient resumed spontaneous

respirations with adequate tidal volumes. The patient was extubated with positive pressure ventilation and maintained a patent airway.

On awakening the patient was calm and appeared to be comfortable. The patient displayed no resistance to the anesthesia team. He was transported to the post anesthesia recovery unit. The patient's mother awaited his arrival in the recovery unit with the patient's empty bottles in hand. The patient was later discharged home with no complications.

Discussion

Individuals diagnosed with ASD are commonly afflicted by three distinguishing behavioral impairments that can vary in severity along a continuum of disorders. These traits are: atypical verbal or non-verbal communication, abnormal social interactions/relationships, and habitual or compulsive actions.² These traits are seen with the most severity in Autism disorder, which is classified as an ASD, along with other similar diagnoses of Asperger's disorder, pervasive developmental disorder-not otherwise specified, Rett's disorder and childhood disintegrative disorder.³ Neurobehavioral symptoms that comprise ASD can be aggravated when any change in routine or environment occurs. Introduction to the hospital milieu can be distressing to the patient with ASD and could potentiate existing behavioral problems. The refusal to cooperate with preoperative routines, such as taking oral medications or having an intravenous line placed can make the experience frustrating not only for the patient, but for the guardian and anesthetist. Any type of physical contact may not be well tolerated and any of the routine practices that are common observances in the operative setting could trigger the patient

to have an aggressive outburst aimed at the perceived antagonist or oneself.⁴

As the operative setting is becoming more common place for the patient with ASD, practitioners of anesthesia should be aware of the important implications in developing a plan that is both safe and effective for this patient.⁴ Awareness of these behavioral impairments and specific patient needs, such as triggering agents or security items, should be addressed with the guardian. Information from previous anesthetic charts and any insight gleaned from the guardian should be utilized. This will enable the anesthetist to choose a premedication that best facilitates safe transport to the operating suite.

Deciding on a premedication plan depends on patient cooperation. On occasion this goes hand in hand with the severity of the ASD. There are different pharmacologic options that can be tailored to maximize cooperation of the individual patient. The premedications that have been used with ASD are similar to those used in the pediatric population. Considering that the patient with ASD could potentially have existing co-morbidities, a careful review of systems and past anesthetics should be examined. The patient with ASD is at a greater risk for having a seizure disorder.⁵ A known history of seizure activity, could influence the anesthetist's choice and implementation of a premedication plan.

The most common drugs reported in the literature used to sedate the patient with ASD are midazolam and ketamine. Both drugs have the advantage of being utilized by multiple routes of administration. Midazolam at doses ranging from 0.25-0.5 mg/kg orally; 0.1-0.15 mg/kg intramuscularly (IM) and 0.02 to 0.05 mg/kg IV can be used.⁶ Along with its amnesic and

sedative pharmacologic actions, midazolam also has anticonvulsant properties. This may prove beneficial to the patient with ASD. Although midazolam can produce ventilatory depression, flumazenil, the benzodiazepine antagonist is available, unlike barbiturates that have no reversal.⁷ The other popular premedication, ketamine has been used successfully with ASD patients. Routes of administration are comparable to midazolam and dosages that have been suggested are 5mg-7mg/kg orally, 2-4mg/kg IM; and 1-2 mg/kg IV.^{4,7} The use of ketamine for the patient with ASD is advantageous. Laryngeal reflexes are preserved, an analgesic effect is elicited with administration, and ketamine is considered to have anticonvulsant properties.⁸ An antisialagogue, such as glycopyrrolate or atropine is indicated to prevent the excessive salivation that may occur with the administration of ketamine.

Current literature is limited when addressing the issue of ASD and the applicability of an anesthesia protocol. Van Der Walt and Moran suggest the use of oral midazolam for mild cases of autism and oral ketamine for those patients with moderate to severe cases.⁴ They conclude that the requirements for each patient vary in every situation and that premedication requirements should depend on the assessment conducted by the anesthetist and information obtained from the guardian. In discussing the patient who is a combative autistic, Bachenberg⁹ suggests the superiority of oral ketamine. He discusses the challenges in adequately premedicating the autistic patient in a non forceful manner. Oral Ketamine at a 600mg dose mixed with Coca Cola to disguise ketamine's bitter flavor, successfully premedicated the patients in two case studies. Preference of oral over IM ketamine was explained as being a potentially less hazardous situation for the practitioner.⁹

While this article focuses on the preoperative aspect of anesthesia management, it is important to acknowledge the emergence and recovery phase of the anesthetic plan. Information from past anesthetic records and pertinent information obtained from the guardian, just as in the preoperative phase of the anesthetic, can be vital in a smooth recovery. Interventions which have been found useful with past anesthetics and the presence of security items, may aid the anesthetist during emergence. Guardian involvement may prove beneficial as well, so as to provide familiarity to an uncertain and possibly alarming environment on awakening. In executing the delivery of anesthesia for the patient with ASD these considerations should be explored for a safe and uneventful anesthetic experience.

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Intraoperative Arousal during BIS Monitoring

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Keywords: intraoperative arousal, awareness under anesthesia, anesthesia, BIS, bispectral index

Due to media attention, intraoperative arousal and awareness has recently come to the forefront of public concern regarding

anesthesia. While the incidence remains 1-2 cases per 1000, patients are becoming more knowledgeable concerning potential risks associated with anesthesia and are more involved in the decisions associated with the healthcare they receive.¹ The Bispectral Index Scale (BIS) monitor was introduced in

1999. Manufactures of the BIS claimed the device would reduce the incidence of awareness during general anesthesia. However, many practitioners question the reliability of this relatively new technology.

Case Report

A 35 year old, 100 kg, 67 in female patient presented for dilation and curettage (D&C) with hysteroscopy and ablation to be followed by left ankle arthroscopy with removal of a loose body near the fibula. Her past medical history included gastric reflux, which was well-controlled on medical therapy. Her past surgical history included a cholecystectomy, tonsillectomy, open reduction-internal fixation of the right elbow, and sphenopalatine clip. The patient reported severe nausea and vomiting following previous general anesthetics. Her current medications included iron, pantoprazole sodium, and hydrocodone-acetaminophen. Her initial vital signs were pulse 78 beats per minute, blood pressure 127/65 mmHg, and oxygen saturation of 97%.

The patient received premedication with midazolam 2 mg. Once in the operating room, an intravenous (IV) induction was performed using propofol 200 mg with subsequent placement of a size 4 laryngeal mask airway (LMA). The placement was confirmed with equal bilateral breath sounds, verification of end-tidal carbon dioxide, and absence of leak around the LMA. Anesthesia was maintained with sevoflurane and a continuous propofol infusion at 25 mcg/kg/min.

As the patient was placed in lithotomy position, an audible inspiratory gasp was noted. Upon assessment of the patient, the BIS value read 38 and the respiratory rate remained the same at 12 breaths per minute.

The patient's heart rate did not increase and her blood pressure was unchanged from baseline. Additionally, it was confirmed that the propofol was connected and infusing and the end tidal concentration of sevoflurane was 2.1%. The surgeon noted that the patient had moved and fentanyl 25 mcg was administered IV. At this time, the BIS value increased to 80 and an IV bolus of propofol 30 mg was administered. Sevoflurane was increased to an end-tidal concentration of 2.7%. As the BIS value returned to 34, the BIS monitor was assessed and the sensor strip was retested to ensure accurate measurement.

Approximately 45 minutes into the procedure, the patient spontaneously inspired a large tidal volume with no other signs of discomfort or change in vital signs. At that time it was noted that the BIS value had been 30-35 with a sudden unexpected increase to >70. An IV bolus of propofol 50 mg was administered and end-tidal sevoflurane was increased to 3.2%. The propofol infusion was increased to 75 mcg/kg/min and fentanyl 25 mcg was administered IV, after which the BIS value returned to 30.

Following the case, the patient had no complaint of pain. Throughout the three hour anesthetic, the patient received a total of 850 mg propofol, 2 mg midazolam, and 150 mcg fentanyl. The patient was taken to the post anesthesia care unit without incident. In the immediate postoperative period she did not report intraoperative awareness, and was discharged to home following the recovery period.

Discussion

Unintended awareness during anesthesia is an event of great concern to the anesthesia professional. The purpose of anesthesia is to

provide analgesia and amnesia during the stress of surgical procedures. If awareness occurs, it essentially negates the usefulness of the anesthesia that has been provided. Indeed, not all instances of arousal and awareness result in the patient experiencing recall of the intraoperative period. However, if recall occurs following inadequate anesthesia the potential sequela range from sleep disturbance and nightmares, to post-traumatic stress disorder (PTSD).² Of those who experience recall, over half of those patients will present clinically with PTSD.³ Anesthetic cases that involve major trauma, obstetrics, and cardiac surgery present with an increased risk of awareness; however all patients undergoing general anesthesia should be treated with the same degree of care and caution to eliminate the occurrence of awareness.⁴ Awareness with resultant PTSD is of great concern to the anesthesia community. Not only do many of these patients who experience PTSD in these instances suffer for years following the event, but also it could lead to legal action against the anesthesia practitioner.³ Moreover, if the incidence of awareness increases and is widely reported to the public, it could affect the level of trust that is essential between the patient and the anesthesia practitioner in the clinical setting.

Anesthesia professionals assess a patient's level of hypnosis by assessing changes in the heart rate and the blood pressure, and by monitoring pupillary response, presence of perspiration and skeletal muscle movement.² The introduction of the BIS monitor does not substitute for the need for practitioner assessment, judgment, and intervention, but can be used to serve as an adjunct to attentive care during the administration of a general anesthetic. This case was unusual in that the patient was receiving greater than one minimum alveolar concentration (MAC) of sevoflurane, in addition to a continuous

propofol infusion. The patient displayed no significant alteration of vital signs from the baseline values prior to her movement during the procedure. While the patient was being closely monitored and assessed, none of the typical physiologic reactions to stress or pain, such as an increase in heart rate, blood pressure, or respiratory rate were evident. Moreover, while the patient's BIS value did rise in conjunction with her movement, this did not transpire until after the patient had moved. Therefore, no preliminary signs or quantitative BIS values were present which could have prevented intraoperative movement in this case.

In this case, patient movement appeared to be just as effective as the BIS in indicating arousal. However, ideally, the BIS should help to differentiate movement that is reflexive (i.e., adequate hypnosis indicated by a low BIS value) from movement that is indicative of lightening anesthesia (i.e., accompanied by a high BIS value, as in this case). Such differentiation of the causes of movement would indicate to the anesthetist whether additional opioids or hypnotics are indicated, or whether additional neuromuscular blockade should be used. Accordingly, the BIS may also provide useful information in patients who receive neuromuscular blocking agents and in whom movement as the sole sign of arousal (such as this patient) would be precluded by neuromuscular blockade.

Conflicting data presented in current literature has made it difficult to determine the requisite of the BIS in prevention of intraoperative awareness. In 2004, the B-Aware trial included over 2000 participants and was conducted to verify the validity and reliability of the BIS monitor. The findings of this prospective, randomized, double-blind study reported an 82% reduction in the incidence of awareness in the group of

participants which utilized the BIS monitoring in contrast to the group which received routine care.⁵ On the contrary, in 2006 the B-Unaware study was conducted to determine the incidence of awareness during the use of BIS versus the use of end-tidal anesthetic gas (ETAG) concentration to provide adequate anesthetic depth. A total of 1941 participants were equally divided into two groups, and both reported an identical incidence of awareness with a 95% confidence interval. The authors were unable to reproduce the previous findings in the B-Aware study and found no significant reduction of awareness in association with BIS use or ETAG value.⁷ Furthermore, while the suggested BIS values for prevention of recall range from 30-50, conflicting evidence in one case report demonstrated explicit recall at a reading of 47.⁶ That particular case report involved a patient undergoing cardiac surgery, which in itself increases the risk of awareness due to the nature of the procedure.⁴ Of note, the patient did not receive benzodiazepines or intravenous narcotics. Rather, the anesthetic technique implemented for this case combined the use of intrathecal morphine and an end-tidal MAC of sevoflurane.⁶ Indeed, all of these factors should be considered when critically evaluating this case as an argument against the usefulness of BIS in reducing awareness.

While the prevention of intraoperative awareness is of utmost concern to each anesthesia practitioner, frequent reevaluation of one's clinical practice to reflect the safest, most current standard of care is essential. Due to the recent findings in favor of BIS monitoring with a reported 82% reduction in awareness, some have suggested it be employed as standard monitoring during each general anesthetic.⁵ However, the presentation of this case should serve as a reminder that there is no substitute for astute

clinical judgment and continual patient assessment during the administration of a general anesthetic. Certainly more research should be conducted, and further clinical evidence needs to be presented on this topic. While the BIS monitor can be used as an adjunct to quantify an estimated level of sedation into a numerical value, there is no replacement for the clinical knowledge and skills in assessment and intervention of an anesthesia practitioner.

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In Anticipation of a Difficult Extubation

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Keywords: difficult airway, difficult extubation, airway exchange catheter, failed extubation, airway adjuncts.

Anesthesia education is centered on recognizing anatomical hallmarks of difficult airways, effective ventilation, and strategies for successful intubation. However, there is a paucity of literature focusing on removal of the endotracheal tube from a difficult airway. The American Society of Anesthesiologists Close Claimed data bases revealed that 18 of 156 peri-operative claims pertaining to difficult airways during 1985-1995 were associated with poor outcomes during extubation.¹ Most patients who present with difficult airways generally perform well post extubation; however, when extubation fails, reintubation is often more challenging than the initial attempt.² The airway Exchange Catheter (AEC) is a tool that can be used during extubation to help facilitate reintubation.²⁻⁵

Case Report

A 52 year old female, 50 inches tall and 130 kg, presented for abdominal hysterectomy with pelvic node dissection for endometrial cancer. Her medical history was significant for: type 2 diabetes, depression, snoring and delayed mental development. Her current medications included: pravastatin, olopatadine eye drops, baclofen, glipizide and a multivitamin. Her history revealed that six years prior, following an abdominal

procedure, she remained intubated for 3 days due to 'respiratory problems' as stated by her guardian.

An airway assessment revealed: Mallampati class 2, oral aperture of 3.5 cm, and poor dentition. She had full range of motion in her neck, a prominent under bite, and substantial facial hair. No history of pulmonary disease was noted; however, the patient used accessory muscles during quiet breathing while sitting upright in a chair.

A lumbar epidural was placed prior to surgery. In the operating room (OR), standard monitors were applied and she was positioned with a ramp under her shoulders and head to maximize visualization of vocal cords. General anesthesia was induced with intravenous (IV) lidocaine 50 mg and propofol 150 mg. Mask ventilation was accomplished after the placement of a 90 mm oral airway. Succinylcholine 100 mg IV was administered and direct laryngoscopy with a Macintosh 3 blade revealed the arytenoid cartilages. A gum elastic bougie was advanced into the trachea and a 7.0 mm endotracheal tube (ETT) was advanced atraumatically over the device. Positive bilateral breath sounds and positive end tidal carbon dioxide (ETCO₂) were noted. Pressure control ventilation was utilized to maintain an ETCO₂ of 32-35 mmHg. General anesthesia was maintained with desflurane, end-tidal concentration of 5-6 %, and vecuronium 8 mg IV was administered during the case. An epidural infusion of

0.25% bupivacaine was initiated at 3cc/hr. An insulin infusion was initiated for glycemic control, blood glucose ranged 169-247 mg/dl.

At the start of incision closure, a dexmedetomidine infusion was initiated at 0.3 mcg/kg/hr in anticipation of utilizing an AEC. The desflurane was titrated off and the head of bed (HOB) was elevated. A nasal trumpet was inserted atraumatically. Once two twitches were present with train of four stimulation, neuromuscular blockade was antagonized with neostigmine 5 mg and glycopyrrolate 1mg. Once the patient followed commands and established an adequate unassisted respiratory effort as evidenced by tidal volumes > 350 cc, an AEC was inserted through her ETT into her trachea. The ETT was removed leaving the AEC in place, oxygen 100% via face mask was applied. The patient continued with adequate respiratory effort and oxygen saturations >95%. She was able to verbalize around the AEC and appeared to be tolerant of it. In the recovery room, the patient continued to ventilate well, and remained comfortable with the AEC in place. The epidural continued to infuse at 3 cc/hr and the patient's vital signs remained stable. The dexmedetomidine and AEC were discontinued 2 hours after surgery as the patient continued with no respiratory complications and oxygen saturations >95%.

Discussion

The difficult airway requires planning and preparation from the anesthesia team throughout the case. Some practitioners prefer to delay extubation in the OR and send the patient to a monitored unit with the endotracheal tube in place; however, this may not be a safest alternative for the patient.⁶ If the extubation attempt fails, the patient's hemodynamic and respiratory

status may deteriorate quickly. Emergent reintubation is associated with hypoxia which may result in a combative, confused and uncooperative patient. The task of reintubation away from the OR where supplies and staff are unfamiliar to the anesthetist complicates an already difficult situation.⁷

The safe progression to extubation must start during the initial assessment of the patient. At this time the anesthetist should construct a plan in the event the patient cannot maintain adequate ventilation upon extubation. The ASA recommends the consideration of using short term devices, such as an AEC, which can serve as an immediate conduit for reintubation of the trachea.⁴ Some AEC designs allow for capnography and oxygen insufflation via jet ventilation. This gives the anesthetist time to gather supplies and personnel in the event an ETT cannot be threaded over the device.^{4,5,7}

Mort, in 2007, conducted a comprehensive prospective chart review of patients who experience extubation over an AEC. Many patients experienced no difficulties once extubated; however, some did not progress as expected and needed reintubation. Successful reintubation over the AEC occurred in 92% of those patients, the vast majority on the first attempt.³ A study conducted by Dosemeci et al. in 2004 also concluded that when a pediatric AEC was utilized in adults before extubation of a difficulty airway, reintubation was facilitated in the majority of cases.⁶

An AEC can be used as an extubation bridge by providing the practitioner with a direct contact to the trachea in the event extubation fails. Successful bridging starts with preparing the patient and family for the possibility of awakening with the catheter in place. Generally, smaller diameter AECs are

better tolerated than larger diameter catheters.^{3,7} Moyers suggests administering lidocaine via the ETT prior to placing the AEC to promote patient comfort.⁶ It is the practitioner's decision on when to remove the AEC, realizing that the need for reintubation can occur any time after removing the ETT. It is not uncommon to leave the device in-situ for 2-8 hours based on the patient's co-morbidities and/or the anticipation of airway edema.³

There are many risks associated with the use of an AEC including: airway trauma, aspiration due to interruption of normal glottic functioning, and accumulation of secretions from impaired cough. These risks may all be minimized by utilizing the smallest AEC appropriate for the patient.⁷ A 14 French AEC was utilized with a 3 mm internal diameter for this patient. This size easily passed through the 7.0mm ETT, and had a large enough internal diameter to assist with jet ventilation if needed. Asai and Shingu's research concerning fiberoptic ETT placement demonstrated that repeated attempts at blindly advancing an ETT over an indwelling device can result in trauma to laryngeal and surrounding tissues. Trauma can be prevented by the use of a flexible intubating laryngeal mask ETT which is more pliable than a standard ETT allowing easier maneuverability. If resistance is met, rotation of the ETT 90 degrees counter clockwise can help advance it over the arytenoids.⁸

In this particular case, the determination to utilize the AEC was made due to: morbid obesity, history of prolonged intubation following her last abdominal surgery, and the noted respiratory effort she displayed while seated upright. With her history of obesity and diabetes she was at an increased risk of aspiration while the AEC was in place. To reduce this risk, prior to removal of the ETT the following interventions were

performed: the patient's stomach was decompressed with an oral gastric tube, she was placed with the HOB >30 degrees, she was able to follow commands and no topical anesthetic was applied to her airway to further assist in her ability to manage secretions. An intubating LMA and flexible ETT were in the room in case the AEC failed and emergency reintubation was necessary.

There has been much reported success with utilizing AEC. However, there is no guarantee this technique will work every time. This is one tool in the anesthesiologist's plan that can help prevent poor outcomes. It is still a priority for the team to ensure prior to any extubation attempt that experienced airway personnel are readily available to assist in a difficult reintubation. Conventional airway devices and personnel trained in emergency cricothyroidotomy, retrograde intubation and other methods need to be present at the bedside.^{3,6,7}

Success of the above intervention depends largely on patient cooperation. To facilitate acceptance of the AEC a dexmedetomidine infusion was utilized. The literature suggests anesthetizing the airway with lidocaine, although an excellent option, its effects are not ideal in this case for reasons stated above. A dexmedetomidine infusion can be titrated and infused as long as needed without altering respiratory effort, which is especially valuable in the patient with developmental delays. Dexmedetomidine can produce blood pressure and heart rate depression, which can be exacerbated further with an epidural infusion for pain control. For this reason, it is imperative to closely monitor cardiovascular as well as respiratory status in this patient. In this case study, the AEC was well tolerated by the patient. The extubation progressed successfully, reintubation was not necessary, the AEC

presented an immediate avenue available to the team in the event of a respiratory emergency.

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Reduction of Postoperative Tonsillectomy Complications

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Keywords: tonsillectomy, adult, postoperative, complications, anesthesia

Adult tonsillectomies are performed for recurrent or chronic tonsillitis and commonly done on an outpatient basis. The first reported tonsillectomy was made by the Roman surgeon Celsus in 30 AD.¹ The patient may return to their normal lifestyle in 7-14 days. The postoperative course may be complicated by pain, nausea, vomiting, and bleeding. Often the patient will describe the pain as the worst sore throat they have ever had in their life. Interventions by the

anesthesia practitioner can help alleviate some of the postoperative complications associated with tonsillectomy.

Case Report

A 32 year-old, 75 kg, 63 inch female presented to the preoperative area with a diagnosis of chronic tonsillitis. She was scheduled for a bilateral tonsillectomy. She had a history of cigarette abuse. She admitted to postoperative nausea and vomiting (PONV) after two previous caesarean sections. Preoperative lab results

were within normal limits. Physical examination revealed a healthy appearing female. She had a Mallampati Classification III airway, midline trachea, thyromental distance of three fingerbreadths, full cervical range of motion, and bilateral enlarged tonsils. She was assigned an American Society of Anesthesiologists' physical status of II due to her smoking history. Clear breath sounds were auscultated bilaterally and heart tones had a regular rate and rhythm.

In the preoperative area, an 18-gauge peripheral intravenous (IV) catheter was inserted and an infusion of lactated ringers initiated. The patient was premedicated with a post auricular scopolamine 1.5 mg patch, midazolam 2 mg and glycopyrrolate 0.2 mg IV. She was then transported to the operating room (OR). The patient transferred herself to the OR table, a roll was placed under her shoulders, her head was placed on a headrest, and monitors were applied. After preoxygenation for five minutes with a SpO₂ of 100%, an intravenous induction with fentanyl 100 mcg, lidocaine 100 mg, propofol 150 mg, a defasciculating dose of rocuronium 1 mg, and succinylcholine 80 mg was successful. Direct laryngoscopy was performed with a Macintosh #3 blade and an oral RAE 7.0 mm ID endotracheal tube (ETT) was atraumatically inserted through the vocal cords. ETT placement was confirmed by the auscultation of bilateral breath sounds and positive end tidal carbon dioxide. Mechanical ventilation was initiated. General anesthesia was maintained with desflurane. The OR table was then turned 90 degrees for surgical access to the oropharynx. A mouth gag was inserted by the surgeon, and the bilateral tonsillectomy was completed in 30 minutes. An oral gastric tube and a 90 mm oral airway were placed by the surgical

resident. The stomach was decompressed and the oropharynx suctioned. The peripheral nerve stimulated indicated a train of four (TOF) of three twitches, so the neuromuscular blockade was antagonized with an IV dose of neostigmine 3 mg and glycopyrrolate 0.6 mg. Ondansetron 4 mg, dexamethasone 10 mg, and an additional dose of lidocaine 100 mg IV were administered. The ETT was removed when TOF stimulation revealed four equal twitches with sustained tetany for five seconds, the patient demonstrated sustained head lift greater than five seconds, and a tidal volume greater than five ml/kg. The oral airway was removed and oxygen four L/min was administered via nasal cannula.

The patient was transferred to the post anesthesia care unit (PACU) and discharged that same day. Two hours after admission to the PACU, the patient denied nausea or vomiting. No excessive bleeding or coughing was reported by the PACU Registered Nurse. The patient did complain of throat pain.

Discussion

In order to decrease the incidence of postoperative tonsillectomy complications, the anesthesia practitioner must focus on pain, coughing, PONV, and bleeding. Pain is the number one patient complaint after a tonsillectomy, and unfortunately the complication least minimized.² Opioids are routinely administered for analgesia but opioids may cause respiratory depression and PONV.³

Other analgesic approaches have been attempted with tonsillectomies, but the literature does not support their efficacy. The first approach is a glossopharyngeal nerve block. In a controlled, randomized double-blind study comparing postoperative

morphine administration with and without a glossopharyngeal nerve block, the researchers found that glossopharyngeal block did not improve analgesia following tonsillectomy.⁴

The administration of anti-inflammatory medication may also provide analgesia after tonsillectomies but the increase risk of post operative bleeding often precludes the administration. Ketoralac, a non steroidal anti-inflammatory (NSAID), has a well established analgesic efficacy but it is also known to prolong bleeding time and is associated with a two to five fold higher incidence of postoperative hemorrhage.² Another NSAID having less effect on coagulation, ketoprofen, has been studied. The results indicate that ketoprofen alone does not provide adequate analgesia but ketoprofen combined with acetaminophen with codeine provides adequate analgesia for most patients.² Dexamethasone, a steroidal anti-inflammatory, has been shown to provide analgesia after tonsillectomies by reducing inflammation and swelling but has also been associated with bleeding and poor wound healing.⁵ Opioids, though, continue to remain the mainstay for analgesia after a tonsillectomy.

The anesthesia practitioner may also consider a non-pharmacological approach to pain control after a tonsillectomy by minimizing trauma to the oropharynx. The first step to minimizing trauma to the oropharynx is to perform an atraumatic intubation. A thorough preoperative evaluation of the airway, which may be compromised by enlarged tonsils, is imperative. Once the patient's airway has been assessed, an appropriate airway management technique is then employed. The use of an oral, preformed RAE endotracheal tube taped in a midline position, allows full surgical access with

minimal manipulation and kinking.⁶ Another strategy that decreases trauma to the oropharynx is the prevention of post extubation coughing. Post extubation coughing is also more prevalent in smokers due to underlying airway irritation.⁷ Deep extubation would minimize the chance of laryngospasm and post extubation coughing, but an increased risk of aspiration from sanguineous drainage has been reported.⁸ Thus extubation was performed after airway reflexes had returned. Intravenous lidocaine 1.5 mg/kg has been shown to be an effective antitussive.⁷ Another antitussive approach is the instillation of 4% lidocaine into the ETT cuff. A study has shown this maneuver to be effective in cases longer than 1.5 hours but the same results were not duplicated in cases less than 1.5 hours.⁷ Since tonsillectomies are usually completed in 30-45 minutes this approach would not be the appropriate for this case.

A third step to reduce oropharyngeal trauma and associated postoperative pain is to avert PONV. This patient was identified as being at high risk for PONV due to the following risk factors: female gender, history of PONV, use of opioids, and an ear, nose and throat (ENT) procedure. Based on these risk factors Habib et al. recommends a multimodal approach to prevent PONV.⁹ The multimodal approach used in this case was the administration of preoperative scopolamine, IV hydration, ondansetron, dexamethasone and stomach decompression.⁹

In summary, the long performed procedure of tonsillectomies has proven effective for the treatment of recurrent and chronic tonsillitis but the common postoperative tonsillectomy complications still include pain, PONV, and bleeding.⁵ Interventions to prevent these postoperative complications must be employed by the surgical team

along with the anesthesia practitioner. The anesthesia practitioner must prevent airway trauma, avoid post extubation coughing, and avert PONV. The risk/benefit ratio of anti-inflammatory medications must also be evaluated prior to the administration of steroids and/or NSAID.

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Nasal Intubation for Maxillofacial Surgery

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Keywords: Nasotracheal intubation, nasal intubation, maxillofacial surgery, nasal RAE[®], laryngoscopy

Nasal intubation was first reported by Kuhn in 1902, and further advocated by Magill in 1930 for intra-oral surgery.¹ Utilization of nasal intubation has advantages and disadvantages which will be discussed. In maxillofacial surgery, isolation of the airway

and anesthetist away from the surgical field becomes greatly important and is facilitated by nasal intubation.² The basic technique is uncomplicated and may be safely performed by fairly inexperienced practitioners under appropriate supervision.¹ Advances in airway management and the use of new rigid videolaryngoscopes are making nasal intubation safer for the patient and easier for the anesthesia professional.

Case Report

A 53-year-old, 93-kilogram, 70-inch male patient presented for palate resection with flap for soft tissue mass of the hard palate as well as a hard palate puncture lesion. His past medical history consisted of a left eye enucleation with prosthesis as a child. His only medication was zolpidem tartrate. Preoperative electrocardiogram and laboratory values were all within normal limits. A hard palate biopsy showed low-grade glandular neoplasm. Maxillofacial computed tomography with contrast showed a soft tissue mass involving the hard palate with extension into the right maxillary sinus and right inferior nasal turbinate.

Physical examination revealed a healthy appearing male with a Mallampati II airway classification, no loose or chipped teeth with natural dentition, and a thyromental distance greater than 6 cm. The patient demonstrated full cervical range of motion, and adequate mouth opening of greater than 5 cm with a lesion visualized on the right posterior hard palate. The patient was given 2 sprays intranasal oxymetazoline hydrochloride and a large bore peripheral intravenous (IV) line was placed with lactated ringers initiated. Patient was premedicated with midazolam 3 mg IV and transferred to the operating room (OR).

In the OR the difficult airway cart was readily available with flexible fiberoptic scope and additional adjuncts in case of unanticipated difficult airway. The surgical team was present at induction of anesthesia. A 7.0 mm internal diameter (ID) nasal RAE[®] tube was softened in a warm sterile water soak. The patient transferred to the OR table without assistance and standard monitors were applied. After 3 minutes of preoxygenation with 100% FiO₂, general

anesthesia was induced with fentanyl 100 mcg IV, lidocaine 40 mg IV, and propofol 180 mg IV. With loss of consciousness and successful mask ventilation, Vecuronium 8 mg IV was administered and ventilation was assisted for 60 seconds. With adequate oxygenation, the left naris was chosen for nasal intubation due to the involvement of the right inferior turbinate. The left naris was progressively dilated with a 6 mm, 7 mm, and 8 mm nasal airways lubricated with 2% lidocaine jelly. Oxygenation was optimized again with mask ventilation and a left nare, softened, 7 mm ID nasal RAE tube lubricated with 2% lidocaine jelly was advanced atraumatically into the trachea with placement visualized under direct laryngoscopy with a Macintosh #3 blade. The cuff was inflated, the tube was connected to the circuit, and placement confirmed with positive bilateral breath sounds, adequate chest rise and fall, and end-tidal carbon dioxide monitoring.

General anesthesia was maintained with desflurane 6% and intermittent boluses of fentanyl. Dexamethasone 10 mg IV was also administered. Neuromuscular blockade was antagonized and the trachea was extubated without incident. A left nare 7 mm nasal airway was placed per surgeon request. The patient fully awoke in the recovery room with no deficits and baseline vital signs. The patient was discharged home on post operative day one following an uneventful hospital course.

Discussion

The hard palate, which was partially removed in this patient, forms the floor of the nasal cavity that extends from the nostrils to the nasopharynx. The three nasal turbinates are located along the lateral wall of the nasal cavity and are covered by thick respiratory mucosa. The largest of the three

turbinate are the inferior pair¹, of which the patient's right was removed. To facilitate the removal of these large structures, nasal intubation allowed the surgeons enhanced oral access versus an oral endotracheal tube. Nasal intubation allows surgeons uninhibited room to maneuver within the oral cavity in many different types of surgeries.¹

Maxillofacial indications for nasal intubation include; "intra-oral and oropharyngeal surgery, complex intra-oral procedures involving segmental mandibulectomy or mandibular osteotomy and mandibular reconstructive procedures, rigid laryngoscopy, microlaryngeal surgery, and dental surgery."¹ Other general indications include; "intubation of patients with intra-oral pathology including obstructive lesions, structural abnormalities and trismus; intubation of patients with cervical spine instability or marked degenerative cervical spine disease, and intubation of patients with obstructive sleep apnea syndrome."¹ Having an enlarged intra-oral surgical field as well as facilitating instrumentation insertion, such as the Boyle-Davis gag utilized for this patient, were the advantages of using nasal intubation.¹

Fiberoptic nasal intubation may be performed when the patient is awake or anesthetized, and is usually less difficult than the oral route as the nasotracheal tube naturally curves toward the upper airway. The gag reflex also is usually less stimulated through the nasal route.³ Many elective procedures are appropriate for nasal intubation, but in an emergency, it may not be appropriate. In this case, nasal intubation was appropriate as the procedure was elective and it called for enhanced access to the oral cavity. Nasal intubations may require more time, cause epistaxis, and possibly delayed sepsis from prolonged

obstruction of the sinus.⁴ Coagulopathy or bleeding disorders can be a contraindication for nasal intubation due to frequent epistaxis³ as the nasal mucosa is highly vascularized.¹ Other disadvantages include being dependent on the patient's respiratory drive with blind nasal intubation, or possibly entering the cranial vault in the presence of a basilar skull fracture.⁴ Contraindication to nasal vasoconstrictors may also deter nasal intubation.³

Preoperative assessment of the nasotracheal airway is important although aberrant nasal anatomy may be common. Deviated septum, spurs or hypertrophied turbinates may make one nare better for tube passage.¹ Previous nasal or facial-oral reconstructive surgery should be noted with health history to evaluate if nasal intubation is feasible.^{1,5}

In the past, a cocaine solution or a combination lidocaine/phenylephrine were used to anesthetize and vasoconstrict the nasal mucosa.^{3,6} Few choices exist for reduction in bleeding and include cocaine, topical lidocaine with phenylephrine or oxymetazoline.¹ In this case, the use of intranasal oxymetazoline was utilized for vasoconstriction along with lidocaine jelly for additional anesthetic, and softening of the nasotracheal tube in warm water. This technique may alter the manufacturer's curve of the tube¹ although submucosal tunneling or mucosal trauma probability is decreased by softening of the tube.³

There is conflicting evidence for the use of dilation with nasopharyngeal airways prior to nasal intubation¹ as was used in the case. It has been advocated as a technique to decrease the amount of trauma and epistaxis but conflicting evidence suggests the opposite.¹ A perpendicular angle to the plane of the face should be taken with insertion of the tube into the inferior border

of nasal rim,³ following the floor of the nose to the posterior nasopharyngeal wall.¹ A 90 degree rotation of the tube counterclockwise can be utilized if resistance is met.³ The tube should never be forced through resistance. A smaller tube size should be used if resistance is met in both nares.⁶

Once the tube is in the oropharynx it can be advanced into the larynx using the blind nasal technique or under direct vision laryngoscopy with the assistance of Magill's forceps if needed.^{1,5,6} Blind nasal intubation avoids unnecessary stimulation and eliminates the risk of dental trauma.¹ This technique is used less frequently and is described as directing the tube toward the increasing breath sounds with auscultation at the proximal end of the tube.⁶

A common technique is direct laryngoscopy with Macintosh laryngoscope and use of Magill forceps.⁶ Fiberoptic nasal intubations are increasingly used with difficult airways but anesthesia professionals should be well versed in all techniques available to them. Recent advances include the use of new rigid videolaryngoscopes that provide an indirect view of the glottis and easy tube placement without Magill forceps.⁶

The overall utilization of nasal intubation is a safe and effective technique when supervised or completed by an experienced practitioner. Seeking further clinical

experience is encouraged to master the various techniques used with nasal intubation.¹ Preparation seemed to be the key to success with nasal intubation. From the preoperative exam and use of vasoconstrictors, to softening of the tube and anesthetic choice, thorough preparation made the process of nasal intubation proceed smoothly.

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General Anesthesia for the Patient with Aortic Stenosis

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Keywords: aortic stenosis, general anesthesia, spinal anesthesia

Patient outcomes differ depending on the type of anesthesia used for hip replacement surgery. Spinal anesthesia is often chosen for hip replacement surgery because there is a reduced incidence of deep vein thrombosis, myocardial infarction and acute confusion compared with patients who receive general anesthesia.¹ However, the anesthesia professional must also consider co-morbidities before a spinal anesthetic is utilized. Anesthetic management for the patient with aortic stenosis (AS) is challenging as it requires the maintenance of adequate preload, a slow to normal heart rate and an increased afterload. Spinal anesthesia is not advised for patients with AS because the loss of venous tone, and subsequent decrease in systemic vascular resistance (SVR), can be life-threatening.² Thus, general anesthesia is often preferred for the AS patient because it offers superior hemodynamic stability if it is administered judiciously and if pain is well controlled in the peri-operative period.

Case Report

A 64-year-old male presented for left hip replacement. The patient weighed 90 kg, was 69" tall and smoked 1-2 cigars per week for more than 10 years. The patient presented with a full beard, Mallampati class three airway, intact dentition, full range of motion in his neck and a thyromental distance of two fingerbreadths. He had been recently placed on metoprolol succinate, fluticasone and salmeterol for hypertension and bronchitis, respectively. Cardiac

evaluation in the previous weeks revealed normal sinus rhythm by electrocardiogram. During the exercise stress thallium test, the patient exhibited poor exercise capacity, significant ectopy with exercise, a small area of moderate ischemia in the anteroseptum, and normal wall motion of the left ventricle. An ejection fraction of 55-60 % was reported on the 2-dimensional echocardiogram, a severely calcified aortic valve, moderate to severe valvular aortic stenosis and mild to moderate aortic regurgitation. The aortic valve area measurement was 1.2 – 1.4 cm². The left ventricle displayed moderate concentric hypertrophy. Blood pressure the day of surgery was 154/71 mmHg, heart rate was 68 beats per minute (BPM). Physical assessment was significant for a loud systolic murmur.

While in the preoperative holding area, a right radial arterial line was placed. Midazolam, two milligrams (mg) were given intravenously (IV) prior to transporting the patient to the operating room (OR). Upon arrival to the OR, standard ASA monitors were placed, the arterial line was connected to the monitor for tracing and 12 L/min of oxygen via face mask were given to the patient. For induction, fentanyl 100 mcg IV were administered, followed by lidocaine 100mg, rocuronium 5mg and propofol 150 mg. Once the patient was rendered apneic, a positive pressure breath was given easily via mask ventilation. Succinylcholine 140 mg was then given IV and mask ventilation was continued for 45 seconds. The patient's trachea was atraumatically intubated. Mechanical ventilation was instituted with

desflurane at 6% in a mixture of 0.4 L/min of oxygen and 0.6 L/min of air.

A decrease in blood pressure and heart rate was treated with 10mg ephedrine IV. Heart rate was maintained between 60 and 70 BPM and blood pressure remained within 20% of baseline. Dilaudid 2 mg and 2,100 L of Ringer's Lactate was given over the course of the two hour OR time. Adequate preload was an important consideration for this patient with AS.³ The endotracheal tube was removed without incident and the patient brought to the post-anesthesia care unit (PACU). Vitals signs in the PACU were blood pressure 145/64 and heart rate 76.

The following day, a postoperative visit was made to the patient on the orthopedic unit. His vital signs were stable and he stated that he was feeling well and comfortable.

Discussion

Significant hemodynamic management is important in the patient with AS. Adequate preload is required to maintain sufficient cardiac output; a slow to normal heart rate is recommended to reduce the myocardial oxygen demand and allow more time for the heart to remain in diastole. Increased afterload is balanced with adequate contractility and maintenance of SVR preserves stroke volume and coronary blood flow.³ Although the type of anesthetic should be considered on an individual basis, general anesthesia is recommended for a patient with aortic stenosis.⁴

The classic symptoms of aortic stenosis are syncope, angina and congestive heart failure. Angina is the result of reduced flow through the coronary arteries.⁵ Vasodilation is often the cause of syncope. The stenotic aortic valve creates a need for increased pressure to fill the left ventricle; the heart

becomes increasingly unable to compensate for this extra pressure, leading to heart failure. This patient did not exhibit any of these symptoms, yet he did display the most common sign, a systolic murmur. Echocardiography with Doppler examination was used to determine the severity of the disease. The size of the aortic valve, the transvalvular gradient and the extent of left ventricular hypertrophy classified the patient with moderate to severe valvular aortic stenosis.^{3,5}

Management of anesthesia in the patient with aortic stenosis involves avoiding tachycardia and bradycardia, decreases in cardiac output, and sudden swings in systemic vascular resistance. Hypotension from spinal anesthesia is more significant and longer lasting than general anesthesia.⁶ For the patient with aortic stenosis, decreases in SVR profoundly decrease coronary blood flow and can lead to hypotension-induced ischemia.⁷ The decrease in SVR from regional anesthesia can cause a terrible cycle of poor perfusion, poor cardiac output and ischemia that is best avoided. The goal is to avoid agents that cause myocardial depression.³ Cardiac depressive agents such as a large induction dose of propofol or greater than one minimum alveolar concentration of volatile anesthetics were avoided. An arterial line is recommended for patients with AS as it provides the ability to monitor and act quickly to decreasing blood pressure.⁷ Controlling pain-related tachycardia is also of fundamental importance as increased heart rate will decrease filling of the left ventricle and thus decrease cardiac output.³ A long acting opioid was chosen to decrease pain during the intraoperative and postoperative period. With adequate pain relief, the release of endogenous catecholamines in response to stress, and thus tachycardia, was reduced. An increased

heart rate also carries an increase in risk for ischemia. During the post-operative period, the patient was started on a dilaudid PCA to maintain an adequate level of analgesia. Although an increase in heart rate was undesirable considering the patient's dependence on low to normal heart rate, with a starting heart rate of 60, phenylephrine was not considered a good choice due to the reflexive decrease in heart rate. Ephedrine was chosen for its ability to increase blood pressure and slightly increase heart rate.

The patient with AS relies on a slow to normal heart rate to pump the blood through the stenotic valve. General anesthesia is the more conservative approach to AS management, and is often preferred.^{3,6} Imperative maintenance of cardiac stability reflects the tenuous state of the patient with AS. Proper recognition of the signs and symptoms of the patient with AS are key to proper anesthetic management. The systolic murmur plus the echocardiogram results confirming moderate to severe aortic stenosis were two of the symptoms that guided management for this patient.

Hypotension was only treated once during the anesthetic and heart rate was maintained throughout the hip replacement. Monitoring of arterial blood pressure offered beat to beat analysis allowing quick treatment of alterations in blood pressure. The patient also reported minimal pain post surgery. The hemodynamic stability, plus the patient's comfort level after surgery confirm that general anesthesia was the appropriate choice for this patient with aortic stenosis. While the consequences of sympathetic

nervous system blockade could have been catastrophic, general anesthesia provided a safe anesthetic with minimal hemodynamic change.

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Organ Procurement in the Brain Dead Donor

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Keywords: organ donor, procurement, cadaveric, brain-dead, transplant

More than 101,000 people are awaiting organs nationwide; yet in 2008, just 28,000 transplants were performed.¹ Considering an organ donor can provide as many as 50 different organs and tissues to recipients, care of the organ donor is of the utmost importance.² Anesthesia practitioners are a critical part of this procurement process as care of the donor transplant patient changes from patient preservation to organ preservation.³ The following is a case study of a patient who underwent organ procurement after sustaining a neurologically unsurvivable injury. Preoperative and intraoperative considerations necessary to facilitate optimal organ procurement are discussed.

Case Report

A 35-year-old, 100 kilogram (BMI 32) woman, presented to the operating room for organ procurement of kidneys and liver. The patient was involved in a motor vehicle accident 72 hours prior and had sustained a catastrophic head injury, multiple rib fractures with lung contusions, and a left femoral shaft fracture. A computerized tomography (CT) scan of the head revealed a subdural hematoma with right-to-left midline shift and effacement of the right lateral ventricle. A neurological assessment of the patient revealed absent papillary, oculocephalic and gag reflex and an initial Glasgow coma score of 3. Following two neurological exams and an apnea test that was confirmatory for brain death, the family consented to organ donation.

Preoperatively, the patient had the following hemodynamic parameters: a non-invasive blood pressure reading of 103/55 millimeters mercury (mm Hg); heart rate (HR), 118 beats per minute (bpm), respiration rate (RR), 15 and pulse oximeter oxygen saturation (SpO₂), 100% at 0.40 fraction of inspired oxygen (FiO₂). Central venous pressure (CVP) readings ranged between 14-17 mm Hg. Blood laboratory analysis of the patient revealed the following: sodium, 159 milliequivalents (mEq) per liter (L); potassium, 3.3 mEq/L, glucose, 142 milligrams (mg) per deciliter (dL); blood urea nitrogen (BUN), 17 mg/dL. Hemoglobin was 10.6 grams (g)/dL and hematocrit 30.5%. The patient was receiving both thyroxine at 40 milliliters/hour (ml/hr) and dopamine at 12 micrograms/kilogram/minute (mcg/kg/min). Potassium chloride, 20 meq/hr, was also infusing.

During procurement, the patient remained ventilated on a high frequency ventilator. The SpO₂ remained at 100% during the 62 minute procedure. Intraoperatively, blood pressure ranged from 78-98 mm Hg systolic blood pressure (SBP) over 41-52 mm Hg diastolic blood pressure (DBP); HR was between 101-118 bpm. To increase systolic blood pressure, the dopamine and thyroxine infusions were titrated to 15 mcg/kg/min and 50 mL/hr, respectively; however, there was no increase in blood pressure. The dopamine infusion was increased to 20 mcg/kg/min and a norepinephrine infusion was started at 10 mcg/min and quickly titrated to 20 mcg/min. The target SBP of greater than 100

mm Hg was not achieved; however, SBP remained stable between 92-98 mm Hg.

No inhalation agents were used. Only a bolus dose of rocuronium 90 mg; mannitol 25 g; heparin 30,000 units, and furosemide 100 mg were administered. Total administered crystalloid intravenous fluid was 700 ml. Urine output totaled 300 ml. Despite a warming blanket, body temperature decreased from 34 degrees Centigrade (C) to 33.5 degrees C. Anesthetic monitoring and care ceased upon the aorta being cross-clamped.

Discussion

Brain death is associated with endocrine, metabolic, and hemodynamic disturbances.⁴⁻⁶ These disturbances must be managed in a potential organ donor so that organ viability is maintained. Upon brain death the vasomotor center in the brainstem becomes impaired. Additionally, all components of the hemodynamic model are affected: hypovolemia secondary to raised intracranial pressure treatment, diabetes insipidus or hyperglycemia-induced osmotic diuresis, decreased contractility due to coincident cardiac dysfunction, and vasodilation secondary to brain death.⁷ Fluid resuscitation should be used when indicated, along with vasopressors. In fact, it has been estimated that over 80% of organ donors require vasoactive support.⁸ The CVP of this patient indicated that volume status was not the etiology of the hypotension and led to the decision to add the second vasopressor to increase blood pressure. The patient intermittently required the use of norepinephrine during the course of her hospitalization to maintain a mean arterial pressure greater than 60 mm Hg. Because there are no randomized clinical trials, there are widely divergent opinions concerning the best vasopressors to use in these patients.

Traditionally dopamine has been used as the inotrope of choice; however, there has been a move toward the early use of vasopressin, due to its catecholamine-sparing effects.⁹

Similarly, hormonal resuscitation with combinations of thyroid hormones, steroids, vasopressin, insulin, and glucose remains controversial, because of limited randomized trials.⁹ There is evidence though, to suggest that the use of glucocorticoids, vasopressin and triiodothyronine (T3), known as triple hormone therapy, converts “unsuitable” donor organs into transplantable organs.¹⁰ The normal sequelae of brain death results in cardiovascular instability and poor organ perfusion, which often requires the use of inotropes. However, inotropes may cause ischemic injury to organs and intramyocardial adenosine triphosphate (ATP) stores, resulting in organs unsuitable for transplantation. In a retrospective study of 10,292 brain-dead patients, those who received hormonal replacement therapy, consisting of a methylprednisolone bolus and infusions of vasopressin and thyroxine infusions were found to have a 22.5% higher organ yield than those who did not receive hormonal replacement.¹⁰ Therefore, some clinicians advocate the use of triple hormone therapy as it is believed to provide hemodynamic stability, maintenance of adequate cellular oxygenation and organ perfusion, thus reducing the need for inotropes. Consequently, “unsuitable” donor organs become transplantable and graft survival is enhanced.

Each drug in triple hormone therapy has a specific effect on the brain-dead donor. High-dose methylprednisolone administration has been shown to significantly improve oxygenation, a probable result from attenuation of the effects of proinflammatory cytokines

released as a consequence of brain death.^{11,12} Triiodothyronine, is thought to improve cardiac function, thereby limiting ischemic injury to organs.¹² Since intravenous T3 is unavailable, intravenous thyroxine (T4) must be used, requiring conversion of T4 to T3 at the cellular level. In brain-dead organ donors, persistent hypotension often occurs despite adequate filling pressures. Vasopressin is used not only for its' vasopressor effect mediated via V1 receptors on blood vessels, but also for its' antidiuretic effect mediated via V2 receptors found on renal collecting duct epithelia. Additionally, a vasopressin infusion results in reduced inotropic requirements¹³ All of these effects of vasopressin contribute to hemodynamic stability and organ perfusion in the brain-dead organ donor. Despite this patient being on a thyroxine infusion and high doses of vasopressors, the blood pressure remained marginal, highlighting the hemodynamic instability in these patients and the challenge in maintaining adequate blood pressure to ensure well-perfused organs.

Electrolyte derangements are to be expected in organ donors and should be addressed prior to the procurement procedure. Potassium regulation becomes impaired in the brain-dead patient, requiring potassium administration, as was the case with this patient. Atrial and ventricular arrhythmias as well as conduction defects occur frequently in organ donors, often resulting from electrolyte and acid-base balance disorders. Should an arrhythmia develop, therapy should follow the usual guidelines except for bradycardia, which is resistant to atropine in the brain dead patient.⁹ Hemodynamically significant bradyarrhythmias require use of a directly acting agents such as isoprenaline or epinephrine, because vagal activity is absent in brain-dead patients.¹⁴

Extreme hypernatremia is also common in this population. Donor hypernatremia is reported to cause postoperative graft dysfunction in human orthotopic liver transplantation (OLT).¹⁵ Serum sodium donors with sodium greater than 155 mEq should have serum sodium corrected prior to being brought into the operating room. Recipients of hepatic allografts from donors with uncorrected hypernatremia have a significantly greater incidence of graft loss compared with recipients of hepatic allografts from normonatremic donors.¹⁵ However, the differences in graft survival were abrogated by the correction of donor hypernatremia before procurement. A normal sodium level was not achieved with this patient prior to the initiation of the surgery. Moreover, the limited surgical time prevented intraoperative correction prior to procurement of the organs.

As with this patient, many trauma patients may be ventilated with a high-frequency ventilator (HFV). In patients with acute lung injury (ALI), conventional mechanical ventilation may cause additional lung injury from overdistention of the lung during inspiration, repeated opening and closing of small bronchioles and alveoli, or from excessive stress at the margins between aerated and atelectatic lung regions.¹⁶ High-frequency ventilation (HFV)-based ventilatory strategies offer two potential advantages over conventional mechanical ventilation for patients with ALI. First, HFV uses very small tidal volumes, allowing higher end-expiratory lung volumes with less overdistention than is possible with conventional ventilations. Secondly, high respiratory rates during HFV allow the maintenance of normal or near-normal partial pressure of carbon dioxide (PaCO₂) levels in arterial blood despite the small tidal volumes.¹⁶

As the goal of the donor procurement process is to recover viable organs quickly with minimal warm ischemia time, hypotension, hypoxia, or surgical trauma, any endocrine, metabolic, and hemodynamic disturbances must be managed appropriately. This can be accomplished by maintaining adequate fluid status, acid-base balance and oxygenation and by appropriate administration and timing of agents by the anesthesia practitioner. Paralytics facilitate opening of the chest and obviate spinal reflexes. Furosemide administration increases urine output while mannitol administration functions as a hydroxyl free radical scavenger to prevent reperfusion injury from oxygen-free radicals. Intravenously administered heparin prevents increases in clotting factor activity or thrombus formation in response to aortic cross clamping.¹⁷

Cardiopulmonary management during the organ exposure phase of surgery prior to aortic cross clamping can be summarized as the “rule of 100s”, which is to maintain systolic blood pressure > 100 mm Hg; urine output > 100 ml/hr, partial pressure of arterial oxygen (PaO₂) > 100 mm Hg and hemoglobin > 100 g/L (10 g/dL).³ Adequate perfusion and oxygenation of organs is essential to maintain viability of transplantable organs.

As fewer than 4 percent of all deaths result in a potentially suitable donor and, unfortunately, less than 10-15 percent of these suitable donors become actual donors, excellent perioperative care needs to be provided to optimize end-organ function and allow for utilization of this limited resource.¹⁸ Anesthesia practitioners must have an understanding of the physiological derangements that occur in the brain-dead organ donor as well as an understanding of any institution or agency developed

protocols for care of these donors. In doing so, the anesthesia practitioner can best serve, not only the donor and donor family who thoughtfully consented to organ donation, but also the many recipients, whose lives are changed from the organ donation program.

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Dexmedetomidine and Pediatric Emergence Agitation

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Keywords: dexmedetomidine, emergence agitation, postoperative agitation, pediatric surgery, general anesthesia.

Emergence agitation (EA) is generally described as a disassociated mental state characterized by restlessness and inconsolability that can be accompanied by thrashing, confusion, disorientation, or combativeness.^{1,2} While this behavior can be quite disturbing to witness, by both parents

and caregivers, it also puts the child and those caring for them at risk of injuries. With an incidence ranging from 10%-80%, emergence agitation is a common challenge faced by post-anesthesia care unit (PACU) caregivers.²⁻⁴ Dexmedetomidine, a selective alpha₂-adrenoceptor agonist, is becoming an effective and safe adjunctive agent for the prevention and treatment of emergence agitation in pediatric patients.^{1,5}

Case Report

A 12 year-old female, ASA physical status III, presented to the preoperative unit for planned dental rehabilitation under general anesthesia. The patient weighed 98 kilograms and was 157 centimeters tall. Her medical history was noted to include autism, seizures, situational anxiety, obesity, type-2 diabetes, obstructive sleep apnea, dental caries and post-operative agitation. Her last tonic-clonic seizure occurred two years earlier after which she was prescribed lamotrigine. Other medications on the patient's profile included clonazepam and aripiprazole. All medications were taken the day of surgery. According to the patient's guardian, she no longer required use of a Bi-level Positive Airway Pressure machine at night since her tonsillectomy the previous summer.

The guardian was very concerned about the patient's history of emergence agitation. According to her the patient was combative and screaming for over thirty minutes following her previous two surgeries. This was confirmed by review of patient's previous anesthesia and post-anesthesia care unit (PACU) records. She had required 9 mg of intravenous (IV) midazolam and had developed large bruises to her forearms as a result of thrashing about.

Physical examination revealed a Mallampati class II airway. The patient appeared calm. Preoperative vital signs were blood pressure 138/95 mmHg, heart rate 78 beats per minute, respiration rate 20 per minute, and oxygen saturation 100% on room air. Heart rate was regular and breath sounds were clear.

Preoperatively, midazolam 20 mg and ketamine 500 mg was administered orally, and after 15 minutes the patient was taken to

the operating room. Standard monitors were applied and she was pre-oxygenated with 100% O₂ via facemask. A peripheral IV catheter was placed and IV induction was performed using fentanyl 150 mcg, propofol 200mg, and rocuronium 70 mg. A #7.0 nasal RAE tube was inserted in the trachea and placement was confirmed by breath sounds and end-tidal CO₂. Assist control mode of ventilation was initiated and general anesthesia was maintained with an end-tidal sevoflurane concentration between 1.1-1.3 % in a mixture of oxygen (1 L/min) and nitrous oxide (2 L/min). Additionally, fentanyl 100 mcg and ondansetron 4 mg were given intra-operatively.

At the end of the surgical procedure, the sevoflurane was discontinued and a single dose of dexmedetomidine 1 mcg/kg was administered over 10 minutes. Train of four monitoring showed fading of all four twitches. Antagonism of neuromuscular blockade was achieved with glycopyrrolate 0.8 mg and neostigmine 4 mg. The patient was extubated upon return of spontaneous ventilation, ability to follow commands and head lift greater than 5 seconds. The patient was given O₂ via a face-tent then transported to the PACU drowsy but easily arousable to voice. She was provided a private recovery room and her guardian was brought to the bedside shortly after arrival to PACU. Recovery was uneventful per nursing staff and patient was discharged home 2.5 hours later. No combative episodes were reported during recovery room stay.

Discussion

A definitive etiology has not yet been identified as to explain why emergence agitation occurs. Many studies have concluded that there are a number of patient, anesthetic and surgical factors that can help predict emergence agitation likelihood.^{2-6,8}

The most accepted factors associated with emergence agitation include young age, preoperative anxiety, use of inhalation anesthetic agents, otorhinolaryngologic surgical procedures, pain, child's personality and rate of emergence.^{2-6,8} The greatest incidence of emergence excitement occurring in children 2-4 years of age.⁷

Dexmedetomidine, due to its sedative and analgesic properties, has been shown to be useful in managing pediatric emergence agitation.^{5,8} Dexmedetomidine, an α_2 agonist, is thought to work by activating pre and post-synaptic α_2 -adrenoceptors, thus leading to a decrease in norepinephrine release, inhibiting sympathetic activity, diminishing sympathetic nervous system response, and resulting in sedation, analgesia and anxiolysis.¹ Even though dexmedetomidine has an $\alpha_2:\alpha_1$ ratio of 1620:1, there can be a clinically significant decrease in blood pressure and heart rate.¹ The benefit of dexmedetomidine over other sedatives is its minimal respiratory depression effects and the reduction in opioid requirements for pain use.⁹

Although the Food and Drug Administration has only approved dexmedetomidine for use in adults, many studies have been performed demonstrating its safe use in children.¹ One prospective randomized study by Ibacache et al. sought to determine the appropriate dose of dexmedetomidine to prevent emergence agitation following sevoflurane anesthesia in children.⁵ Selecting 90 patients age 1-10 years, the authors evaluated two different single-doses of dexmedetomidine (0.15 mcg/kg and 0.3 mcg/kg) against a saline placebo-control. The study sample consisted of children receiving sevoflurane for minor ambulatory surgery procedures. The incidence of agitation was significantly lower in the dexmedetomidine groups

compared to the control group, with the least amount of agitation noted in the group with higher dexmedetomidine dose. No significant change in heart rate, respiratory rate, and mean arterial pressure was noted amongst the groups.

In another placebo-controlled, randomized study, a larger dose of dexmedetomidine and placebo were compared in effectiveness to reduce emergence agitation of children following sevoflurane anesthesia.⁸ This study included 60 patients aged 3-7 undergoing adenotonsillectomy. Each child was given either a single-dose of dexmedetomidine (0.5 mcg/kg) or saline 5 minutes prior to the completion of surgery. The results showed that pain and agitation were significantly lower for the dexmedetomidine group; however, emergence and extubation were delayed. No clinically significant effects to heart rate, blood pressure, and oxygen saturation were evident in either group. The authors concluded that dexmedetomidine was effective for emergence agitation prevention and could be given safely to children. The patient in this case report mirrored these results. The patient did not meet extubation criteria until 20 minutes after the dexmedetomidine infusion was completed and 25 minutes after all surgical stimulation. The PACU nurse reported that the patient denied having any discomfort prior to discharge and no pain medications were given.

The patient in this case report displayed several of the factors associated with emergence agitation. One was the pre-operative anxiety she demonstrated by her withdrawal and non-verbal communication, as well as a previous history of extreme emergence agitation. Although pre-operative anxiolytic was given to decrease anxiety, the incidence of emergence agitation is

relatively unchanged for patients who receive anxiolytics alone and has been shown to be more effective in the treatment of emergence agitation than in prevention.^{1,4,10} Several studies have demonstrated that ketamine can be effective in preventing emergence agitation in children; however, other studies point out that ketamine emergence reactions can be unpredictable, especially as age increases.^{2,10}

Sevoflurane is widely used in pediatric anesthesia because of its well-tolerated quick induction and emergence from anesthesia. Sevoflurane provides hemodynamic stability, has a nonpungent odor and does not irritate the airway, making it an ideal agent for mask induction in the pediatric population.⁵ Despite these and other benefits of sevoflurane, it is also associated with a high incidence of emergence agitation, of up to 80%, in pediatric cases.⁵ It has been suggested that this is in part due to the rapid emergence that is associated with sevoflurane.^{6,8} To attenuate the rapid emergence from sevoflurane anesthesia, single-dose dexmedetomidine has been shown to provide light analgesia, sedation and anxiolysis while allowing for a smoother emergence.^{1,5,8}

By understanding the numerous factors that can contribute to the risk of emergence agitation, anesthesia professionals can develop plans that address the specific needs of their patients. While there are various medications and anesthetic techniques that can decrease the likelihood of emergence agitation in general anesthesia, dexmedetomidine is emerging as a potentially safe and effective treatment for pediatric and adult surgical patients. Although the risk of preemptively treating patients for emergence agitation is at the discretion of the anesthesia practitioner, it is

worth noting that its occurrence leads to both parents', and health care teams' dissatisfaction.²

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Managing Intraoperative Supraventricular Tachycardia

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Keywords: supraventricular tachycardia, arrhythmia, intraoperative complications

Supraventricular tachycardia (SVT) includes all forms of tachycardia originating above the ventricles of the heart. Most SVTs are caused by either a pathological reentry circuit, instability of the cardiomyocyte membrane potential or increased automaticity.¹ The incidence of SVT is approximately 35 cases per 100,000 persons per year.² Supraventricular tachycardia affects all age groups, but occurs more frequently in the elderly due to a higher prevalence of cardiovascular disease and impaired cardiac reflexes.^{1,2} A number of adverse physiological events including high adrenergic tone, an imbalance of myocardial oxygen supply and demand, and large intravascular volume shifts can precipitate SVT in anesthetized patients.

Case Report

A 70 year old, 5'8", 90 kg female presented for an elective anterior/posterior lumbar fusion with bone grafting and instrumentation after failing to respond to non-surgical treatments. Surgical history included a total abdominal hysterectomy without complications. Her medical history was significant for lumbar scoliosis and hypertension which was well controlled with

metoprolol. She reported taking metoprolol the morning of surgery.

On physical examination her heart rate was 73 beats per minute (bpm) with a regular rate and rhythm. A preoperative EKG revealed normal sinus rhythm (NSR) with a rate of 72bpm, a PR interval of 0.11 seconds and a QRS complex of 0.14 seconds. She reported no history of chest pain or syncope. Laboratory values were within normal limits. Airway evaluation revealed a Mallampati class II with adequate thyromental and interincisor distance.

The patient was taken to the operating room after being medicated with intravenous (IV) midazolam 2 mg. The patient was positioned supine and standard monitors were applied. Anesthesia was induced with lidocaine 100 mg IV, fentanyl 150 mcg IV and propofol 150 mg IV. Adequate mask ventilation was assured and rocuronium 50 mg IV was administered. The trachea was intubated and endotracheal tube placement was confirmed. Anesthesia was maintained with desflurane 6-7% and oxygen one liter per minute. A radial arterial line was placed.

Fifty minutes after being positioned prone for the posterior portion, the patient's heart rhythm, converted from NSR, with rates consistently ranging from 60-70 bpm, to

SVT with a heart rate of 150-180 bpm. Three doses of esmolol IV were administered in 20 mg aliquots, however the SVT persisted. Her blood pressure, which was previously stable since induction, quickly deteriorated from 110-120/50-60 mmHg to 50-60/30-40 mmHg. Oxygen saturation values remained stable. A phenylephrine infusion (0.05-1 mcg/kg/minute) was initiated and successfully improved her blood pressure. The procedure was abated by the surgeon and the incision was closed. A single dose of Adenosine 6mg IV was administered and successfully restored her to NSR at a rate of 70-80 bpm. Her blood pressure stabilized and the phenylephrine infusion was discontinued. Arterial blood gas analyses were normal.

Postoperatively, the patient remained intubated and sedated and was transferred to the intensive care unit (ICU). On arrival her heart rate was 72 bpm, her oxygen saturation 100% and her blood pressure was 117/62 mmHg, without the support of vasopressors. Cardiac enzymes were negative. A 12 lead EKG was unchanged from her preoperative EKG. The patient was extubated two hours after admission to the ICU. The remainder of her postoperative period was uneventful for SVT. She was discharged on post-operative day four.

Discussion

The most common type of SVT is atrioventricular nodal reentrant tachycardia (AVNRT), which occurs in approximately 60% of patients with SVT.³ In AVNRT, the reentry circuit is contained entirely within the AV node. Dual conduction pathways within the AV node allow electrical impulses to recycle at rate of 150-250 bpm. The impulse conducts to the ventricle in the slow pathway (antegrade conduction), while

the fast pathway recovers and conducts backward toward the atrium (retrograde conduction). This sets up the reentrant circuit.^{2,3} For unknown reasons, AVRNT occurs more frequently in females and is generally not a result of preexisting heart disease.³ SVTs are characterized by an abrupt onset and termination. The only consistent perioperative risk factor for an increased incidence of intraoperative SVT is age greater than 60, which is possibly due to degenerative changes of the conduction system.^{4,5} Other predictors of intraoperative SVT include an increased preoperative heart rate, a history of hypertension, congestive heart failure, coronary artery disease and chronic pulmonary disease.⁵ Intraoperative events that serve as arrhythmia substrates include electrolyte abnormalities, hypotension, myocardial ischemia, hypoxemia, hypercarbia, elevated catecholamine states and inadequate depth of anesthesia.⁶ This patient's known predictors included hypertension. Her electrolyte status was monitored hourly by means of arterial blood gases, however all values remained within normal limits, with only slight alterations from her baseline.

Diagnosis of AVNRT requires a twelve lead EKG, however if the arrhythmia is complicated by hemodynamic instability, aggressive therapy takes priority. The American Heart Association (AHA) recommends initiation of a vagal maneuver to terminate a narrow QRS-complex tachycardia in hemodynamically stable individuals.^{2,5,6} If this fails, medications which exert their maximum effect on the AV node should be administered. Adenosine is the first drug of choice because it offers the advantage of its short duration of action (6-10 seconds), its rapid onset, short half-life and relative cardiovascular stability.⁶ Adverse effects of adenosine include atrial

fibrillation, asystole, ventricular arrhythmias and bronchospasm.^{7,8}

When the QRS complex is narrow and adenosine fails to terminate the SVT, ventricular rate control can be achieved with a with class II (beta-adrenergic antagonists) or class IV (calcium channel antagonists) activity.^{6,7,8} Among the beta-adrenergic antagonists, esmolol is advantageous because of its rapid elimination properties which render it titratable to allow dose adjustment during critical periods of hemodynamic changes. Calcium channel antagonists, such as verapamil, are less titratable than esmolol and have the potential of causing increased hypotension. One advantages of verapamil is that it provides rapid slowing of the ventricular rate which lengthens diastole and increases left ventricular filling.^{6,7,8}

The patient's AVNRT responded to adenosine suggesting her sinus node tissue was involved in a re-entrant circuit. A vagal maneuver was not initiated for this patient due to her hemodynamic instability. Esmolol was the beta-adrenergic antagonist of choice due to its favorable pharmacokinetics and was given prior to adenosine because of the concern that adenosine could lead to prolonged asystole or a ventricular arrhythmia which could be complicated in a prone patient with an open incision. Verapamil was considered, however it was not the drug of choice due to its longer half-life and ability to potentiate her hypotension.

The most effective and rapid means of terminating any hemodynamically unstable narrow or wide QRS-complex tachycardia is external direct current (DC) cardioversion.⁶ DC cardioversion is a very effective mode of therapy because of rapid homogeneous depolarization of the entire atrium.^{6,7}

According to the AHA, indications for DC cardioversion include a ventricular rate greater than 150 bpm with concurrent hemodynamic instability. Contraindications to DC cardioversion include patients with digitalis toxicity-associated tachydysrhythmia, a low (<40%) ejection fraction, multifocal atrial tachycardia and those with a history of atrial arrhythmias at risk for embolization from atrial clots.^{6,7} In retrospect, DC cardioversion would have been an excellent choice for this patient, however deterrents included the prone position and an urgency to improve the patients hemodynamics.

The use of phenylephrine has been used for many years to terminate SVT due to its various effects on a variety of baroreceptors.⁹ Phenylephrine causes a reflex-induced vagal tone in patients with AVNRT and can terminate the tachycardia by enhancing vagal tone and prolonging the AV node conduction time. Although a phenylephrine infusion was initiated to improve the patient's hypotension, it is unknown whether or not the phenylephrine infusion contributed to the termination of SVT.

The management of intraoperative SVT presents a significant challenge to anesthesia practitioners. The altered hemodynamic state associated with anesthesia coupled with a tachyarrhythmia can produce deleterious cardiovascular effects. SVT in an anesthetized patient can be a valuable forewarning of a correctable life threatening condition including hypoxemia, hypoventilation, hypotension, electrolyte imbalance and myocardial ischemia.⁷ An important clinical consideration in this case is that the length of patient's hemodynamic instability may have been avoided by initially treating the SVT with external DC cardioversion.

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Mentor: Carrie Bowman, CRNA, MS

Correlation of Undergraduate GPA and GRE Scores with Academic Success and Pass Rates on the National Certification Exam of Nurse Anesthesia Students

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Introduction

Many graduate level disciplines, such as medicine, dentistry, physical therapy and advanced practice nursing, have looked at specific pre-admission criteria to investigate possible relationships between those criteria and the success of their students. However, there does not seem to be any research, at present, that specifically investigates the success rates of nurse anesthesia students in relation to pre-admission criteria. The goal of this research was to examine whether

undergraduate GPA and/or GRE are indicators of performance (GPA) in Nurse Anesthesia programs and passing the National Certification Exam (NCE). This information may be used to make targeted changes, such as possible implementation of a Nurse Anesthesia-specific entrance exam.

Methods

After approval of the institutional review board of the Medical University of South Carolina, nurse anesthesia programs

accredited by the American Association of Nurse Anesthetists were requested to provide de-identified students' undergraduate GPA and GRE scores, graduating GPA scores, and success rates on the NCE. Correlations between variables were computed using SPSS version 16.0 (SPSS, Inc., Chicago, Illinois).

Results

Two schools provided data for 185 students; N=74 for school A, N=111 for school B. A t-test was performed comparing both schools on all variables of interest and it was determined that they were too statistically different and was not advisable to collapse them into one population. At school A, GRE predicted nursing graduate GPA ($p=0.001$). However, undergraduate GPA was not correlated with graduate GPA. At school B, GRE did not correlate Nursing Grad GPA ($p=0.247$); however undergraduate GPAs did (undergraduate total GPA($p=0.005$) and undergraduate science GPA($p=0.025$)). Upon further statistical analysis on school A

(linear regression, ANOVA), it was found that these results show that when both undergraduate science GPA and GRE scores were considered as predictors of graduate nursing GPA, GRE was the stronger ($p=0.003$) correlation. Pass/fail rates for both schools on the NCE showed no variability due to a 97% pass rate on the first attempt and a 100% pass rate by the second attempt.

Conclusions

Due to the high passing rate on the NCE, and therefore lack of any variability, correlations between admission variables and pass/fail on the NCE could not be performed. However, these results showed that when both undergraduate science GPA and GRE scores were considered as predictors of graduate GPA, GRE was the stronger and only significant predictor of unique variance.

Mentor:

Anthony James Chipas, CRNA, PhD

EDITORIAL

This issue contains an excellent assortment of case studies as well as, I'm pleased to announce, a research abstract. It is my hope to increase the number of published research abstracts and I encourage students and mentors to submit them for consideration. Evidence-based analysis report guidelines will be presented in the near future, offering an additional option for publication in the journal.

In closing I would like to wish everyone a joyful holiday season, and may the new year hold the very best for you.



Vicki C. Coopmans, CRNA, PhD
Editor