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Front Cover:

On the front cover residents enrolled in the Cedar Crest College Nurse Anesthesiology Program utilize handheld personal ultrasound devices during a skills mentorship session to gain hands-on experience with central line placement in the simulation lab. Pictured clockwise from the top are: Mitch Dent BSN, RN, CCRN and Quinn Luckenbill, BSN, RN, CCRN; Candice Townsend, BSN, RN, CCRN, Kathryn Comitz, BSN, RN, CCRN, and Brittany Seliga, BSN, RN, CCRN; Liane Bacon, BSN, RN, CCRN, Candice Townsend, BSN, RN, CCRN, Mitch Dent BSN, RN, CCRN, Bimpe "Bebe" Adenusi, PhD, APRN, CRNA, CNE, FAANA (Program Director), Jennifer Perry, BSN, RN, CCRN, and Kevin Udo, BSN, RN, CCRN.

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For additional information, please contact:

Vicki Callan, PhD, CRNA, CHSE, FAANA
Webster University Department of Nurse Anesthesia
Browning Hall, ISB 107
8274 Big Bend Blvd.
St. Louis, MO 63119
314-246-5928; Intsjna@aol.com

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Anesthetic Management of a Pediatric Patient with Russell-Silver Syndrome

Ryan Houlihan, DNAP
Yale New Haven Hospital School of Nurse Anesthesia

Keywords: Russell-Silver syndrome, macrocephaly, postnatal growth failure, hypoglycemia

Russell-Silver Syndrome (RSS) is a rare disorder characterized by intrauterine growth restriction, postnatal growth failure, macrocephaly, and dysmorphic features.¹ Genetic abnormalities have been associated with this syndrome, most frequently involving chromosomes 7 or 11. Patients with RSS have also been discovered to develop neurologic, gastrointestinal, endocrine, and orthopedic complications.^{1,2} The rate and severity of symptoms vary significantly among patients with RSS and can increase the complexity of care under general anesthesia.²

Case Report

A 4-year-old male with a BMI of 14.37 kg/m² presented for a rigid bronchoscopy, adenoidectomy, and frenuloplasty. The patient's past medical history included RSS, ketotic hypoglycemia, seizures, failure to thrive (FTT), obstructive sleep apnea, and gastroesophageal reflux disease (GERD). Of note, the same scheduled procedure was canceled in the setting of symptomatic hypoglycemia one week prior. Pertinent anesthetic history included Cormack-Lehane classification as a grade 1 view with a Wis-Hipple Miller 1.5 laryngoscope blade two years earlier for a laparoscopic liver, muscle, and skin biopsy.

The patient was scheduled for the first case of the day and admitted to the hospital the night prior for optimization. Blood glucose and urine ketone levels were monitored regularly per the endocrinologist's recommendations. The patient arrived in the preoperative holding area with intravenous (IV) dextrose 10% and normal saline 0.45% infusing at 60 mL/hour since 00:00. Preoperative blood glucose was collected and documented as 95 mg/dL. During the preoperative assessment, the patient was noted to have macrocephaly and micrognathia, craniofacial features consistent with RSS. The patient's airway was documented as a Mallampati class 2 with a decreased thyromental distance. No other airway evaluation was performed due to lack of patient cooperation.

Upon arrival to the operating room (OR), the patient was positioned supine, standard noninvasive monitors were applied, and vital signs were noted to be stable. Anesthesia was induced intravenously with fentanyl 10 mcg and propofol 20 mg boluses as well as a propofol infusion at 300 mcg/kg/min. Following induction, manual ventilation with O₂ at 10 L/min was performed by the anesthesia practitioner for 3 minutes to adequately preoxygenate the patient prior to the start of the procedure. The OR table was then turned ninety degrees for the bronchoscopy and frenuloplasty to be performed. Preceding the adenoidectomy, the OR table was rotated back to its original position for tracheal intubation by the anesthesia practitioners. Prior to laryngoscopy, a shoulder roll was positioned under the patient, an additional dose of fentanyl 10 mcg was administered, and manual ventilation resumed with O₂ at 10 L/min and sevoflurane 2% inspired concentration.

Direct laryngoscopy (DL) was performed with a Macintosh size 2 blade by the initial anesthesia practitioner who reported a Cormack-Lehane grade 4 view. A second anesthesia practitioner performed a DL with the same laryngoscope and reported a grade 4 Cormack-Lehane view as well. Manual ventilation was restarted with O₂ at 10 L/min and sevoflurane 2% inspired concentration and a GlideScope (Verathon Inc.) was called for. During this waiting period, the pediatric otolaryngologist performed a DL with a Wis-Hipple 1.5 laryngoscope that also resulted in a grade 4 view and manual bag-mask ventilation was reestablished. Upon delivery of the GlideScope (Verathon Inc.), the initial anesthesia provider resumed control of the airway and obtained a grade 1 view with the video-assisted device and successfully intubated the trachea. Vital signs remained stable throughout instrumentation of the airway. Intravenous dexamethasone 8 mg was administered for any potential adverse effects due to airway manipulation and the remainder of the surgical procedure was performed. The patient emerged from general anesthesia, was extubated without complication, and was transported to the recovery area. Postoperative blood glucose was collected and documented as 130 mg/dL. The patient was successfully recovered and discharged home the same day with no adverse complications noted.

Discussion

The prevalence of RSS globally is estimated to range from 1:30,000 to 1:100,000 births.¹ The extensive range is due to the fact that only 60% of diagnoses are confirmed by molecular genetic testing, most commonly with findings of hypomethylation on chromosome 11p15 or maternal uniparental disomy of chromosome 7.^{1,2} For the remaining 40% of cases, the genetic cause is unknown and a clinical diagnosis is made with the Netchine-Harbison clinical scoring system.^{1,3} Multidisciplinary healthcare is essential for optimal management of these patients due to the wide range and severity of complications associated with RSS.¹ Anesthesia professionals must be aware of these abnormalities and potential complications when caring for a patient with this syndrome.

Craniofacial abnormalities are a hallmark complication of RSS and can lead to difficult airway management for the anesthesia practitioner. Common findings are macrocephaly, prominent forehead, micrognathia, and a small triangular face.¹ Scoliosis has been reported in up to 36% of patients with RSS.² These abnormalities can lead to challenges with ventilation and direct laryngoscopy, thus the necessary supplies should be readily available to manage a difficult airway. Fortunately, there were no issues with manual ventilation in this patient's case, which allowed time for the GlideScope (Verathon Inc.) to be retrieved. This device was not initially in the room due to prior documentation of an unchallenging intubation. In addition to macrocephaly, many RSS patients have FTT with average head growth leading to an increasingly abnormal head-to-body ratio.^{2,4} These common changes among RSS patients can lead to alterations in their airway throughout childhood; therefore, prior airway histories should not be deemed reliable.

Endocrinologic disorders associated with RSS are also of importance in anesthetic management. The typical features of low muscle and liver mass with decreased subcutaneous fat and feeding difficulties place these patients at higher risk for hypoglycemia.^{1,2} Children under 5 years of age with RSS are at the greatest risk, with approximately 27% suffering a hypoglycemic event, many

which occur at night.¹ Extended periods of fasting should be avoided in this patient population. If necessary, recommendations are to administer dextrose-containing fluids intravenously and monitor blood glucose and urine ketones during fasting.¹ Initially, this patient was instructed to fast at home and experienced hypoglycemia and cancellation of surgery. Following this event, the plan of care was altered, and the patient was admitted to the hospital the night before the rescheduled date. Overnight, the patient was medically optimized for surgery with dextrose-containing intravenous fluids and lab monitoring.

Gastrointestinal disorders are another common complication of RSS. Failure to thrive is a frequent diagnosis in these children due to digestive problems and malnutrition. Greater than 70% of patients have been diagnosed with digestive problems and 55% present with GERD.¹ Anesthesia practitioners must be aware and vigilant of the increased risk of aspiration in this population. The gastrointestinal disorders mentioned can also lead to thermoregulation and wound healing complications in a surgical setting. These patients are at increased risk for hypothermia due to the abnormal head-to-body ratio, lack of muscle, and low-fat stores.⁵ In the setting of hypothermia and malnutrition, these patients may also be predisposed to impaired wound healing and infection.¹

In conclusion, RSS is a rare genetic, heterogenous syndrome that carries many implications when formulating a safe anesthetic plan. Recognition of the potential for difficult airway management and having the necessary emergency equipment available must be a priority. Nutritional status and fasting guidelines should be discussed with multidisciplinary team members to optimize these patients prior to surgery and prevent hypoglycemia. In addition, practitioners must be vigilant with the maintenance of normothermia, as patients with RSS are at increased risk for hypothermia. Awareness of the important anesthetic implications associated with RSS will improve patient care in this population.

References

1. Wakeling EL, Brioude F, Lokulo-Sodipe O, et al. Diagnosis and management of Silver-Russell syndrome: first international consensus statement. *Nat Rev Endocrinol*. 2017;13(2):105-124. doi:10.1038/nrendo.2016.138
2. Saal HM, Harbison MD, Netchine I. Silver-Russell syndrome. In: Adam MP, Mirzaa GM, Pagon RA, et al, eds. *GeneReviews*. University of Washington, Seattle; 2019.
3. Azzi S, Salem J, Thibaud N, et al. A prospective study validating a clinical scoring system and demonstrating phenotypical-genotypical correlations in Silver-Russell syndrome. *J Med Genet*. 2015;52(7):446-453. doi:10.1136/jmedgenet-2014-102979
4. Ohan F, Zheng-Ward F, Tsai E. Anesthetic management of a pediatric patient with Russell-Silver syndrome. DOM UCLA Proceedings. 2019. Accessed July 11, 2022. <https://proceedings.med.ucla.edu/wp-content/uploads/2019/05/Zheng-Ward-A190410FZ-W-BLM-edited.pdf>
5. Passier RHA, Verwijs E, Driessen JJ. Anaesthesia for orphan disease: management of an infant with Silver-Russell syndrome. *Eur J Anaesthesiol*. 2014;31(6):336-338. doi:10.1097/EJA.000000000000013

Mentor: Marianne S. Cosgrove, PhD, DNAP, CRNA, APRN, FAANA

Central Cord Syndrome from Acute Cervical Injury

Brandon Gomes, DNP, BSN
Northeastern University

Keywords: Spinal cord injury, central cord syndrome, cervical fracture

Central cord syndrome is an incomplete spinal cord injury involving the center of the spinal cord.¹ Acute trauma is the most common cause of central cord syndrome, while other causes include syringomyelia and intramedullary spinal cord tumors.¹ This injury, which can be associated with cervical fractures or disc herniation after acute trauma, has various treatment options, including conservative management, delayed surgery, and early surgery.¹ Historically, early surgery for central cord syndrome was associated with suboptimal neurological outcomes, however, more recent evidence suggests that early surgical intervention is one of the key predictors of improvement.²

Case Report

A 67-year-old, 170.2 cm, 72.5 kg male with central cord syndrome in the setting of severe critical stenosis at C3-C6 levels presented to the operating room from the trauma intensive care unit for a posterior cervical decompression and fusion after falling down eight stairs at his home the day prior. The patient's history included chronic obstructive pulmonary disease, asthma, and substance use disorder. Prior to arrival to the operating room, an endotracheal tube resided in the patient's trachea, and they were being mechanically ventilated. The patient's femoral artery had also previously been cannulated with an arterial catheter and the femoral vein had been cannulated with a central venous catheter. Norepinephrine was infusing at 22 mcg/min IV to maintain a mean arterial pressure (MAP) of 80 mm Hg. He was sedated with an intravenous propofol infusion. An earlier assessment by the orthopedic spine team revealed trace movement of his fingers and toes with 2/5 strength, some external rotation of the left hip, and intermittent ankle dorsiflexion and plantar flexion while the IV sedation was held.

Mechanical ventilation was continued using the anesthesia machine after the patient arrived in the operating room. We continued the propofol and norepinephrine infusions, and dexmedetomidine 0.5 mcg/kg/hr IV and remifentanyl 0.1 mcg/kg/min IV were started. Total intravenous anesthesia was planned due to the neuromonitoring of motor evoked potentials and somatosensory evoked potentials. Dexamethasone 8 mg IV was administered. The patient's left radial artery was then cannulated with an arterial catheter and arterial blood pressure monitoring was moved from his femoral artery to his radial artery with a concern of potential transducing issues from the femoral artery once the patient was placed in the prone position. After administering propofol 50 mg IV, the surgical team placed the patient's head in Mayfield headpins. Next, the operative team moved the patient into the prone position.

Throughout the procedure, attention was focused on maintaining hemodynamic stability. There was minimal blood loss, yet his norepinephrine requirements increased to 25 mcg/min. His pulse pressure variation (PPV) was calculated by the Philips (Philips Healthcare) monitor PPV feature using the arterial blood pressure waveform. The patient's measured PPV and was 14%,

indicating that he could benefit from additional volume to increase his preload. He received continuous intravenous crystalloid without an improvement in blood pressure. A vasopressin infusion of 0.06 units/min was administered to maintain a MAP of 80 mm Hg as requested by the surgery team to maintain spinal cord perfusion. With the addition of the vasopressin infusion, the norepinephrine infusion was adjusted to 10 mcg/min.

The two-hour surgery was uneventful with no acute changes in the baseline neuromonitoring values which were stable at the start of the procedure. A posterior C3-C6 laminectomy and arthrodesis was successfully performed. The patient's trachea remained intubated for transfer back to the trauma intensive care unit. He remained on intravenous infusions of dexmedetomidine, norepinephrine and vasopressin. Care was resumed by the trauma service and the patient remained hemodynamically stable after the anesthesia team's care. In the following days, the patient remained in the intensive care unit. The patient did not show signs of neurologic improvement and was unable to maintain hemodynamic stability without vasopressor support. The family of the patient decided to change the focus of care to comfort as the patient showed no signs of improvement. The patient expired soon after vasopressor support and mechanical ventilation was withdrawn.

Discussion

Differing opinions exist concerning the management of spinal cord injury with central cord compression.^{1,2} Controversy pertains to whether or not surgical intervention within the first twenty four hours is beneficial or harmful.^{1,2} There is some evidence that patients with central cord compression secondary to vertebral fracture, dislocation, traumatic herniation or instability have better outcomes with an early surgery that is less than twenty-four hours from injury, although some studies have also shown good hand recovery in patients with central cord syndrome secondary to an extension injury with conservative management.¹ In this case report, the patient was taken to the operating room for surgery within twenty-four hours from injury. The surgery team was unsure of the benefits of the surgery as they believed there was an overall poor prognosis even with surgical intervention. They decided to perform the procedure while allowing the patient's family to decide on their goals of care.

A focus of the anesthesia team was the hemodynamic management of the patient intraoperatively. It is important to optimize and maintain the MAP and avoid hypotension for the first five to seven days following a traumatic spinal cord injury in order to minimize secondary spinal cord ischemic damage.³ Clinical guidelines recommend that the MAP be maintained between 85 and 90 mm Hg for the first five to seven days after suffering the injury.³ In this case discussion, the goal for MAP was 80 mm Hg, below the recommendation in the clinical guidelines. This was the MAP goal communicated by the surgical team with consideration of the patient's baseline blood pressure and vasopressor support in the intensive care unit. Optimization of the blood supply to the injured spinal cord through aggressive hemodynamic management is important in minimizing secondary ischemic injury.³ Maintenance of these hemodynamic parameters can be difficult in the pre-operative phase of care when the patient is being transferred between care units and to the operating room and is where there may be suboptimal hemodynamic monitoring and blood pressure management.³

In the trauma intensive care unit and the intraoperative period, an infusion of norepinephrine was administered to maintain the MAP at the desired goal of 80 mmHg. Norepinephrine increases the MAP by directly agonizing the alpha-1 receptors, inducing vasoconstriction of arterial and venous vessels.⁴ Norepinephrine also increases myocardial contractility from agonizing the beta-1 receptor, which along with the provided peripheral vasoconstriction, contributes to a rise in MAP.^{4,5} A vasopressin infusion was started intraoperatively to improve hemodynamic stability. Vasopressin is an endogenous peptide hormone which increases vascular tone.⁶ After the infusion of vasopressin was administered, norepinephrine requirements decreased. The vasopressin infusion was started as the norepinephrine infusion had reached a rate of 30 mcg/min IV without improvement in reaching the target MAP. Vasopressin may be used in combination with norepinephrine to raise MAP to target goal.⁶ The need for increasing vasopressor support was thought to be due to a combination of hypovolemia and surgical anesthesia from the combination of propofol, dexmedetomidine, and remifentanyl.

In summary, managing this patient population requires clear communication of intraoperative goals and knowledge of clinical practice guidelines. While the literature is still unclear on whether surgery within twenty-four hours is recommended in patients with central cord syndrome due to conflicting evidence,^{1,2} clinical guidelines recommend a mean arterial blood pressure of 85-90 mm Hg be maintained five to seven days after suffering the spinal cord injury. These parameters need to take the patient's medical conditions into consideration. If a patient has uncontrolled hypertension the autoregulatory curve shifts to the left and a higher mean arterial pressure should be considered. Moreover, understanding the patient's clinical condition and their prognosis requires clear and open communication with the surgical team around goals of care because this will play a critical role in defining the anesthesia professional's plan of care.

References

1. Yelamarthy PKK, Chhabra HS, Vaccaro A, et al. Management and prognosis of acute traumatic cervical central cord syndrome: Systematic review and spinal cord Society—Spine trauma study group position statement. *Eur Spine J.* 2019;28(10):2390-2407. doi: 10.1007/s00586-019-06085-z.
2. Fehlings MG, Tetreault LA, Wilson JR, et al. A clinical practice guideline for the management of patients with acute spinal cord injury and central cord syndrome: Recommendations on the timing (≤ 24 hours versus >24 hours) of decompressive surgery. *Global Spine J.* 2017;7(3_suppl):195S-202S. doi: 10.1177/2192568217706367.
3. Tee JW, Altaf F, Belanger L, et al. Mean arterial blood pressure management of acute traumatic spinal cord injured patients during the pre-hospital and early admission period. *J Neurotrauma.* 2017;34(6):1271. doi: 10.1089/neu.2016.4689.
4. Butterworth JF, Mackey D, Wasnick J. Anesthesia for patients with cardiovascular disease. In Butterworth JF, Mackey D, Wasnick J, eds. *Morgan and Mikhail's Clinical Anesthesiology.* 6th ed. McGraw-Hill Education; 2018;381-440.
5. Foulon P, De Backer D. The hemodynamic effects of norepinephrine: far more than an increase in blood pressure. *Ann Transl Med.* 2018;6(Suppl 1):S25. doi: 10.21037/atm.2018.09.27
6. McIntyre WF, Um KJ, Alhazzani W, et al. Association of vasopressin plus catecholamine vasopressors vs catecholamines alone with atrial fibrillation in patients with distributive

shock: A systematic review and meta-analysis. *JAMA*. 2018;319(18):1889-1900. doi: 10.1001/jama.2018.4528

Mentor: Maria Van Pelt, PhD, CRNA, FAAN

A Case Report of Masseter Spasm Following Propofol Induction

Nataliya Hurskaya, BSN
Virginia Commonwealth University

Keywords: propofol, seizures, masseter muscle spasm, succinylcholine

Propofol-induced severe neuroexcitation (propofol “frenzy”) is an unexpected reaction related to propofol administration. It presents with a range of symptoms, including seizure-like activity and decreased level of consciousness.¹⁻³ Myoclonic jerks, twitching, and seizures have been described in 1% of the propofol-linked neuroexcitation cases.^{2,4} The majority of cases occur within 30 minutes after anesthesia.⁴ However, it can also be delayed for up to six hours.² It was described in both male and female patients. In our case, a 36-year-old female developed a masseter spasm, an unusual propofol-related complication that was successfully treated with succinylcholine.

Case Report

A 36-year-old Hispanic female was admitted for a right leg phlebectomy. Her health history included deep vein thrombosis in a distal vein of the right lower extremity, asthma, migraine, helicobacter pylori infection, biliary colic, gestational hypertension, obesity, and antiphospholipid syndrome. Her surgical history included cesarean section and laparoscopic cholecystectomy. The patient did not report any allergies. Medication history included albuterol sulfate, cetirizine, and pseudoephedrine-guaifenesin as needed. She also reported having a levonorgestrel-releasing intrauterine system. Three days before the surgery, the patient was prescribed benzonatate and prednisone 20 mg for acute upper respiratory infection. Dosage: 40 mg every 12 hours for 5 days. The patient only took 20 mg per day and self-administered 20 mg on the day of surgery. The patient’s anesthetic plan included general anesthesia with sevoflurane, laryngeal mask airway (LMA), and background propofol drip. No muscle relaxation was planned initially. Standard non-invasive monitors were applied in the operating room. The patient was pre-oxygenated to an end-tidal O₂ concentration of 94%. Pre-induction vital signs were unremarkable.

In a preoperative area, the patient self-administered 3 puffs of albuterol. She also received midazolam 2 mg and famotidine 20 mg. At the beginning of induction, she was administered fentanyl 25 mcg, lidocaine 50 mg, and propofol 200 mg (i.e., approximately 2 mg/kg). Soon after an intravenous injection of propofol 200 mg, active movement of the upper and lower extremities, resembling a seizure-like activity, was noted. Heart rate increased from 89/min pre-induction to 123/min, and blood pressure increased to 131/71 mm Hg from 114/69 mm Hg baseline. An attempt was made to place LMA. However, it was unsuccessful due to the masseter

muscle spasm. The patient's teeth were clenched, making it challenging to provide ventilation. A chest wall rigidity and an increase in body temperature were not observed. A paralysis with succinylcholine 50 mg was provided to relax the masseter spasm and facilitate LMA placement. This unexpected neuroexcitation lasted for about 3 minutes and subsided with succinylcholine administration. Nearly 4 minutes passed from propofol administration to LMA insertion. Oxygen saturation measured by pulse oximetry remained at 100%, and vital signs were stable throughout the episode. The patient's ventilation was supported using pressure support ventilation protect (PSV-Pro). The amount of delivered pressure support set on PSV-Pro was 8 cm H₂O. The patient maintained respirations of 20/min and TV of 300-375 mL.

After induction, the patient received cefazolin 2g, dexamethasone 4 mg, fentanyl 75 mcg, phenylephrine 200 mcg, and glycopyrrolate 0.2 mg. General anesthesia was maintained with sevoflurane 1.7% inspired concentration in a mixture of O₂ 1 L/min and air 1 L/min. A propofol infusion was initiated at 30 mcg/kg/min, which is acceptable when the plane of anesthesia needs to be deepened during or immediately after the induction.⁵ An additional self-limiting 3-5 seconds-long episode of myoclonic jerks of the upper extremities were noticed during the maintenance phase. In total, the patient received approximately 402 mg of propofol. Emergence from anesthesia was unremarkable. The patient was alert and conversational 20 minutes after arrival to the post-anesthesia care unit. She had no complaints of jaw pain, muscle aches, or weakness. She was made aware of the episode and denied any recall. The patient was discharged from the facility on the same day.

Discussion

Experiencing neuroexcitation and masseter rigidity due to propofol administration is rare and unexpected. Patient anxiety with involuntary teeth clenching before induction could be associated with masseter rigidity.⁵ However, our patient was premedicated with midazolam and did not appear anxious. In up to 1% of cases, neuroexcitation was reported as jerking movements, myoclonus, and seizures. It is most commonly observed in young, healthy patients, including males and females, during induction, emergence, and maintenance of anesthesia. In most cases, the signs and symptoms occur within 30 minutes but also can be delayed for up to 6 hours. The Swedish Adverse Drug Reaction Advisory Committee reported 44 cases of severe reactions with female 2:1 predominance and a median age of 27. Dystonia of the masseter and larynx is usually observed with drugs such as succinylcholine, sevoflurane, and nondepolarizing neuromuscular blockers.^{1,5} Without these common offenders, this episode was unexpected.

The mechanism of neuroexcitation is poorly understood. At the molecular level, it could involve gamma-aminobutyric acid receptor desensitization.⁴ Large propofol concentration at the receptor site can cause receptor desensitization with the resulting excitation. The involvement of N-methyl-D-aspartate (NMDA) receptors of glutamate was also suggested. Propofol inhibits NMDA receptors of glutamate, a major excitatory neurotransmitter. Through this action, propofol can cause reactions similar to a tonic-clonic seizure following ketamine administration. Glycine receptors could also be involved in producing neuroexcitation. Propofol antagonizes glycine receptors which are widely distributed in subcortical regions, including the spine, where it is the primary inhibitory neurotransmitter.⁴

Diagnosis can be challenging and usually is made by exclusion. Propofol-induced neuroexcitation can present similar to other conditions such as status epilepticus, neuroleptic malignant syndrome, serotonin syndrome, local anesthetic systemic toxicity, malignant hyperthermia, and propofol infusion syndrome.^{1,5} In our case, propofol-induced neuroexcitation was suspected based on myoclonus, masseter muscle spasm, propofol administration, and the absence of the drugs commonly implicated in causing muscle rigidity. In addition, the patient did not meet the criteria for other differential diagnoses. Diagnosing the condition is challenging due to the broad spectrum of presenting signs and symptoms, including thrashing body movements requiring multiple people to hold and keep a patient safe, increased muscle rigidity, clonus, and hyperreflexia.^{1-4,6} Thrashing of the head side-to-side is believed to be a common theme, although our patient did not experience it.^{1,3,4} In some cases, excitation periods were alternated with periods of calm unconsciousness.³ In others, patients regained consciousness for 10-15 minutes only to return to the frenetic state again.¹ A loss of a bladder tone and persistent hyperthermia were also described.²

The duration and severity of the symptoms also vary. Our patient's episode was short-lived and subsided after succinylcholine administration. Our patient did not experience any adverse outcomes due to mild neuroexcitation and timely airway establishment. In some cases, neuroexcitation was described to last several minutes to several days, and the consequences were severe. One patient spent 64 days in the hospital, including 23 days in the Intensive Care Unit.² In another instance, a patient developed complications in her surgical hip with a loss of gross sensory and motor function.⁴ One patient underwent dental surgery and required trachea intubation and mechanical ventilation lasting more than 10 hours due to propofol.¹

Available treatment options vary depending on the severity of the presentation. In our case, succinylcholine was chosen due to ventilation challenges and the need for masseter muscle relaxation. Succinylcholine is a fast-onset and short-duration-of-action depolarizing neuromuscular blocker that can be used to facilitate LMA placement.⁷ Succinylcholine is known to trigger malignant hyperthermia (MH) in susceptible individuals, so MH was ruled out before administering the drug. Alternatively, an endotracheal tube could be utilized to secure the airway, especially if neuroexcitation was severe. Deepening of the anesthesia plane and muscle paralysis is recommended if the masseter spasm occurs on induction.⁵ In one case study, the masseter spasm was self-limiting and did not require pharmacological interventions.⁵ Treatment options for more severe reactions included discontinuation of propofol exposure, dexmedetomidine, intralipids, fentanyl, and benzodiazepines.¹⁻⁴

Propofol has an excellent safety profile and is a commonly used induction drug. Although rare, complications in the form of a seizure-like activity and masseter muscle spasms can occur and require a prompt response. Otherwise, the consequences could be life-threatening. Masseter spasms specifically may complicate ventilation and airway access. In the case of masseter spasm, paralysis with succinylcholine or non-depolarizing agents and establishing an airway should be a priority.

References

1. Carvalho DZ, Townley RA, Burkle CM, Rabinstein AA, Wijdicks EFM. Propofol frenzy: Clinical spectrum in 3 patients. *Mayo Clin Proc Innov Qual Outcomes*. 2017;92(11):1682-1687. doi:10.1016/j.mayocp.2017.08.022
2. Pantelakis L, Alvarez V, Gex G, Godio M. Severe neuroexcitatory reaction: A rare and underrecognized life-threatening complication of propofol-induced anesthesia. *Neurohospitalist*. 2020;11(1):49-53. doi:10.1177/1941874420929536
3. Barsoum S, Kim A, Tse J. A possible treatment for propofol-induced neuroexcitation or propofol frenzy. *Eur J Anaesthesiol*. 2019;36(8):618-620. doi:10.1097/eja.0000000000000963
4. Panchamia JK, Amundson AW, Demirci O, Braksick SA, Wijdicks EF. A case report of “propofol frenzy”: Anesthetic considerations for a severe propofol-induced neuroexcitation reaction. *AA Pract*. 2022;16(3). doi:10.1213/xaa.0000000000001569
5. Saeidi M, Alikhani R, Hormati A, Sabouri SM, Aminnejad R. Propofol-induced masseter muscle spasm in a woman with a major depressive disorder. *Anesth Pain Med*. 2018;8(3). doi:10.5812/aapm.78748
6. Rutazaana D, Kasturi L. Propofol-induced seizure. *Am J Gastroenterol Suppl*. 2018;113(Supplement). doi:10.14309/00000434-201810001-02471
7. George LR, Sahajanandan R, Ninan S. Low-dose succinylcholine to facilitate laryngeal mask airway insertion: A comparison of two doses. *Anesth Essays Res*. 2017;11(4):1051. doi:10.4103/aer.aer_98_17

Mentor: Jiale Hu, PhD, RN, FAAN

Bradycardia and Cardiac Arrest Following Sugammadex Administration

Cara Lazaroff, DNAP, BSN
Yale New Haven Hospital School of Nurse Anesthesia

Keywords: sugammadex, bradycardia, hypotension, cardiac arrest, anaphylaxis

Sugammadex is a modified gamma-cyclodextrin compound designed to selectively bind aminosteroid non-depolarizing muscle relaxants, specifically rocuronium and vecuronium, for rapid antagonism of neuromuscular blockade. Since its Food and Drug Administration approval in 2015, sugammadex has been widely adopted by anesthesia practitioners as it offers several advantages compared to anticholinesterase reversal agents. These include rapidly effective antagonism of deep neuromuscular blockade and an overall better safety profile.^{1,2} However, as with any medication, there is a risk of adverse effects associated with sugammadex. The following case report describes bradycardia and cardiac arrest following sugammadex administration.

Case Report

An 83-year-old female presented for an elective repair of a paraesophageal hernia due to persistent dyspnea at rest, thought to be exacerbated by the existing hernia. She was 145 cm and 58.3 kg with a calculated BMI of 25.4 kg/m². Her past medical history was significant for hypertension, diastolic heart failure, coronary artery disease, mitral regurgitation with pulmonary hypertension, aortic insufficiency, atrial fibrillation, gastroesophageal reflux disease and breast cancer. She had an allergy to penicillin. Past surgical history included a percutaneous coronary angioplasty to the left anterior descending artery, coronary artery bypass graft with aortic valve replacement, mitral valve repair, left atrial appendage closure and MAZE procedure, mastectomy, and hysterectomy. Preoperative vital signs were blood pressure 114/68 mm Hg, heart rate 76/min, respiratory rate 18/min, and SpO₂ of 94% on room air. Laboratory values were unremarkable. Her 12-lead ECG was unchanged from baseline, demonstrating sinus rhythm with a right bundle branch block. Echocardiogram revealed a preserved ejection fraction of 63% with mild concentric left ventricular hypertrophy, mildly decreased right ventricular (RV) systolic function with a RV systolic pressure of 29 mm Hg, and a severely dilated left atrium.

The patient received pre-operative clearance from her cardiologist with recommendations to hold apixaban for 48 hours prior to surgery, hold aspirin for one week prior to surgery, hold furosemide the morning of surgery, and continue all other medications including amlodipine 5 mg, metoprolol tartrate 100 mg, pantoprazole 40 mg, rosuvastatin 40mg, and spironolactone 25 mg QD.

Upon entrance to the operating room, the patient was positioned supine with the head of bed elevated and standard noninvasive monitors were applied. The patient was preoxygenated with O₂ 15L/min via facemask for 5 minutes and general anesthesia was induced with intravenous (IV) administration of fentanyl 50 mcg, lidocaine 40mg, propofol 100 mg, and succinylcholine 100 mg. A rapid sequence induction was performed to intubate the trachea and subsequent mechanical ventilation was initiated once the airway was secured. General anesthesia was maintained with sevoflurane 1% inspired concentration in a mixture of O₂ 1 L/min and air 1 L/min, and a propofol infusion at 75 mcg/kg/min. Prior to incision, cefazolin 1g was administered as well as dexamethasone 4 mg IV. Rocuronium 50 mg IV was given for muscle relaxation, and a phenylephrine infusion at 0.3 mcg/kg/min was titrated to maintain MAP >80. At the end of the case, acetaminophen 1g was infused IV over 10 minutes and ondansetron 4mg IV was given. Upon closure, the anesthetic gas was discontinued, O₂ flow was increased to 10 L/min, and the propofol infusion was decreased to 50mcg/kg/min before being stopped. A TO4 count of 2/4 was measured and IV sugammadex 200mg was administered for antagonization of neuromuscular blockade. Approximately 1 minute following sugammadex administration (TO4 count 4/4), there was a sudden decrease in heart rate from 65/min to 20/min, accompanied by hypotension that quickly evolved into PEA cardiac arrest. The initial bradycardia was unresponsive to atropine 1mg IV. CPR was initiated, and a total of 3 mg of epinephrine IV was administered. Return of spontaneous circulation was achieved after 15 minutes. Within this time, the patient was also treated for possible anaphylaxis with famotidine 20 mg, hydrocortisone 100 mg, and diphenhydramine 50 mg IV. An epinephrine infusion was started at 0.2mcg/kg/min. An arterial line was placed, and a transthoracic echocardiogram exhibited significant RV strain.

Review of the anesthesia record also showed a sudden and significant drop in ETCO₂ following the sugammadex administration. With suspicion for pulmonary embolism, heparin 5000 units IV was given followed by an infusion. The patient was transported to the ICU for further care. She was stabilized and extubated before being transferred to a surgical floor 8 days post-surgery, and ultimately discharged from the hospital on day 12. It was concluded that this incident was related to the administration of sugammadex as no PE was diagnosed, and all additional workups resulted negative.

Discussion

As the only currently available cyclodextrin type reversal for neuromuscular blocking agents (NMBA), sugammadex is a novel drug that has improved patient safety regarding utilization of intraoperative neuromuscular relaxation.¹ Its unique mechanism of action provides prompt and reliable reversal of aminosteroidal-produced neuromuscular blockade. By noncovalently binding at a 1:1 ratio, sugammadex encapsulates, neutralizes, and inactivates NMBAs, specifically rocuronium. Vecuronium may also be reversed; however, sugammadex exhibits a 2.5 times higher affinity for rocuronium comparatively.³ Traditionally, acetylcholinesterase (AChE) inhibitors (eg, neostigmine) have been used for antagonization of neuromuscular blockade, but these drugs facilitate NMBA reversal via an indirect mechanism.² Furthermore, they exhibit variable efficacy coupled with undesirable muscarinic responses, necessitating concomitant use of anticholinergics (eg, glycopyrrolate) to blunt the effects.² The risk of residual paralysis after administration of AChE inhibitors poses challenges for anesthesia practitioners as this can lead to significant pulmonary complications and morbidity.¹

The advent of sugammadex and its direct effects on NMBAs allows for rapid, predictable, and complete restoration of muscle strength (TOF ratio >0.9) at any degree of muscular blockade, thus reducing the incidence of residual paralysis and its sequelae during recovery.^{2,3} While its clinical utility with lack of muscarinic effects is advantageous compared to AChE inhibitors, sugammadex has been found to have several of its own potential side effects that should be considered by anesthesia practitioners.³ Specific complications including bradycardia, cardiac arrest, and hypersensitivity reactions have been reported.³

Manufacturers have acknowledged marked bradycardia as a potential side effect of the drug, with a <1% reported incidence rate.^{4,6} It has been suggested that sugammadex-induced bradycardia requiring intervention is rare, with isolated incidences progressing into cardiac arrest.^{4,6} Successful recovery from these complications were reported with management strategies including anticholinergics (eg, atropine) in combination with vasopressor therapy and/or CPR as needed.^{4,5} Another known adverse effect associated with sugammadex is that of hypersensitivity reactions, including anaphylaxis.^{4,5,7} Symptoms may range from isolated skin reactions including urticaria, flushing, and rash, to more severe symptoms including swelling, hypotension, bronchospasm, and pulmonary obstruction.^{4,5,7} Studies indicate anaphylaxis occurrence in 0.3% of patients following administration of sugammadex, most often manifesting after larger doses (16 mg/kg vs. 4 mg/kg), and in patients with no previous exposure to sugammadex.^{4,5,7} However, cyclodextrins are present in several foods, thus possibly explaining a likely cross-reaction with sugammadex for these patients.⁷

Regarding the described case report, further work-up was performed in the intensive care unit for differential diagnosis. In addition to sugammadex-induced anaphylaxis, pulmonary embolism (PE) could not be overlooked. New and significant RV strain demonstrated by the intraoperative echo report as well as the notable drop in ETCO₂ at the onset of the event suggested possible PE. While computed tomography angiography (CTA) was negative for PE, diagnosis of a hypersensitivity reaction could not be excluded as a tryptase level was not obtained post-event and subsequent allergy testing was not performed. However, the common presentation of documented sugammadex-induced anaphylaxis (as detailed above) was not observed during this case.

In conclusion, sugammadex has been found to be generally well-tolerated and safe in both adult and pediatric patients ages 2 years and older.⁴ Some suggestions for utilization of sugammadex include using the lowest recommended dose based on the degree of neuromuscular recovery obtained by TOF or objective neuromonitoring, administering intravenously over at least 10 seconds with full standard monitoring in place to detect for ECG or hemodynamic changes, and avoidance in patients with known hypersensitivity to sugammadex or any of its components.^{4,7}

References

1. Stoelting RK. Monitoring of neuromuscular blockade: what would you expect if you were the patient? *APSF Newsletter*. 2016;30(3):45-47. <https://www.apsf.org/wp-content/uploads/newsletters/2016/February/pdf/APSF201602.pdf>
2. Hristovska AM, Duch P, Allingstrup M, Afshari A. Efficacy and safety of sugammadex versus neostigmine in reversing neuromuscular blockade in adults. *Cochrane Database Syst Rev*. 2017;8(8):CD012763.doi:10.1002/14651858.CD012763
3. Swerdlow B, Osborne-Smith L. Sugammadex: pharmacometrics, clinical utility, and adverse effects. *AANA J*. 2022;90(2):133-140.
4. BRIDION: highlights of prescribing information. Available from: https://www.merck.com/product/usa/pi_circulars/b/bridion/bridion_pi.pdf (Accessed 6 August 2022)
5. Hunter JM, Naguib M. Sugammadex-induced bradycardia and asystole: how great is the risk?. *Br J Anaesth*. 2018;121(1):8-12. doi:10.1016/j.bja.2018.03.003
6. Sims T, Peterson J, Hakim M, et al. Decrease in heart rate following the administration of sugammadex in adults. *J Anaesthesiol Clin Pharmacol*. 2020;36(4):465-469. doi:10.4103/joacp.JOACP_346_19
7. Iwasaki H, Renew JR, Kunisawa T, Brull SJ. Preparing for the unexpected: special considerations and complications after sugammadex administration. *BMC Anesthesiol*. 2017;17(1):140. doi:10.1186/s12871-017-0429-9

Mentor: Marianne S. Cosgrove, PhD, DNAP, CRNA, APRN, FAANA

Anesthetic Management for Laryngeal Carcinoma and Perioperative Complications

Randall Barlow, DNP, BSN
Uniformed Services University

Key Words: anesthesia, difficult intubation, airway, intubation, laryngectomy, peak pressures, high peak pressures.

Laryngeal carcinoma (LC) is the second most common cancer of the head and neck, and accounts for approximately 1% of all cancers.¹ The incidence of LC is higher in males than females with greater than 90% presenting as squamous cell carcinoma (SCC).^{1,2} Pathologic anatomy can increase difficulty in endotracheal intubation in patients with laryngeal tumors.³ This case study describes the preparation, planning, and tracheal intubation of a patient with a known transglottic neck mass, as well as the management of unanticipated elevated peak inspiratory pressures during the intraoperative period.

Case Report

A 42-year-old, 77 kg male was scheduled for a total laryngectomy with a radical neck dissection due to LC. The patient originally presented to the emergency department for an anterior neck mass causing increasing hoarseness over a 2-week period. The patient had a BMI of 21 kg/m² and no known drug allergies. The patient was a smoker with no additional medical history. A soft tissue neck computed tomography (CT) scan found a transglottic neck mass measuring 4.6 cm which involved the thyroid cartilage, cricoid cartilage, extensive involvement of the neck strap musculature, and anterior neck soft tissues.

Standard noninvasive monitors and a bispectral index monitor (BIS) were applied in the operating room. For induction, the patient was given lidocaine 50 mg and propofol 100 mg. Upon loss of eyelid reflex, the ability to mask ventilate was verified and lidocaine 50 mg, propofol 200 mg, and succinylcholine 100 mg were administered. Utilizing a video laryngoscope, the glottic opening was noted to be swollen and narrow with a visible bilateral mass at the opening of the true vocal cords. A 6.5 mm oral endotracheal tube (OETT) was advanced into the trachea without difficulty and placement was confirmed. The OETT was secured, and mechanical ventilation was initiated. General anesthesia was maintained with inspired sevoflurane 2% in a mixture of O₂ 1 L/min and air 1 L/min and titrated as necessary to maintain appropriate anesthetic depth via BIS monitoring. An intra-arterial catheter was then inserted into the patient's right radial artery, secured in place, and connected to a transducer for continuous blood pressure monitoring.

The ventilator was set to synchronized intermittent mechanical ventilation, pressure control ventilation-volume guaranteed (SIMV PCV-VG) mode with the tidal volume set to 500 mL/breath, respiratory rate of 14/min, and positive end-expiratory pressure (PEEP) of 5 cm H₂O. To achieve these settings the patient required a peak inspiratory pressure (PIP) ranging between 21-24 cm H₂O throughout the first 6 hours of the procedure. In preparation for the laryngectomy, a tracheostomy was performed by the surgical team. The patient was then placed on 100% FiO₂ and the original OETT was withdrawn. A new 6 mm wire-reinforced

endotracheal tube (ETT) was inserted into the trachea by the surgeon and connected to the anesthesia circuit by the anesthesia provider. The new ETT was then securely sutured to the patient's anterior chest. For the next four hours, ventilator settings remained unchanged; however, the patient's PIPs gradually increased from 27 to 35 cm H₂O.

During this time, the surgeon was notified of increasing PIPs, and bilateral breath sounds were assessed as clear to auscultation. The SpO₂ was maintained between 98-100%. An additional 20 mg rocuronium was given for neuromuscular relaxation. To decrease peak pressures, tidal volume was decreased to 450 mL and respiratory rate was increased to 15/min. As a result, PIP dropped to 32 cm H₂O; however, PIP slowly increased back to 35 cm H₂O over the next 30 minutes. Next, inspiratory time was adjusted from 1.2 to 1.5 seconds and the respiratory rate was decreased to 13/min. Peak pressures decreased, but again gradually increased over the next 30 minutes to 35 cm H₂O. The PIP was reported to the surgical team and the anesthesia provider requested the surgeon to suction down the ETT. Suction did not yield any secretions and peak pressures were unchanged. The surgeon estimated the procedure would require an additional 45 minutes.

The patient was then administered ketamine 20 mg, magnesium sulfate 2 g, and diphenhydramine 25 mg IV. Ventilator settings were adjusted again to a respiratory rate of 8/min, tidal volume of 480 mL, and PEEP maintained at 5 cm H₂O. Approximately 30 minutes later, in preparation for the surgical team to replace the ETT with a laryngectomy tube, neuromuscular blockade was antagonized with sugammadex 300 mg and spontaneous ventilation was supported via SIMV PCV-VG. A PIP of 40 cm H₂O was required to achieve a TV of greater than 300 mL. The anesthesia provider requested that the surgeon rotate the patient's ETT 90 degrees prior to removing the ETT from the trachea. The PIP decreased to 27 cm H₂O and tidal volumes increased. The surgeon then replaced the ETT with a laryngectomy tube and the patient continued to spontaneously ventilate without signs of distress.

Discussion

A laryngeal mass can present various complications during induction of anesthesia and endotracheal intubation. For this reason, it is vital that preoperative planning for the management of potentially difficult airway scenarios is discussed. The foundation for successful management of these patients requires excellent communication between the surgeon and anesthesia provider.³ The fundamental decision between awake tracheal intubation or awake tracheostomy, or intubation after induction of anesthesia should be made as a team, with strategies for failure clearly defined, and staff and equipment present.³ The anesthesia team approached the surgeon to discuss the possibility of an awake tracheostomy for this patient, however, due to the location of the tumor, this was not an option.

For this procedure, extra staff and equipment necessary for assistance with possible difficult intubation were assembled. Per discussion with the surgeon, if the ability to mask ventilate was not possible, the patient should be awakened, and the procedure canceled. For this reason, we administered enough propofol to appreciate the ability to mask ventilate for the attempt to mask ventilate to be appreciated before proceeding with the anesthetic induction and endotracheal intubation. Fortunately, the patient was intubated without difficulty.

In hindsight an awake fiberoptic intubation while maintaining spontaneous respirations could have been an additional approach for tracheal intubation. Patients should not be anesthetized prior to securing the airway unless there exists both a reasonable expectation of being able to intubate without severe difficulty, and of being able to oxygenate and ventilate adequately with a face mask.³

Toward the end of the case, the patient's peak inspiratory pressures continued to increase. Recommendations for managing increases in peak inspiratory pressures include: first, increase the FiO₂, then manually ventilate in order to manually assess pulmonary compliance, next, relieve mechanical stimulation, and finally, start medical intervention.⁴ Due to the difficulty of gaining access to the patient's ETT, we could not determine if an obstruction was present or attempt to relieve any mechanical obstruction by passing a suction catheter through the ETT. Peak inspiratory pressures continued to gradually increase despite ensuring adequate anesthetic depth, assessing all anesthesia equipment accessible, adjusting ventilator settings, and administering pharmacologic therapies. This caused the anesthesia team to suspect there was obstruction of the ETT. When the surgeon rotated the ETT 90 degrees, the peak pressures decreased below 30 cm H₂O. This supported a theory that the opening of the ETT was resting against the posterior tracheal wall and we the patient was being ventilated through the Murphy's eye of the ETT.

In this case, the patient's vital signs remained within normal limits, and the procedure was successfully completed. Communication and preparation are critical from planning through completion of the procedure. An experienced surgeon and an experienced anesthetist must use their best judgment about whether tracheal intubation is possible.⁵ If the request for the surgeon to rotate the ETT was made when an obstruction was first suspected, it may have prevented the need for troubleshooting the ventilator and additional medication administration.

References

1. Hofmeyr R, Llewellyn R, Fagan J. Multidisciplinary difficult airway challenges: Perioperative management of glottic and supraglottic tumors. *Oper Tech Otolaryngol Head Neck Surg.* 2020; 31(2):120-127. <https://doi.org/10.1016/j.otol.2020.04.008>
2. Zhang X, Cavus O, Zhou Y, Dusitkasem S. Airway management during anesthetic induction of secondary laryngectomy for recurrent laryngeal cancer: Three cases of report and analysis. *Front Med.* 2018;5:264. doi:10.3389/fmed.2018.00264
3. Winterhalter M, Kirchhoff K, Gröschel W, et al.. *Eur J Anaesthesiol.* 2005;22(9):678-682. doi: 10.1017/S0265021505001122.
4. Yao FF, Malhotra V, Fong J, Skubas NJ. Yao & Artusio's anesthesiology: problem-oriented patient management. 8th ed. Wolters Kluwer; 2016:20-21.
5. Flory A, Appadurai I. Special considerations in anesthesia for laryngeal cancer surgery. *Otorhinolaryngol Clin.* 2010;2(3):185-190.

Mentor: Danielle K. Cuevas DNP, CRNA, CDR, NC, USN

Occult Placental Abruption in a Community-based Hospital

Zachary Gaarder, DNAP, BSN
Missouri State University

Keywords: placental abruption, abruptio placentae, hemorrhage, neuraxial anesthesia

Placental abruption, abruptio placentae, is the premature separation of the placenta before the delivery of the fetus. These events pose an extraordinary risk to maternal and fetal morbidity and mortality. In this case report, a 41-year-old female presented at 39 weeks gestation to the 58-bed community-based facility for a scheduled cesarean section. During the procedure, she was found to have an abrupted placenta which led to the use of blood products to maintain the fluid status of the mother during the cesarean delivery.

Case Report

A 41-year-old grand multigravida (G5P4) female at 39 weeks gestation, presented to a local community hospital for a scheduled elective cesarean section. The patient was admitted to labor and delivery the evening before the scheduled surgery date, anticipated for an approximate 0730 surgical start time. Preoperatively, the patient's physical status was assessed as an American Society of Anesthesiologists Physical Status classification of 3 related to gestational diabetes and obesity, with a BMI of 44.5 kg/m². Her airway was assessed and rated a mallampati II on physical exam with a thyromental distance greater than three fingerbreadths. Surgical history includes three previous cesarean section deliveries without complication. Vital signs demonstrated that she was beginning to become hypotensive overnight. On admission, her initial systolic blood pressure (SBP) was 120 - 130 mmHg but declined to 90 - 100 mm Hg the day of surgery. After receiving a 1 L fluid bolus via a 20-gauge peripheral IV in her left forearm, her SBP rose to 100 -110 mmHg before arriving at the operating room. On admission, the night before surgery, the patient's hemoglobin was 8.9 g/dL, the platelets were 149,000 platelets/ μ L, and fetal heart tones (FHT) were 150/min. The patient was typed and cross-matched for three units of blood.

Upon arrival to the operating room, ondansetron 4 mg IV was given. A subarachnoid neuraxial block with 1.6 mL of 0.75% bupivacaine was administered at the L3-L4 interspace. Intermittent boluses of phenylephrine and ephedrine were administered to maintain SBP above 100 mm Hg and uterine perfusion. The patient was positioned with left uterine displacement to avoid aortocaval compression syndrome. Following positioning, O₂ 6 L/min was supplied via a simple mask. Appropriate surgical anesthesia was assessed at the T4 dermatome level. At this time, it can be assumed based on the preoperative assessment, FHTs of 150/min, that the condition of the fetus is adequate.

Shortly after the Pfannenstiel incision was made, the surgeon assessed and diagnosed an acute abruptio occulta, placental abruption, which likely occurred overnight or early morning. Essentially, the placenta was floating free in the pelvis, no longer attached to the uterine wall or receiving perfusion. The fetus was quickly delivered and appeared well with initial APGAR scores of 5 and subsequent scores of 7 and 8 taken at 1, 5, and 10 minutes following the

clamping of the cord., The infant weighed approximately 3,100 grams. Oxytocin was held initially per the surgeon's request to have enough uterine tissue to suture back together. After the surgeon was able to properly gain control of the uterine tissue, oxytocin 20 units was mixed in a liter bag of lactated ringers and administered at a free-flowing rate to contract the uterus. Since the surgeon was able to properly maintain the physical structure of the uterus, the patient did not warrant a hysterectomy. A STAT hemoglobin was drawn following the surgeon's initial assessment of the placental abruption, revealing a hemoglobin value of 5.2 g/dL. The estimated blood loss (EBL) was around 1.5 L. Tranexamic acid 1 gram was administered IV while the surgical staff was retrieving the banked blood. With the impending need for blood, an 18-gauge peripheral IV was placed in the right antecubital fossa during this time. Three units of packed red blood cells (PRBCs) and 1 unit of fresh frozen plasma (FFP) were administered over the following 15 to 20 minutes using a pressure infuser. A post-transfusion H/H value resulted in 12.2 gm/dL. The patient remained awake and maintained adequate oxygenation throughout the procedure. No adverse responses were noted to the transfusion.

Upon delivery to the postoperative care unit, in addition to the blood products that were administered, a total of 2,500 mL of crystalloid and approximately 900 mL of oxytocin were given. The mother and infant recovered uneventfully and were discharged on postoperative day 4. An additional 1 unit of PRBC was transfused approximately 18 hours postoperatively, ordered by the surgeon.

Discussion

Obstetric emergencies increase the risk to both mother and the fetus. The use of regional anesthesia can reduce these risks if the situation allows, usually dictated by the severity of the situation and the time required to deliver the neuraxial anesthetic.³ Acute fetal distress is a fetal heart rate outside the range of 110 - 160 bpm.⁴ This is usually due to a lack of oxygen supply, hypercapnia, or acidosis.⁴ This phenomenon is considered emergent due to the high morbidity/mortality that can accompany such conditions. In this case, the fetal heart tones remained within the normal range. Without signs of fetal distress, this event was occult and a neuraxial anesthetic was not contraindicated for the patient and the fetus at the time of the delivery. Hemorrhagic emergencies, such as in this case present many challenges. The use of a subarachnoid block results in the blockade of sympathetic nerve fibers, inhibiting the body's innate physiologic compensatory mechanisms. Whereas, a general anesthetic provides an adequate depth of surgical anesthesia much quicker than a neuraxial blockade. It may be safer for the patient to convert to a general anesthetic to meet the increased oxygen demands due to the increased blood loss.³ The anesthesia provider must weigh these concerns as to which will benefit both the patient and the successful delivery of the neonate. In this case, general anesthesia was not needed as the placental abruption was not recognized and the patient was hemodynamically stable; however, maintaining adequate oxygenation should be a priority for the anesthesia practitioner.

This patient presented many challenges related to the increased blood loss secondary to the placenta abruption. According to Wang et. al., the ability to remain hemodynamically stable is related to the parturient's increased blood volume and enhanced coagulation functions during the third trimester.⁵ It was not known when the placental abruption occurred, yet the fetus was not

compromised. The rapid identification of the abruption by the surgeon followed by the use of PRBCs, FFP, tranexamic acid, and the EBL being within acceptable limits all led to the fortunate outcome for both the parturient and the fetus. One can also assume that due to the blood loss that was sustained during the abruption, there was a greater deficit in the autotransfusion that is typically sustained from the enhanced uterine blood flow following the delivery of the infant.⁶ Thus, it is imperative to resuscitate the mother with blood products to prevent the hemodynamic instability that can be seen from this potentially catastrophic event.

With the lack of current studies and a deeper understanding of placental abruption cases' morbidity and mortality, it is difficult for a practitioner to predict the risks or sequelae following the surgical case. It is known that there is a risk of low birth weight, preterm birth, and perinatal mortality associated with placental abruptions.⁶ In addition to the heightened risk of fetal death, cerebral palsy, and obstetric bleeding, there is a concern for disseminated intravascular coagulation (DIC).⁷ If the placental abruption or uncontrolled bleeding leads to a deficit in clotting factors, DIC can persist. Since the risk of DIC is historically believed to be high in these catastrophic situations, the use of salvaged blood products has been avoided due to these debunked fears of amniotic fluid embolisms and alloimmunization related to fetal antigen exposure.⁸

With this in mind, the American College of Obstetrics and Gynecologists has deemed it safe for the utilization of blood salvage to manage hemorrhage due to placenta accreta.^{8,9} However, this practice is up to the surgeon. In addition, this facility did not possess the resources to perform blood salvage. In this particular case, the utilization of PRBCs, FFP, and other coagulation measures was sufficient and supported the outcome of this patient. If DIC and multiorgan failure progression is diagnosed, further management may necessitate a hysterectomy to prevent this progression and limit maternal morbidity and mortality.⁷ It is important to support oxygenation, ventilation, and hemodynamics of the patient not only to maintain the viability of the mother but to support the mother's vital organs. Fortunately, DIC did not occur in this particular case, and this patient did not require further treatment.

References

1. Ananth CV, Lavery JA, Vintzileos AM, et al. Severe placental abruption: clinical definition and associations with maternal complications. *Am J Obstet Gynecol.* 2016;214(2):272.e1-272.e9. doi:10.1016/j.ajog.2015.09.069
2. Li Y, Tian Y, Liu N, Chen Y, Wu F. Analysis of 62 placental abruption cases: Risk factors and clinical outcomes. *Taiwan J Obstet Gynecol.* 2019;58(2):223-226. doi:10.1016/j.tjog.2019.01.010
3. Sivasundar A, Giri S, Singh SK. Role of regional anesthesia in obstetric emergencies. *Anaesth, Pain Intensive Care.* 2015;19(1):71-79. <https://www.apicareonline.com/index.php/APIC/article/view/331/1210>
4. Metogo, J.A.M., Nana, T.N., Ngongheh, B.A. General versus regional anaesthesia for caesarean section indicated for acute foetal distress: a retrospective cohort study. *BMC Anesthesiol* 2021;21(68). doi:10.1186/s12871-021-01289-7

5. Yao Wang, Juan Xiao, Fanzhen Hong. A risk prediction model of perinatal blood transfusion for patients who underwent cesarean section: a case control study. *BMC Pregnancy Childbirth*. 2022;22(1):1-8. doi:10.1186/s12884-022-04696-x
6. Downes KL, Grantz KL, Shenassa ED. Maternal, Labor, Delivery, and Perinatal Outcomes Associated with Placental Abruption: A Systematic Review. *Am J Perinatol*. 2017;34(10):935-957. doi:10.1055/s-0037-1599149
7. Takeda J, Takeda S. Management of disseminated intravascular coagulation associated with placental abruption and measures to improve outcomes. *Obstet Gynecol Sci*. 2019;62(5):299-306. doi:10.5468/ogs.2019.62.5.299
8. Liu Y, Li X, Che X, Zhao G, Xu M. Intraoperative cell salvage for obstetrics: a prospective randomized controlled clinical trial. *BMC Pregnancy Childbirth*. 2020;20(1):452. doi:10.1186/s12884-020-03138-w
9. Elisha S. Case Studies in Nurse Anesthesia E-Book. *Jones and Bartlett Publishers, LLC*. 2011.

Mentor: Jeanie Skibiski, DNAP, CRNA, FAANA

Troubleshooting for One-lung Ventilation in Anesthesia

Eric A. Fitzpatrick, DNAP, BSN
University of Kansas Medical Center

Keywords: One-lung ventilation, double-lumen endotracheal tubes, bronchial blockers

One lung ventilation (OLV) was first conceptualized in 1871 by Eduard Pfluger and Claude Bernard, who studied gas exchange in dogs.¹ It was not until the 1930s that the original equipment was adapted for clinical use in humans.² The invention of Carlen's double lumen tube (DLT) in the 1950s was revolutionary in anesthesia because it allowed anesthesiologists to isolate one lung reliably.³ One lung ventilation is accomplished using special airway devices with either a DLT or a bronchial blocker (BB). Placement of these specialized airways and maintenance of OLV can require extensive troubleshooting to complete an intrathoracic surgery successfully.

Case Report

A 61-year-old female presented to the operating room for a T9-10 corpectomy and T9-11 arthrodesis with structural allograft and rib autograph. The patient was six months post T10 to S1 fusion complicated by infections requiring multiple washouts and subsequent hardware removal. Past medical history included discitis of the thoracolumbar region, intractable back pain, neurogenic pain, spasticity, paraplegia, chronic heart failure with preserved ejection fraction, asthma, hypertension, type 2 diabetes mellitus, and anemia.

A history and physical exam were completed, and informed consent for general anesthesia with invasive monitoring was obtained. The patient was given midazolam prior to leaving the preoperative bay. Once in the operating room, standard monitors were applied, and oxygen was administered via a circuit mask prior to induction. General anesthesia was induced using

lidocaine, fentanyl, propofol, and succinylcholine. A right radial arterial line and a second intravenous catheter were inserted following tracheal intubation.

The patient was intubated with a 37 F left-sided DLT. Once the cuff passed the vocal cords, the DLT was rotated 90 degrees counterclockwise, advanced to the left bronchus, and secured at 21 cm. End-tidal CO₂ was observed via capnography, and bilateral breath sounds were heard on auscultation. A fiberoptic bronchoscope was then used to confirm the correct placement of the DLT. The carina could not be visualized and the DLT was removed. A 37 F DLT could not be advanced beyond the glottic opening on the second attempt. The 37 F DLT was removed, and the patient was mask ventilated. A third attempt was made with a 35 F DLT. Moderate edema was observed at the vocal cords and the DLT could not be advanced. The decision was made to attempt a single-lumen endotracheal tube (ETT) intubation and use a BB.

The patient was positioned in the supine position with pressure points padded prior to intubation. A 7.0 ETT was placed with ease, and the BB was passed through it and into the right main bronchus. Verification of the correct placement of the BB was made using a fiberoptic bronchoscope. The patient was then repositioned to left lateral decubitus position with pressure points padded. An axillary roll was placed beneath the axilla protecting the neuro-vascular structures in the axillary region. After two minutes of passive deflation of the operative right lung, the surgeon stated that the lung was still moving. Multiple adjustments to the BB were made throughout the first hour of the procedure by deflating and re-inflating the cuff at various positions throughout the right bronchus; all adjustments were visualized with a fiberoptic bronchoscope. These adjustments were unsuccessful and the surgeon could not continue to operate due to excessive lung movement. Upon further discussion, the decision was made to remove the BB and advance a single-lumen ETT into the left bronchus. This was accomplished by advancing the ETT several centimeters until correct placement was verified with fiberoptic. This technique for OLV proved optimal for the surgeon to complete the surgery successfully. Dexamethasone 8 mg was given intravenously to help reduce airway edema. Two ABGs were drawn with a PaO₂ value of 182 mm Hg and 153 mm Hg while maintaining an FiO₂ administration of 60% throughout the case. The patient's SpO₂ was maintained above 92% for the duration of the procedure. Based on these results, it was determined that the patient was not at risk for hypoxia or acute lung injury. The patient did well throughout the intra- and post-operative periods.

Discussion

Indications for OLV include surgical lung exposure, spine surgery, video-assisted thoracoscopic surgery (VATS), and lung isolation.¹ After seeing the patient in the preoperative bay and speaking with the surgeon, OLV was determined to be the best choice to isolate the lung. One of the major unsolved questions in thoracic anesthesia is; What is the best airway device for performing OLV, a DLT, or BB? A recent meta-analysis suggested that the DLT was easier to position and required less time to place but had a higher incidence of airway injuries, sore throat, and hoarseness.⁴ BBs are often more difficult to position for OLV and are more prone to dislodgment than DLT.¹ Single-lumen ETTs may be placed endobronchially to provide OLV, but a significant disadvantage of this technique is the inability to access the non-intubated lung.¹

One of the difficulties encountered by most anesthetists performing OLV is the selection of an appropriately sized DLT.⁵ Selection of the appropriate size is typically based on the patient's height and gender. This recommendation is inadequate for all patients, especially those of certain ethnicities or genetic abnormalities.⁶ The most accurate method of selecting the correct sized DLT uses measurements of the left main-stem bronchial diameter from a computed tomography (CT) scan. The traditional approach uses 37F for females and 39F for males, but some thoracic anesthetists now advocate using smaller-sized DLTs to minimize the risk of airway trauma. The use of a fiberoptic bronchoscope with every DLT or BB is recommended to confirm proper tube position.³

The BB is recommended for difficult airway management, rapid sequence induction, one-lung ventilation in children, or when postop ventilatory support is needed.⁴ Modern BBs are one-use, disposable items that incorporate a high-volume, low-pressure balloon cuff which helps decrease the likelihood of airway edema.² They are placed under direct fiberoptic visualization in patients where a DLT is not desirable. The disadvantages of a BB are a tendency to move during surgery, an inability to ventilate blocked lung segments, cuff herniation into the carina, and clinicians with limited experience.²

Another option for OLV is to advance a single lumen ETT into the main bronchus of the nonoperative lung while permitting slow collapse of the contralateral lung. This technique is rarely used in adult patients except in emergency surgeries or difficult airways.³ No matter which approach is utilized, standard vital signs and ABGs are important in confirming adequate ventilation. The decision was made use a DLT during our preoperative interview because of provider familiarity.

Anesthetic management of OLV should be performed by a provider who is comfortable placing a DLT or BB and using a fiberoptic bronchoscope. The DLT was developed from early animal experimental equipment and continues to evolve through anesthetic practice today.² DLTs and BBs are available in various shapes and sizes. Tube choice depends on the patient, the type of surgery, and the comfort of the anesthesia provider. Using a CT scan to determine the DLT size for this patient prior to her surgery would have been a better choice. If a smaller DLT had been initially chosen, then edema to the trachea and multiple direct laryngoscopy attempts might have been avoided. This case demonstrated the appropriate steps to take when OLV is required and how to troubleshoot when issues arise. Through critical thinking and real-time troubleshooting, OLV was achieved, and the surgery was completed safely.

References

1. Mehrotra M, Jain A. Single Lung Ventilation. *StatPearls*. Updated July 31, 2021. Accessed April 1, 2023. <https://www.ncbi.nlm.nih.gov/books/NBK53814/>
2. McGrath B, Tennuci C, Lee G. The history of one-lung anesthesia and the double-lumen tube. *J Anesth Hist*. 2017;3(3):76-86. doi: 10.1016/j.janh.2017.05.002.
3. Ashok V, Francis J. A practical approach to adult one-lung ventilation. *BJA Educ*. 2018;18(3):69-74. doi:10.1016/j.bjae.2017.11.007
4. Bernasconi, F., & Piccioni, F. One-lung ventilation for thoracic surgery: Current perspectives. *Tumori*. 2017;103(6), 495–503. doi.org/10.5301/tj.5000638

5. Hernandez A, Cogdill R, Hinojosa-Laborde C, Restrepo MI. Comparison of silicone spray versus water soluble lubricating jelly for the aid in bronchoscopic examination. *J Anesthesiol Clin Sci*. 2013;2:7. <https://doi.org/10.7243/2049-9752-2-7>
6. Ideris SS, Che Hassan MR, Abdul Rahman MR, Ooi JS. Selection of an appropriate left-sided double-lumen tube size for one-lung ventilation among Asians. *Ann Card Anaesth*. 2017;20(1):28-32. doi: 10.4103/0971-9784

Mentor: Tim Gengler, DNAP, CRNA

Prophylactic Use of Tranexamic Acid to Prevent Postpartum Hemorrhage

Anna Hudson, DNP, BSN
Samford University

Keywords: tranexamic acid, uterine atony, postpartum hemorrhage, vaginal deliveries, cesarean deliveries

Postpartum hemorrhage (PPH) is the leading cause of maternal mortality, accounting for over 29% of maternal deaths worldwide.¹ Although various definitions of PPH exist, the American College of Obstetrics and Gynecologists define PPH as a cumulative blood loss of greater than or equal to 1,000 mL or blood loss accompanied by signs or symptoms of hypovolemia within 24 hours after the birth process.² When blood loss exceeds such thresholds, maternal morbidity and mortality increase, making early recognition and proactive management key.¹ This case report discusses the benefits of prophylactic administration of tranexamic acid (TXA) as an adjunct to standard uterotonics.

Case Report

A 34-year-old African American gravida 3 para 2 presented at 39 weeks gestation for an elective repeat cesarean delivery. Her pregnancy was complicated by preexisting hypertension, gestational diabetes, obesity, and polyhydramnios. The estimated fetal birth weight was 4000 gm. Her pregnancy history included two previous cesarean deliveries, in which she presented with the same complications. Upon preoperative evaluation, the patient's vital signs were: blood pressure (BP) 133/92 mm Hg, heart rate (HR) 83/min, respiratory rate (RR) 12/min, SpO₂ 99% on room air, and normal fetal heart tracings. Current lab work included a type and screen with a negative antibody crossmatch and baseline hemoglobin (Hgb) 10.2 mg/dL and hematocrit (Hct) 32.1%. Her estimated blood volume of 6650 mL and allowable blood loss of 2299 mL were calculated based on her preoperative weight of 95 kg. An 18-gauge intravenous (IV) catheter was placed in her right forearm with continuous lactated ringers (LR) infusing.

Standard non-invasive monitors, including fetal heart tone monitoring, were applied upon arrival into the operating room. Oxygen was administered at 2 L/min via nasal cannula. The sitting-flexed position was used for optimal placement of the subarachnoid block. The patient received 0.75% hyperbaric bupivacaine 11.25 mg with morphine 0.15 mg intrathecally at the lumbar 3-4 interspace. The patient was then positioned supine with left uterine displacement and exhibited a

decrease in BP (111/72 mm Hg) with an increased HR at 97/min. Her decrease in BP was treated with phenylephrine 100 mcg IV. The patient displayed sensory blockade to the 6th thoracic dermatome with associated motor blockade.

A transverse incision was made with the subsequent delivery of a male neonate, followed by an intact placenta. The patient remained alert and oriented throughout the procedure but required hemodynamic support with IV vasopressors totaling phenylephrine 600 mcg and ephedrine 30 mg in addition to LR 1000 mL IV. Immediately after placental delivery, a continuous IV infusion of oxytocin 30-unit admixture in 1 liter of LR was initiated. During uterine closure, the surgeon noted an atonic uterus and performed intraoperative uterine massage. An additional bolus dose of oxytocin 6 units was administered with 10 units added to the infusion. Despite these measures, the uterus remained atonic. The surgeon ordered methylergometrine 0.2 mg intramuscular (IM) and misoprostol 800 mcg to be given rectally as second-line uterotonics. After surgical closure, the patient experienced a decrease in BP to 110/74 mm Hg BP and increased HR of 100/min. Overall, the patient experienced a quantifiable blood loss of 1400 mL. Ondansetron 4 mg IV was administered, and the patient was transported to the labor suite for recovery and continued monitoring.

Within 1 hour post-delivery, she displayed signs of hemodynamic stability with the return of baseline vital signs. She continued to receive fundal massages. The following day her laboratory results displayed a decrease in Hgb from 10.2 mg/dL to 7.8 mg/dL, illustrating a 23.5% decrease for the first 24 hours. Her Hct decreased from 32.1% to 24% showing a 25% decrease. The patient did not require additional uterotonics and did not receive any blood products postpartum.

Discussion

Postpartum hemorrhage remains the leading cause of maternal deaths worldwide despite ongoing efforts.¹ Particularly in the third stage of labor, when the placenta separates from the uterus, the fibrinolytic system is activated, causing a massive release of fibrin and subsequent hemorrhage, making early recognition and treatment crucial to preventing PPH.^{1,3}

In this case report, the patient presented with several underlying factors predisposing her to uterine atony and placing her at high risk for PPH. Current statistics report uterine atony as the primary etiology of PPH.⁴ Due to her high-risk presentation, blood products were made available prior to surgical start. Standard precautions were initiated, including obtaining baseline laboratory values for Hct and Hgb, and IV access with crystalloid administration to optimize intravascular volume.

Throughout the procedure, cumulative blood loss was measured, and the patient was continuously assessed for signs and symptoms of hemorrhage based on her physical appearance, cognitive response, and hemodynamics. The patient experienced decreased BP as a result of sympathetic blockade from the spinal anesthetic. A careful distinction was made between sympathetic blockade versus hemorrhage to determine the cause of hypotension. With the support of vasopressors and fluids, the patient tolerated neuraxial anesthesia and maintained hemodynamic stability.

Blood loss greater than or equal to 1,000 mL accompanied by signs or symptoms of hypovolemia within 24 hours after delivery is considered PPH and should be recognized and treated promptly.⁵ Currently, the most common treatment for PPH includes the IV administration of exogenous oxytocin; through its mechanism of action, it causes uterine contraction and slows bleeding.⁴ For the presenting patient, standard uterotonic measures were employed, including oxytocin administration and intrauterine massage performed by the surgeon. Despite these efforts, the patient continued to bleed, requiring extra support from second-line uterotonics, including misoprostol and methylergometrine. Through their mechanism of action, both drugs target the smooth muscle within the uterus resulting in increased strength and frequency of uterine contractions to decrease overall blood loss from uterine hypotonicity. Although these interventions were effective and hemodynamic stability was achieved, the use of TXA could prevent the PPH experienced by this patient.

In 2012, the World Health Organization (WHO) recognized the multiple benefits of TXA in surgical settings and suggested it become a standard practice for high-risk PPH parturients undergoing cesarean or vaginal delivery.⁶ The most current WHO recommendation includes TXA 1g IV at the onset of bleeding, unless contraindicated regardless of the cause of PPH.⁶ Patients with a history of a thrombolytic disease, coagulopathy disorders, subarachnoid hemorrhage, renal failure, or newly placed vascular stents should not receive TXA.⁷

Two recent studies consider potential side effects of TXA, including possible fetal exposure due to its ability to diffuse passively across the placental barrier.^{3,8} A meta-analysis conducted by Alam et al.⁸ and several randomized control trials analyzed by Chattopadhyay et al.³ found no increased risk for adverse events, including thrombosis or seizures in parturients or their fetuses. Although rare, there are reports of mild gastrointestinal symptoms, including nausea, vomiting, and diarrhea. Chattopadhyay et al.³ associate these findings with doses exceeding 1g IV.^{3,8} Overall, these side effects were mild and well-tolerated.

Large-scale meta-analyses are being conducted in the obstetric population; the results point toward the protective mechanisms of TXA in its recipients.³ For instance, evidence shows a significant reduction of total blood loss and the use of additional uterotonics.⁸ There are also reports of reduced blood product administration and variability in hematocrit and hemoglobin perioperatively.⁸ These factors support the findings of the World Maternal Antifibrinolytic trial linking TXA to a staggering 21% reduction in maternal mortalities caused by excessive bleeding.⁵

When comparing current evidence to the presenting case study, TXA could benefit this patient since she had no underlying contraindications. Because she was at high risk for PPH, it could have been given intraoperatively to reduce the overall bleeding. It could also be administered at the first recognition of uterine atony as an adjunct to oxytocin to augment hemostasis. Due to its antifibrinolytic properties and duration of action of up to 8 hours, TXA could further decrease blood loss experienced in the postpartum period.³ Incorporating TXA into the patient's anesthesia management may have improved her outcomes by reducing blood loss and the incidence of PPH and, perhaps, prevent the use of second-line uterotonics.⁸

Evidence not only supports the use of TXA for this patient but all parturients undergoing vaginal or cesarean deliveries unless contraindicated.⁸ Introducing a new medication or practice into a facility can be challenging. Through promotion and education of current evidence showing TXA's high safety profile and efficacy, this barrier may be minimized, thus gaining practitioner acceptance. Other limitations may include the cost and availability within each facility. By incorporating TXA into practice, anesthesia practitioners can improve outcomes for the obstetric population by reducing blood loss during delivery, the incidence of PPH, and its associated maternal mortalities.⁵

References

1. Borovac-Pinheiro A, Pacagnella RC, Cecatti JG, et al. Postpartum hemorrhage: new insights for definition and diagnosis. *Am J Obstet Gynecol*. 2018;219(2):162-168. doi:10.1016/j.ajog.2018.04.013
2. Committee on Practice Bulletins-Obstetrics. Practice bulletin no. 183: Postpartum hemorrhage. *Obstet Gynecol*. 2017;130(4):e168-e186. doi: 10.1097/AOG.0000000000002351
3. Chattopadhyay S, Sarkar S, Chakrabarti S, et al. Effect of intravenous tranexamic acid administration on blood loss during and after elective caesarean delivery - a randomized placebo-controlled study. *J Evolution Med Dent Sci*. 2017;6(16):1286-1292. doi:10.14260/Jemds/2017/279
4. Bienstock JL, Eke AC, Hueppchen NA. Postpartum hemorrhage. *N Engl J Med*. 2021;384:1635-1645. doi: 10.1056/NEJMr1513247
5. Shakur H, Roberts I, Fawole B, et al. Effect of early tranexamic acid administration on mortality, hysterectomy, and other morbidities in women with post-partum haemorrhage (WOMAN): an international, randomized, double-blind, placebo-controlled trial. *Lancet*. 2017;389(10084):2105-2116. doi:10.1016/S0140-6736(17)30638-4
6. World Health Organization. Updated WHO recommendation on tranexamic acid for treatment of postpartum haemorrhage. 2017. Accessed August 17, 2022.
7. Goobie SM. Tranexamic acid: still far to go. *Br J Anaesth*. 2017;118(3):293-295. doi:10.1093/bja/aew470
8. Alam A, Choi S. Prophylactic use of tranexamic acid for postpartum bleeding outcomes: a systematic review and meta-analysis of randomized controlled trials. *Transfus Med Rev*. 2015;29(4):231-241. doi:10.1016/j.tmr.2015.07.002

Mentor: Maria Ledbetter, DNAP, CRNA

Anesthetic Management for Patients with Limb-Girdle Muscular Dystrophy

Julius Brown, DNP
Uniformed Services University

Keywords: limb-girdle muscular dystrophy, progressive genetic disorders, muscle wasting

Limb-girdle muscular dystrophy (LGMD) is a rare form of muscular dystrophy with numerous subtypes. Other names for LGMD include pelvofemoral muscular dystrophy and proximal muscular dystrophy. LGMD is the fourth most frequent genetic cause of muscle weakness with an incidence of 6.5 in 100,000 patients diagnosed annually.¹ The specific subtype of LGMD is categorized based on its gene and inheritance. The symptoms initially affect the proximal muscles around the shoulders (shoulder girdle) and hips (pelvic girdle).² Certain subtypes of LGMD may cause cardiomyopathy, cardiac arrhythmias, and weakened muscles of respiration. These patients have an increased risk of pneumonia, reintubation, and inpatient stay in the postoperative period.¹

Case Report

An 88-year-old female with breast cancer presented for a left partial mastectomy after a previous lumpectomy revealed cancerous nodules. The patient weighed 73 kg, had a height of 167 cm, and had a body mass index of 26 kg/m². She reported an allergy to sulfa drugs. She had a history of gastroesophageal reflux disease (GERD), hypertension (HTN), hyperlipidemia (HLD), gout, right breast cancer, and LGMD. The patient required a consult and clearance for surgery from a pulmonologist due to an extensive history of muscle weakness. Preoperative pulmonary function test (PFT) revealed a forced expiratory volume in 1 second (FEV₁/FVC) of 79 (normal value > 65 in persons older than 65). Her diffusion capacity of carbon monoxide (DLCO) was 10.4 (57% of the predicted value [normal >75%]). Upon preoperative assessment, the patient was found to be wholly bed-bound, and control over her body was limited to moving her neck from side to side. The patient had a calculated muscular impairment rating scale (MIRS) score of five. A MIRS score ranges from one (no muscular involvement) to five (severe proximal weakness).³ The patient was apprised of her increased risk for requiring postoperative ventilation due to her LGMD. The patient acknowledged the risk and agreed to continue with the scheduled procedure.

Her daily medications included clonidine 0.1mg twice per day, famotidine 40 mg once per day, fosinopril 20 mg once per day, furosemide 40 mg once per day, and cinacalcet 30 mg twice per day. Vital signs taken post arrival to the operating room (OR) yielded a blood pressure (BP) of 150/95 mmHg, heart rate (HR) of 78/min, respiratory rate (RR) of 14/min, and pulse oximetry of 97% after preoxygenation with 10 L/min of O₂ via facemask (room air saturation 93%). The decision was made to proceed with total intravenous anesthesia (TIVA). General anesthesia was induced with lidocaine 50 mg, remifentanyl 50 mcg, and propofol 100 mg intravenously (IV). A laryngeal mask airway (LMA) size 4.0 was placed into the oropharynx. A TIVA was maintained with a continuous infusion of propofol, titrated 50-130 mcg/kg/min, remifentanyl 0.05mcg/kg/min, and dexmedetomidine 40 mcg (10 mcg aliquots IV every 30 minutes). A bispectral index monitor was utilized to assess the sedation level; values were maintained between 40-60 during the procedure). The ventilator was set to pressure control mode (20 cm

H₂O) with O₂ and air flow rates at one liter per minute respectively (FiO₂ 60.5%). Additional IV medications during the case included dexamethasone 4mg, acetaminophen 1000 mg, phenylephrine 100 mcg, and ondansetron 4 mg. Approximately 20 mL of liposomal bupivacaine was instilled directly into the surgical site by the surgeon for postoperative pain control. The course of the case, emergence from anesthesia, and extubation were uneventful. The patient was able to protect her airway and was transported to the postoperative care unit with an O₂ saturation of 97% while wearing a simple face mask at 8L/minute.

Discussion

Patients with LGMD can be very challenging to manage in the perioperative setting. Numerous systems are affected by muscle weakness caused by chronic muscle fiber necrosis, degeneration, and regeneration. Severe forms of LGMD can have cardiac and respiratory involvement.⁵ Cardiac symptoms can present as atrioventricular block, atrial fibrillation/flutter, cardiomyopathy, and complete cardiac failure. Inhalation anesthetics and succinylcholine should be avoided in this patient population due to the increased risk of MH and rhabdomyolysis. Appropriate trigger-free medications for induction include propofol, etomidate, and opioids.¹ TIVA with propofol was chosen as the primary anesthetic to decrease this possibility.

The sensitivity to anesthetics, opioids, and muscle relaxants can be increased in myopathic patients. Utilization of short-acting agents can minimize the risk of postoperative respiratory depression. For this case, propofol, dexmedetomidine, and remifentanyl were chosen as the primary anesthetics. Propofol causes a positive modulation of the inhibitory function of the neurotransmitter gamma-aminobutyric acid receptors (GABA) which produces sedative and hypnotic effects. This drug was chosen due to its short duration of action, anesthetic, sedative, hypnotic, and anticonvulsant properties. Dexmedetomidine centrally agonizes pre and postsynaptic alpha-2 adrenoceptors to exert its effects. This agent was chosen for its properties in decreasing opioid requirements, increasing sedation, and promoting analgesia with minimal respiratory depression. Remifentanyl is an opioid mu agonist chosen for its analgesic potency, rapid onset, and short duration of action. Hyperalgesia was not a concern for this patient due to the low rate of infusion. Postoperative analgesia was achieved with the use of a non-opioid adjunct and liposomal bupivacaine.

Muscle relaxant use is discouraged in patients with LGMD due to a high sensitivity and prolonged duration of action. The avoidance of muscle relaxants influenced the decision to utilize an LMA instead of an endotracheal tube as the primary airway adjunct. When paralysis is required, rocuronium is the most utilized non-depolarizing muscle relaxant in this patient population. Neuromuscular blockade reversal with sugammadex 4mg/kg has been shown to restore 100% of previous neuromuscular function with minimal adverse cardiovascular incidents. Conversely, neuromuscular blockade antagonism with neostigmine may induce rhabdomyolysis, malignant arrhythmias, and heart failure in patients with LGMD.²

Patients with LGMD should receive pulmonary function testing, ECG, and chest X-ray prior to surgery.³ Positive findings should be followed up with echocardiography.¹ Pulmonary function testing should evaluate the FVC and FEV₁ in both the supine, decubitus, and upright seating positions. The patient is at an increased risk of requiring ventilative assistance in the

postoperative period if their FVC is below 50% of the expected level. Diaphragmatic function tests may also be performed to aid in predicting the patient's postoperative ventilatory support requirements.

Most LGMD patients are transferred to the intensive care unit for postoperative recovery due to their increased risk of respiratory depression, gastric reflux, aspiration, ventilation dysfunction, and respiratory depression. The patient in this case study was transferred to the post anesthesia care unit and then to a step-down surgical unit for postoperative monitoring. This decision was influenced by the patient's stable condition and vitals quickly returning to preoperative levels. Extubation 24 to 48 hours after surgery or non-invasive mechanical ventilation is recommended if neuromuscular blockade is not reversed.³

There are currently no randomized controlled trials comparing general anesthesia to regional anesthesia due to the rarity of the disorder. Many institutions recommend employing regional anesthetics whenever surgery allows to avoid the risk of triggering agents and respiratory depression. Current literature also encourages the use of local anesthetics for post operative analgesia. Analgesic alternatives include IV or rectal paracetamol, regional epidural, and paravertebral blocks for thoracic procedures.⁵ Opioids and sedatives should be avoided in patients with compromised respiratory function during the postoperative period.⁴

Management of patients with LGMD under general anesthesia can present numerous challenges. This case was conducted without any complications due to clear communication and preoperative planning by all members of the multidisciplinary perioperative team. The critical issues considered in the interoperative period were MIRS score, preoperative respiratory fitness level, cardiovascular status, type of surgery, positioning, postoperative pain control, and patient postoperative functional goals.

References

1. Cao XQ, Joypaul K, Cao F, Gui LL, Hu JT, Mei W. Anesthetic management of a patient with limb-girdle muscular dystrophy 2B:CARE-compliant case report and literature review. *BMC Anesthesiol.* 2019;19(1):155. doi:10.1186/s12871-019-0813-8
2. Devkota S, Shrestha S, Gurung T, Shrestha S. Regional anesthesia as a safe option in patient with limb girdle muscular dystrophy undergoing total abdominal hysterectomy: A case report and case review. *Clin Case Rep.* 2022;10(11):e6523. doi:10.1002/ccr3.6523
3. Echeverry-Marín PC, Bustamante-Vega ÁM. Anesthetic implications of muscular dystrophies. *Colombian J of Anes.* 2018;46(3):228-239. doi:10.1097/cj9.000000000000059
4. Katz JA, Murphy GS. Anesthetic consideration for neuromuscular diseases. *Curr Opin Anaesthesiol.* 2017;30(3):435-440. doi:10.1097/ACO.0000000000000466
5. Sarkılar G, Mermer A, Yücekul M, Çeken BM, Altun C, Otelcioğlu Ş. Anaesthetic Management of a Child with Limb-Girdle Muscular Dystrophy. *Turk J Anaesthesiol Reanim.* 2014;42(2):103-105. doi:10.5152/TJAR.2013.52

Mentor: Steven Holmes, DNP, CRNA, Maj, USAF, NC

Scalp Nerve Block for an Awake Craniotomy

Quinn Luckenbill, BSN
Cedar Crest College

Keywords: awake craniotomy, scalp nerve block, anesthesia, moderate sedation, spontaneous ventilation

A scalp nerve block for awake craniotomy under moderate sedation is an anesthetic option for patients undergoing supratentorial tumor resections.¹ An awake craniotomy is preferred when physicians wish to monitor motor and sensory function during the operation.¹ When a scalp nerve block is not performed for a craniotomy, there is an increase in inflammatory cytokine and C-reactive protein (CRP) release.² The purpose of this case report is to discuss the anesthetic management of an awake craniotomy, the efficacy of scalp nerve blocks, and complications related to awake craniotomies under moderate sedation.

Case Report

A 48-year-old female (105 kg, 160 cm, BMI 41kg/m²) presented to the emergency department with chronic headaches and left-hand numbness over her 2nd and 3rd digits. Magnetic resonance imaging (MRI) revealed a 4.5 x 2.6 cm right frontal intra-axial lesion. A brain biopsy was performed and revealed a grade II oligodendroglioma. Other significant past medical history included hypertension and prediabetes. Pertinent negatives include non-smoker and no prior history of lung or heart disease. Informed consent was obtained for an awake right frontal craniotomy and tumor resection under moderate sedation.

Education was provided to the patient regarding moderate sedation, the goals and expectations of the patient during the procedure, and the scalp nerve block. Anesthesia consent was obtained once questions were answered. Midazolam 2 mg intravenous (IV) was administered, and the patient was transported to the operating room where standard noninvasive monitors were applied. The patient presented in normal sinus rhythm, a blood pressure of 146/78 mm Hg, and an SpO₂ of 100% on room air. Oxygen was administered at 6 L/min via nasal cannula. Moderate sedation was achieved by initiating a dexmedetomidine infusion at 0.5 mcg/kg/hr and a remifentanyl infusion at 0.02 mcg/kg/min. A peripheral IV catheter was placed along with a left radial arterial line prior to the scalp block.

The patient remained supine, and fentanyl 20 mcg was given prior to the scalp block. A betadine preparation solution was applied around the scalp. The anesthesia professionals injected a total volume of 40 mL of 0.5% bupivacaine circumferentially to complete the scalp block. The dosage was divided and administered to both the left and right scalp in the following manner: 4 mL around the greater occipital nerve, 4 mL toward the lesser occipital nerve, 5 mL around the auriculotemporal nerve, 5 mL at the zygomaticotemporal nerve, 1 mL toward the supraorbital nerve, and 1 mL at the supratrochlear nerve. Then propofol 40 mg and fentanyl 30 mcg boluses were given prior to pinning.

The patient complained of an increased pressure in her scalp after pinning. Vital sign changes were noted at this time with a heart rate of 105/min and a blood pressure of 170/74 mm Hg. Fentanyl 60 mcg and propofol 80 mg boluses were administered in response. There was a brief period of apnea following pin insertion. Oxygen administration was switched to 15L/min via face mask. The remifentanyl and dexmedetomidine infusions were discontinued. Once spontaneous respirations ventilation returned, dexmedetomidine 0.05 mcg/kg/hr and remifentanyl 0.02mcg/kg/min infusions were restarted. Decadron 10 mg, ondansetron 4 mg, 2 g cefazolin, and levetiracetam 1000 mg were administered at this time. Vital signs returned to normal, and patient's neurological status was assessed by asking to squeeze their hands and answer questions.

Moderate sedation was maintained throughout the case with the above infusion rates. Fentanyl 10 mcg boluses were administered throughout the case in response to complaints of cranial pressure totaling 300 mcg. To keep the patient normotensive and maintain a mean arterial pressure (MAP) goal of 65 mm Hg, a nicardipine 15 mg/hr infusion was initiated and titrated to the desired goals. Spontaneous ventilation was maintained with supplemental O₂ provided at 15 L/min via face mask. After tumor resection, the remifentanyl and dexmedetomidine infusions were titrated down and discontinued after closure. Thirty minutes prior to procedure completion ondansetron 4 mg was administered for postoperative nausea and vomiting (PONV) prophylaxis. Total procedure time was approximately 6 hours and was largely uneventful outside the brief apnea period. Nicardipine 10 mg/hr infusion was continued upon transferring the patient to the neurosurgical intensive care unit for further observation.

Discussion

Awake craniotomies have been used for aneurysm repairs, arteriovenous malformation excisions, and metastasis surgery.³ Awake craniotomies for grade II oligodendroglioma may be chosen to monitor the motor cortex in the prefrontal gyrus, the sensory cortex in the postcentral gyrus, and Broca's or Wernicke's area.¹ These areas are monitored to provide real-time responses from the patient to the surgeon to prevent unnecessary resection or damage to the aforementioned locations. Absolute contraindications for a patient to undergo an awake craniotomy are patient refusal, and the patient's inability to follow commands.¹ Providers will not be able to adequately assess patient's motor or language abilities if patients cannot follow commands. Relative contraindications to an awake craniotomy include patients with obstructive sleep apnea or known airway abnormalities.¹ A thorough preoperative evaluation and discussion with the patient are warranted prior to an awake craniotomy to ensure the patient understands their role and expectations prior to the procedure.

There are three techniques anesthesia professionals can utilize for an awake craniotomy: asleep-awake-asleep, awake-awake-awake, and moderate sedation.⁴ For asleep-awake-asleep, patients are placed under general anesthesia before cortical mapping, awake for the resection, and then sedated for closure.⁴⁻⁵ Awake-awake-awake requires IV analgesia and a scalp block without the use of hypnotic infusions.⁵ Moderate sedation utilizes a scalp block, hypnotic infusions, and IV analgesia to support spontaneous ventilation.⁵

In this case, moderate sedation with the scalp nerve block was utilized. The scalp is innervated with multiple A-fibers and C-fibers.² Incision pain or pressure activates these fibers which

initiates the release of inflammatory cytokines such as interleukins and C-reactive proteins (CRP).² Scalp nerve blocks have shown to decrease interleukin-6 (IL-6), interleukin-10 (IL-10), and CRP levels postoperatively to improve healing and pain control.² Scalp nerve blocks demonstrate a significant improvement in hemodynamic control compared to patients only receiving general anesthesia.²⁻⁴ Despite this, the patient complained of increased pressure around her scalp post-Mayfield pin placement. The increased pressure caused an increase heart rate and blood pressure. Pain control was supplemented with fentanyl boluses and blood pressure control goals were maintained with a nicardipine infusion. Additionally, nausea is a major concern post pin insertion, and postoperative nausea and vomiting may increase intracranial pressure (ICP). Scalp nerve blocks can indirectly decrease the incidence of PONV.² In this case, dexamethasone 10 mg and ondansetron 4 mg were administered at the beginning of the case and ondansetron 4 mg was given 30 minutes prior to ICU transport to aid in PONV prevention.

Alternative local anesthetics such as 0.75% ropivacaine have proven to be an effective choice for scalp nerve blocks.² Anesthesia professionals chose 0.5% bupivacaine for this procedure as research has shown 0.5% bupivacaine blunts the hemodynamic response and nociceptive stimuli with similar efficacy to injected 0.75% ropivacaine.² Determining which local anesthetic to use requires careful consideration to the amount administered based on the drug and patient weight in kilograms to prevent local anesthetic systemic toxicity (LAST). Alternative risks to awake craniotomies under moderate sedation include hypoxemia, hypercapnia, and airway obstruction.⁵ Spontaneous ventilation strategies include an SpO₂ > 95% and PaCO₂ 35 and 45 mmHg.⁵ A remifentanil and propofol infusion remain a popular choice for anesthesia professionals to support spontaneous ventilation.⁵ Dexmedetomidine and remifentanil infusions support spontaneous ventilation and provide a synergistic analgesic effect.⁶ This combination was used in conjunction with the scalp nerve block and fentanyl boluses to provide analgesia throughout the case.

Performing a scalp nerve block under moderate sedation provides an advantageous anesthetic as it improves pain control, reduces PONV, and allows surgeons to communicate with patients during the procedure.²⁻⁴ Anesthesia professionals must understand the cranial nerve distribution and the pharmacodynamics and pharmacokinetics of local anesthetics to administer an effective nerve block while providing adequate sedation to safely support spontaneous ventilation, comfort, and cooperation. Proper education should be provided to the patient by the anesthesia professionals and the surgeon prior to the surgery to discuss their role and expectations during the procedure.

References

1. Hyun Kim S, Ho Choi S. Anesthetic considerations for awake craniotomy. *Anesth Pain Med.* 2020;15(3):269-274. doi: 10.17085/apm.20050
2. Yang X, Ma J, Li K, et al. A comparison of effects of scalp nerve block and local anesthetic infiltration on inflammatory response, hemodynamic response, and postoperative pain in patients undergoing craniotomy for cerebral aneurysms: A randomized controlled trial. *BMC Anesthesiol.* 2019;19(91). doi: 10.1186/s12871-019-0760-4

3. Kwinta BM, MyszkA AM, Bigaj MM, et al. Intra-and postoperative adverse events in awake craniotomy for intrinsic supratentorial brain tumors. *Neurol Sci.* 2021;42:1437-1441. doi: 10.1007/s10072-020-04683-0
4. Sato T, Okumura T, Nishiwaki K. Preanesthesia scalp blocks reduce intraoperative pain and hypertension in the asleep-awake-asleep method of awake craniotomy: A retrospective study. *J Clin Anesth.* 2020;66. doi: 10.1016/j.jclinane.2020.109946
5. Abaziou T, Tincres F, Mrozek S, et al. Incidence and predicting factors of perioperative complications during monitored anesthesia care for awake craniotomy. *J Clin Anesth.* 2020;64. doi: 10.1016/j.jclinane.2020.109811
6. Shiraki A, Goto W, Fukagawa H, et al. Effects of low-dose remifentanyl infusion on analgesic or antiemetic requirement during brain function mapping: A retrospective cohort study. *Acta Anaesthesiol Scand.* 2020;64(6):735-741. doi: 10.1111/aas.13554

Mentor: Bimpe Adenusi, PhD, CRNA, APRN, CNE, FAANA

Anesthetic for a Malignant Hyperthermia Patient for Cardiac Surgery

Jennifer Perry, BSN
Cedar Crest College

Keywords: cardiac surgery, CABG, malignant hyperthermia, anesthesia, TIVA

Malignant hyperthermia (MH) is a rare genetic life-threatening disorder of the skeletal muscle. It is a hypermetabolic response triggered by volatile agents, the depolarizing muscle relaxant succinylcholine, and other stressors including exercise and heat.¹ While MH symptoms during cardiac surgery present the same as in other operations, providing anesthesia for a patient undergoing cardiac surgery with a history of MH can result in severe morbidity and mortality.² This case report describes the anesthetic management for a patient with MH undergoing cardiac surgery.

Case Report

A 74-year-old, 102.3 kg, 163 cm Caucasian female presented for an elective coronary artery bypass graft surgery. The patient's medical history included angina/chest pain, coronary artery disease, heart failure, hypertension, hyperlipidemia, malignant hyperthermia, gastro-esophageal reflux disease, liver dysfunction, renal disease, and diabetes mellitus type II. The patient reported a penicillin allergy and two previous MH reactions during anesthesia. The patient could not recall the outcomes and treatment of previous MH reactions. A caffeine halothane contracture test confirmed the MH diagnosis.

The patient was brought into the operating room (OR) and defibrillator pads were attached along with standard monitors including a pulse oximeter, electrocardiogram leads, and a blood pressure cuff. A lactated ringer infusion was attached to a pre-existing 20-gauge intravenous (IV) catheter in the right antecubital vein. The patient was pre-oxygenated with oxygen flows at 10 L/min. A right brachial arterial line and a 4 French peripheral IV catheter in the right upper extremity were

placed using ultrasound guidance. For line placement, the patient received fentanyl 150 mcg and midazolam 2 mg IV. Next, the patient was placed under anesthesia with fentanyl 350 mcg, lidocaine 100 mg, phenylephrine 50 mcg, propofol 80 mg, and rocuronium 50 mg IV. Tracheal intubation was successfully completed via video assisted laryngoscopy 4 and a 7.5mm cuffed endotracheal tube was secured at 21 cm at the teeth. The patient was ventilated using volume control mode with ventilator settings including tidal volume (Vt) 500mL, respiratory rate (RR) 12/min, and PEEP 5 cm H₂O. Goal end-tidal CO₂ was between 30-32 mmHg. General anesthesia was maintained with propofol infusion at 100 mcg/kg/min and midazolam infusion at 4 mg/hr IV. Last, a 9 French MAC 2 lumen 11.5 cm length central line was placed in the left internal jugular vein using ultrasound guidance. A pulmonary artery (PA) catheter was placed, advanced to 50 cm, and secured for continuous hemodynamic monitoring.

Prior to surgical incision, baseline values included central venous pressure (CVP) 13 mm Hg, pulmonary artery pressure (PAP) 30/21 mm Hg, cardiac index (CI) 2.4 L/min/m², and mixed venous oxygen saturation (SVO₂) 88%. Intraoperative temperature was monitored by PA catheter and an indwelling Foley catheter. Cardiopulmonary bypass (CPB) was initiated after confirmation of activated clotting times (ACT) greater than 400 seconds. The patient underwent therapeutic hypothermia and total body temperature was cooled to 32°C. Arterial blood gases were drawn every 20 minutes by perfusion with special attention to PaCO₂ and the base deficit. No major events occurred during rewarming and temperatures between PA and Foley catheters were maintained within 1°C difference. The CPB course was uneventful, and the patient was successfully weaned from CPB with norepinephrine infusions.

The patient was transported to the intensive care unit (ICU) on propofol 50 mcg/kg/min, norepinephrine 1 mg/min, and insulin 4 units/hr IV. Total CPB time was 80 minutes, clamp time 55 minutes with surgery time of 5 hours. Ventilator settings for transport were Vt 580 mL, RR 16/min, and PEEP 5 cm H₂O. An orogastric 18 French tube was placed. The patient had 3 chest tubes including 1 pleural and 2 mediastinal and epicardial pacemaker wires. Patient was atrioventricular paced using dual-chamber antibradycardia pacing (DDD) at a rate of 90/min. Estimated blood loss for the procedure was approximately 1,400 mL. Post-procedure hemodynamic values included CVP 7 mm Hg, PAP 31/9 mm Hg, CI 3.9 L/min/m², and SVO₂ 82%.

Discussion

Malignant hyperthermia is rare life-threatening genetic disorder involving mutations in the ryanodine receptor type 1 (RYR1). The main triggering substances include volatile anesthetics, the depolarizing muscle relaxant succinylcholine, strenuous exercise, and environmental heat. When an individual encounters triggering substances there is an excessive calcium release from the sarcoplasmic reticulum (SR) leading to skeletal muscle hyper-metabolism. The classical presentation of MH symptoms includes hypercarbia, sinus tachycardia, masseter spasm, hyperthermia, acidosis, muscle rigidity, hyperkalemia, and myoglobinuria. A halothane contracture test is considered the gold standard for MH diagnosis. Dantrolene is the drug of choice to treat MH for its suppression of calcium release from the SR. Due to the life-threatening nature of MH, it is important to undertake special precautions for these surgical patients.¹

There are limited recommendations for anesthesia management of MH patients undergoing cardiac surgery. So, a general anesthetic plan for MH patients that fit the cardiac surgery environment was followed. A thorough pre-operative evaluation along with surgical and anesthesia preparation is important for all patients undergoing surgery, especially those patients at risk or with a history of MH. The standard anesthetic assessment to evaluate for MH is through direct questioning.² Therefore, the preoperative preparation included obtaining pertinent medical history with added attention to the patients MH experiences. The patient reported having a history of MH with two previous MH triggers from anesthesia. The diagnosis of MH can be obtained through specialized tests on freshly excised muscle strips by open biopsy, known as the in-vitro contracture tests. The contracture test is considered the gold standard for diagnosis, however, genetic testing can also be done.³ Due to the patient's previous surgical MH exposures a halothane contract test was completed as part of the pre-procedure tests for this surgery.

Because of the patient's history of MH, it was important to rid the OR of MH triggers. The two main triggers of MH including volatile agents and succinylcholine were removed from the anesthesia machine and OR.⁴ The Drager Fabius anesthesia machine was used. This hospital had no dedicated anesthesia machine for MH-susceptible patients, so careful attention to the preparation of the anesthesia machine was completed. The vaporizers were removed from the machine and succinylcholine was removed from the Omnicell medication pyxis. Carbon dioxide absorbents were replaced and a new anesthesia circuit was attached. Fresh gas flow of 10L/min was run for 1-2 hours and low flows at 1L/hr were run throughout the night prior to the case. Charcoal filters can also be utilized, however, none were available at this hospital. An MH cart was moved outside the OR with dantrolene readily available. Prior to the surgical start, the proper weight based Dantrolene dosing was calculated. The isoflurane vaporizer was also removed from the CPB machine prior to the procedure start. The chance of a MH reaction is greatly decreased with preparation of the anesthesia machine and removal of all possible triggers.⁴

After OR preparation an anesthetic plan was tailored to avoid MH triggers. Due to the contraindication of volatile agents, a total intravenous anesthetic (TIVA) regimen should be implemented to reduce mortality in MH susceptible patients.⁴ This case utilized, a TIVA regimen using propofol and midazolam. Sufentanil infusions have also been utilized in TIVA anesthetic plans.⁵ Also, the use of non-depolarizing muscle relaxants, such as rocuronium is appropriate. The anesthesia plan specific for cardiac surgery needs to have consideration and appropriate monitoring in place during the rewarming phase of the surgery. It has been shown that rapid rewarming and administration of catecholamines might trigger an MH episode in those patients with MH susceptibility. Current research does not specify rewarming time, but states that rewarming should be done slowly with avoidance of core body temperatures greater than 36°C.⁵ In this case, the patient was monitored with cardiac monitors, continuous mixed venous oxygenation, and continuous cardiac output monitors. The patient's temperature between the PA and Foley catheter was maintained within 1°C and the patient was brought to the ICU with a temperature of 36°C.

Lastly, research has shown a possibility of a systemic inflammatory response from CPB which could trigger MH. Therefore, whenever possible it is recommended to avoid CPB and do an off-pump technique when only a CABG is required.⁵ In summary, limited studies are available for

anesthetic management of MH patients undergoing cardiac surgery. A TIVA anesthetic approach with careful consideration to the rewarming process should be utilized for all MH susceptible patients. Case reports should continue to be published to help identify best practices for managing MH patients undergoing cardiac surgery.

References

1. Yang L, Tautz T, Zhang S, Fomina A, Liu H. The current status of malignant hyperthermia. *J Biomed Res.* 2020;34(2):75-85. doi:10.7555/JBR.33.20180089
2. Ruffert H, Bastian B, Bendixen D, et al. Consensus guidelines on perioperative management of malignant hyperthermia suspected or susceptible patients from the European Malignant Hyperthermia Group. *Br J Anaesth.* 2021;126(1):120-130. doi:10.1016/j.bja.2020.09.029
3. Hopkins PM, Dalay GS, Jenkinds B, Thacker A, Patteril M, McGrady E. Malignant hyperthermia 2020: Guideline from the Association of Anaesthetists. *Anaesthesia.* 2021;76(5):655-664. doi:10.1111/anae.15317
4. Gupta PK, Bilmen JG, Hopkins PM. Anaesthetic management of a known or suspected malignant hyperthermia susceptible patient. *BJA Educ.* 2021;21(6):218-224. doi:10.1016/j.bjae.2021.01.003
5. Agarwal S, Graham K, Kigwana S, Castresana M. Successful management of hypothermic cardiopulmonary bypass in a malignant hyperthermia susceptible patient. *Ann Card Anaesth.* 2020;23(3):367-371. doi:10.4103/aca.ACA_245_18

Mentor: Bimpe Adenusi, PhD, APRN, CRNA, CNE, FAANA

Effect of Serratus Anterior Plane Block on Pain following Multiple Rib Fractures

Melisa Highfield, DNAP
Bryan College of Health Sciences

Keywords: rib fractures, serratus anterior plane block, pain scores, nerve block, opioid requirements

Introduction

Patients with multiple rib fractures (MRFs) are at an increased risk of morbidity from subsequent respiratory complications.¹ Adequately managed pain in patients with MRFs is pivotal in supporting pulmonary hygiene and preventing atelectasis.² Although opioids are commonly used to treat rib fracture pain, they are associated with deleterious side effects leading to further respiratory compromise.³ In the trauma patient, neuraxial anesthesia and paravertebral nerve blocks are limited due to the potential requirement for anticoagulation and the need for repositioning.² Additionally, intercostal and paravertebral nerve blocks place the patient at risk for developing pneumothorax and Horner's syndrome.⁴

The serratus anterior plane block (SAPB) is an ultrasound-guided technique in which local anesthetic is deposited between the serratus anterior and latissimus dorsi muscles.⁴ Analgesic

coverage to the hemithorax is provided by anesthetizing dermatomes T2 through T9.⁴ In comparison to other pain control methods, SAPB has a limited side-effect profile and can be accomplished in the supine position.⁴

Methods

A population, intervention, comparison, and outcome (PICO) question was developed as a framework to analyze current evidence. “In (P) adult patients with multiple rib fractures, what effect does (I) serratus anterior plane block (C) compared to no block have on (O) pain scores and opioid consumption?” Identification of relevant information involved a search limited to English language articles published between 2015 and 2022 utilizing the following databases: PubMed, Scopus, and Academic Search Elite. The following search terms were used alone and in combination: rib fractures, serratus anterior block, serratus plane block, serratus anterior plane block, and nerve block. This search yielded approximately 169 results from PubMed, 277 from Scopus, and 491 from Academic Search Elite. Studies were excluded if the research primarily focused on thoracotomy pain or compared SAPB to other blocks. Using the Johns Hopkins evidence level and quality guide, ten studies were evaluated including 2 randomized control trials (RCTs) (Level 1), 3 case series (Level 5), 1 retrospective cohort study (Level 2), 1 retrospective pilot study (Level 2), 1 retrospective observational cohort study (Level 2), 1 prospective interventional study (Level 2), and 1 prospective observational study (Level 2).

Literature Analysis

Adult trauma patients with MRFs and ultrasound-guided SAPBs were included in all studies.⁵⁻¹⁴ Pain scores measured in all 10 studies utilized a 0-10 numeric pain rating scale.⁵⁻¹⁴ A few researchers mentioned SAPB not being useful in posterior rib fracture pain,^{7,10,12} however, 3 studies utilized SAPB regardless of fracture location.^{5,11,13} Exclusion criteria included head injuries, emergent surgery, hemodynamic instability, morbid obesity, altered anatomy, puncture site infection, local anesthetic allergy, coagulopathy, communication barrier, neuropathy, liver/renal failure, or underlying lung injury.⁵⁻¹⁴ One study recruited patients regardless of body habitus and extent of injuries.¹¹ All participants involved received alternative forms of multimodal analgesia including but not limited to ketamine, non-steroidal anti-inflammatory medications, clonidine, acetaminophen, morphine, tramadol, fentanyl, and paracetamol.⁵⁻¹⁴ Of the 10 studies selected, 5 were purely descriptive.^{10,11,12,13,14} The other 5 studies included 2 RCTs, a retrospective cohort study, a retrospective pilot study, and a retrospective case series.⁵⁻⁹ A summary of these studies can be found in Table 1.

All but 1 of the 10 studies analyzed found substantial reductions in patient reported pain scores through SAPB administration.⁵⁻¹⁴ Although pain scores were not significantly different in this single study, pain scores for the SAPB group were reduced.⁹ This provides evidence that SAPB is an effective option in treating rib fracture pain while avoiding the side effects of opioid analgesics. Five of the 10 studies compared opioid requirements for patients with rib fractures and discovered meaningful reductions for those receiving an SAPB.^{5,7,9,12,13} Tramadol, morphine, fentanyl, and morphine equivalents were compared with consistently lower opioid consumption noted among the block group.^{5,7,9,12,13}

Studies comparing pain scores between SAPB and opioid only pain control recorded pain scores in the SAPB group that were consistently 2 to 3 times lower than the opioid group.^{5,6,7} Researchers that documented pain scores over multiple time intervals following SAPB noted a greater benefit over time.^{7,10,12} For example, Schnekenburger et al.¹² measured pain scores over 3 consecutive time intervals with more substantial reductions noted over an extended time period.

Unfortunately, there was significant variability among local anesthetic drug, dosing, and concentration for the SAPBs. However, a commonality found within the research was that a large volume of local anesthetic was most effective in providing adequate coverage.⁵⁻¹⁴ When comparing volumes, the average range was between 20 and 60mL at various concentrations of lidocaine, ropivacaine or bupivacaine.⁵⁻¹⁴ In these studies local anesthetic was delivered through either a single shot injection or via catheter with a continuous infusion.⁵⁻¹⁴ Complications with block placement were minimal and only noted when a catheter was advanced.^{9,14}

SAPB was effective in the management of rib fracture pain regardless of fracture location in this evidence-based practice analysis.^{5,11,13} Researchers assert that anticoagulated individuals can receive an SAPB because local anesthetic is injected into a compartment with clear landmarks distant from blood vessels.^{5,12} In the event of patient anticoagulation, catheter use should be avoided in individuals who are at a therapeutic level.⁸

Strengths of this evidenced-based practice analysis include the level of evidence and consistency in findings. Limitations include sample size, inconsistencies in local anesthetic dosing, and indistinguishable patient injuries. Another notable limitation was that all patients received alternative analgesia in addition to SAPB.⁵⁻¹⁴ A few limitations were noted regarding the research methods and data presentation. For example, Martel et al.¹⁴ grouped results for rib and hip fracture patients making it difficult to determine results attributed to SAPB. Martinez et al.⁹ were unclear in comparison variables for pain assessment at rest during utilization of SAPB and pain scores with coughing. These limitations highlight the need for additional robust research.

Table 1: Details and Findings of Research Articles Utilizing SAPB for Multiple Rib Fractures

Author/date/design/level of evidence/ # of participants	Alternative analgesia/ variables	Catheter or single shot/local used/dose	Findings/conclusions								
5) Tekşen et al., 2021 RCT Level 1 SAPB n=30 Tramadol only n=30	tramadol IV: SAPB vs tramadol only DV: 24-hour tramadol consumption & pain scores (30-min, 1hr, 2hr, 4hr, 6hr, 12hr, & 24hr)	Single shot Dose- 30mL 0.25% bupivacaine	<p>Mean 24-Hour Total Tramadol Consumption</p> <table border="1"> <tr> <td>SAPB</td> <td>98.33mg (+74.13)</td> </tr> <tr> <td>Tramadol only</td> <td>148.30mg (+87.68)</td> </tr> </table> <p>P=0.02</p> <p>Median (IQR) pain scores before intervention</p> <table border="1"> <tr> <td>SAPB</td> <td>5.5 (5-6.25)</td> </tr> <tr> <td>Tramadol only</td> <td>5 (3-6)</td> </tr> </table> <p>P=0.116</p>	SAPB	98.33mg (+74.13)	Tramadol only	148.30mg (+87.68)	SAPB	5.5 (5-6.25)	Tramadol only	5 (3-6)
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			<p>Median (IQR) pain scores after SAPB</p> <table border="1"> <thead> <tr> <th>Time</th> <th>SAPB</th> <th>Tramadol only</th> </tr> </thead> <tbody> <tr> <td>30-min^a</td> <td>1 (1-2)</td> <td>3 (2-4)</td> </tr> <tr> <td>1hr^a</td> <td>1 (1-1)</td> <td>3 (2-4)</td> </tr> <tr> <td>2hr^a</td> <td>1 (1-1)</td> <td>3 (2-4)</td> </tr> <tr> <td>4hr^a</td> <td>1 (1-1)</td> <td>3 (2-4)</td> </tr> <tr> <td>6hr^a</td> <td>1 (1-2.25)</td> <td>2.5 (2-4)</td> </tr> <tr> <td>12hr^b</td> <td>1 (1-3.25)</td> <td>2.5 (2-3.25)</td> </tr> <tr> <td>24hr^c</td> <td>1 (1-1)</td> <td>2 (2-2)</td> </tr> </tbody> </table> <p>^aP <0.001 ^bP=0.002 ^cP=0.026 Significant decrease in tramadol requirements & pain scores.</p>	Time	SAPB	Tramadol only	30-min ^a	1 (1-2)	3 (2-4)	1hr ^a	1 (1-1)	3 (2-4)	2hr ^a	1 (1-1)	3 (2-4)	4hr ^a	1 (1-1)	3 (2-4)	6hr ^a	1 (1-2.25)	2.5 (2-4)	12hr ^b	1 (1-3.25)	2.5 (2-3.25)	24hr ^c	1 (1-1)	2 (2-2)
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<p>6) El-Galil Abu-Elwafa et al., 2021</p> <p>RCT Level 1</p> <p>SAPB n=20</p> <p>morphine n=20</p>	<p>paracetamol, ketoralac</p> <p>IV: Before & after SAPB DV: Pain scores</p>	<p>Single shot</p> <p>Dose- 15mL 0.25% bupivacaine & 15mL 1% lidocaine</p> <p>Morphine group: Bolus- 0.1mg/kg Infusion- 10-20mcg/kg/hr</p>	<p>Mean Pain Scores</p> <table border="1"> <thead> <tr> <th></th> <th>SAPB</th> <th>Morphine</th> </tr> </thead> <tbody> <tr> <td>Before^a</td> <td>9.1 (+0.7)</td> <td>9.3 (±0.8)</td> </tr> <tr> <td>After^b</td> <td>0.6 (±0.7)</td> <td>1.15 (±0.8)</td> </tr> </tbody> </table> <p>^aP >0.05 ^bP <0.05 SAPB compared to morphine showed a significant reduction in pain scores.</p>		SAPB	Morphine	Before ^a	9.1 (+0.7)	9.3 (±0.8)	After ^b	0.6 (±0.7)	1.15 (±0.8)															
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<p>7) Diwan and Nair, 2021</p> <p>Retrospective Cohort Study Level 2</p> <p>SAPB n=38</p> <p>Fentanyl n=34</p>	<p>fentanyl, paracetamol</p> <p>IV: SAPB vs fentanyl DV: Pain scores in 6-hour intervals & 24-hour fentanyl use</p>	<p>Catheter</p> <p>Bolus- 25mL 0.2% ropivacaine with 50mcg clonidine Infusion- 8mL/hr 0.1% ropivacaine</p> <p>Fentanyl group: Bolus- 1.5mcg/kg Infusion- 0.5mcg/hr, PRN bolus 0.5mcg/kg for pain >4</p>	<p>Mean Pain Scores</p> <table border="1"> <thead> <tr> <th>Interval</th> <th>Fentanyl</th> <th>SAPB</th> </tr> </thead> <tbody> <tr> <td>6hr</td> <td>4</td> <td>2.6</td> </tr> <tr> <td>12hr</td> <td>6.3</td> <td>2</td> </tr> <tr> <td>18hr</td> <td>5.5</td> <td>2.4</td> </tr> <tr> <td>24hr</td> <td>5.8</td> <td>2.3</td> </tr> <tr> <td>30hr</td> <td>5.7</td> <td>2.6</td> </tr> </tbody> </table> <p>P <0.05</p> <p>Mean 24-Hour Fentanyl Consumption</p> <table border="1"> <tbody> <tr> <td>Fentanyl</td> <td>717.06mcg (+84.104)</td> </tr> <tr> <td>SAPB</td> <td>95.26mcg (±17.162)</td> </tr> </tbody> </table> <p>P=0.001 SAPB compared to fentanyl showed a significant reduction in pain scores and opioid consumption.</p>	Interval	Fentanyl	SAPB	6hr	4	2.6	12hr	6.3	2	18hr	5.5	2.4	24hr	5.8	2.3	30hr	5.7	2.6	Fentanyl	717.06mcg (+84.104)	SAPB	95.26mcg (±17.162)		
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<p>8) Hernandez et al., 2019</p> <p>Retrospective Pilot Study Level 2 n=34</p>	<p>“opioids”</p> <p>IV: Before & after SAPB DV: pain scores after 4 hours</p>	<p>Catheter for non-therapeutically anticoagulated. Single shot for therapeutic</p> <p>Dose- not provided, medications used: 0.25% & 0.5% bupivacaine with/without dexamethasone, 0.2% & 0.5% ropivacaine, or liposomal bupivacaine Infusion- 12mL/hr 0.2% ropivacaine</p>	<table border="1" style="width: 100%;"> <tr> <th colspan="2">Median (IQR) Pain Scores</th> </tr> <tr> <td>Pre-SAPB</td> <td>7 (6-9)</td> </tr> <tr> <td>4hr post-SAPB</td> <td>3 (0-4)</td> </tr> </table> <p>P <0.001 SAPB significantly reduced pain scores.</p>	Median (IQR) Pain Scores		Pre-SAPB	7 (6-9)	4hr post-SAPB	3 (0-4)																
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<p>9) Martinez et al., 2020</p> <p>Retrospective Case series Level 5 n=10</p>	<p>morphine, ketamine, NSAIDs, clonidine, acetaminophen, nefopam</p> <p>IV: Before & after SAPB DV: Morphine consumption and pain scores before/after, with coughing, & at rest</p>	<p>Catheter-7 Single shot-3</p> <p>Catheter: Bolus- 0.4mL/kg 1% lidocaine Infusion- 0.15mL/kg/hr 0.2% ropivacaine</p> <p>Single shot: 0.4mL/kg 0.325% ropivacaine</p>	<table border="1" style="width: 100%;"> <tr> <th colspan="2">Median (IQR) Opioid Use</th> </tr> <tr> <td>24hr pre-SAPB</td> <td>107.5mg (66.8-120)</td> </tr> <tr> <td>24hr post-SAPB</td> <td>18.5mg (0-57.8)</td> </tr> </table> <p>P=0.015</p> <table border="1" style="width: 100%;"> <tr> <th colspan="2">Median (IQR) Pain Scores at Rest</th> </tr> <tr> <td>24hr pre-SAPB</td> <td>2.7 (1.1-3.6)</td> </tr> <tr> <td>24hr post-SAPB^a</td> <td>0.7 (0-1)</td> </tr> <tr> <td>During utilization of SAPB^b</td> <td>2.2 (0.4-2.9)</td> </tr> </table> <p>^aP=0.1 ^bP=0.826</p> <table border="1" style="width: 100%;"> <tr> <th colspan="2">Median (IQR) Pain Scores with Coughing</th> </tr> <tr> <td>24hr pre-SAPB</td> <td>7.3 (5.3-8.8)</td> </tr> <tr> <td>24hr post-SAPB^c</td> <td>4 (3.6-4.6)</td> </tr> <tr> <td>During utilization of SAPB^d</td> <td>4.6 (4.1-4.9)</td> </tr> </table> <p>^cP=0.03 ^dP=0.006 SAPB significantly reduced opioid requirements & pain scores with coughing. Differences in pain scores at rest were not significant.</p>	Median (IQR) Opioid Use		24hr pre-SAPB	107.5mg (66.8-120)	24hr post-SAPB	18.5mg (0-57.8)	Median (IQR) Pain Scores at Rest		24hr pre-SAPB	2.7 (1.1-3.6)	24hr post-SAPB ^a	0.7 (0-1)	During utilization of SAPB ^b	2.2 (0.4-2.9)	Median (IQR) Pain Scores with Coughing		24hr pre-SAPB	7.3 (5.3-8.8)	24hr post-SAPB ^c	4 (3.6-4.6)	During utilization of SAPB ^d	4.6 (4.1-4.9)
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<p>10) Kring et al., 2022</p> <p>Prospective Interventional</p>	<p>“adjuncts”</p> <p>IV: Before & after SAPB DV: pain scores at</p>	<p>Single shot</p> <p>Dose- 20mL 0.5% bupivacaine</p>	<table border="1" style="width: 100%;"> <tr> <th colspan="2">Mean Pain Score Decrease</th> </tr> <tr> <th colspan="2">At Rest Post-SAPB</th> </tr> <tr> <td>15-min</td> <td>1.8 (+2.17, 95% CI 0.79-2.81)</td> </tr> </table>	Mean Pain Score Decrease		At Rest Post-SAPB		15-min	1.8 (+2.17, 95% CI 0.79-2.81)																
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<p>11) Paul et al., 2020 Case series Level 5 n=10</p>	<p>fentanyl IV: Before & after SAPB DV: pain scores after 30/60 minutes</p>	<p>Single shot Dose- 1mg/kg 0.25% bupivacaine</p>	<p>Median (IQR) Pain Score Reduction</p> <table border="1"> <tr> <td>Pre-SAPB</td> <td>9 (\pm 1.5)</td> </tr> <tr> <td>30-min post-SAPB</td> <td>5 (\pm 4)</td> </tr> <tr> <td>60-min post-SAPB</td> <td>7.5 (\pm 2)</td> </tr> </table> <p>SAPB reduced pain scores.</p>	Pre-SAPB	9 (\pm 1.5)	30-min post-SAPB	5 (\pm 4)	60-min post-SAPB	7.5 (\pm 2)								
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<p>12) Schnekenburger et al., 2021 Prospective Observational Study Level 2 n=20</p>	<p>morphine IV: Before & after SAPB DV: pain scores 30/60/240 min post-block & opioid use</p>	<p>Single shot Dose- 150mg ropivacaine</p>	<p>Median (IQR) Pain Scores</p> <table border="1"> <tr> <td>Pre-SAPB, utilizing morphine</td> <td>6.5 (6-8)</td> </tr> </table> <p>Median (IQR) Pain Scores After SAPB</p> <table border="1"> <thead> <tr> <th>Time Lapse</th> <th>Pain Score</th> </tr> </thead> <tbody> <tr> <td>30-min</td> <td>4 (1-5)</td> </tr> <tr> <td>60-min</td> <td>3 (1-5)</td> </tr> <tr> <td>240-min</td> <td>3 (2-5)</td> </tr> </tbody> </table> <p>Median (IQR) morphine Equivalents</p> <table border="1"> <tr> <td>Pre-SAPB</td> <td>27.5mg (15-51.2)</td> </tr> <tr> <td>24hr post-SAPB</td> <td>47.5mg (30-71.5)</td> </tr> </table> <p>SAPB reduced pain scores & morphine requirements.</p>	Pre-SAPB, utilizing morphine	6.5 (6-8)	Time Lapse	Pain Score	30-min	4 (1-5)	60-min	3 (1-5)	240-min	3 (2-5)	Pre-SAPB	27.5mg (15-51.2)	24hr post-SAPB	47.5mg (30-71.5)
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<p>13) Singh et al., 2021 Retrospective case series Level 5 n=7</p>	<p>morphine IV: Before & after SAPB DV: pain scores & morphine use</p>	<p>Single shot Dose- 40-60mL 0.25% ropivacaine</p>	<p>Median (IQR) Pain Scores</p> <table border="1"> <tr> <td>Pre-SAPB</td> <td>7 (IQR 3)</td> </tr> <tr> <td>Post-SAPB</td> <td>2.5 (IQR 1)</td> </tr> </table> <p>Median (IQR) Oral Analgesic Requirements (morphine equivalents)</p> <table border="1"> <tr> <td>Pre-SAPB</td> <td>23mg (IQR 18)</td> </tr> <tr> <td>Over 12hr post-SAPB</td> <td>6mg (IQR 15)</td> </tr> </table> <p>Reduced pain scores & analgesic requirements after SAPB.</p>	Pre-SAPB	7 (IQR 3)	Post-SAPB	2.5 (IQR 1)	Pre-SAPB	23mg (IQR 18)	Over 12hr post-SAPB	6mg (IQR 15)						
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14) Martel et al., 2020 Retrospective Observational Cohort Study Level 2 n=27	morphine	Catheter	Mean morphine equivalents	
	IV: Before & after SAPB	Bolus- 3mg/kg ropivacaine Infusion- 28mg/hr	Pre-SAPB	3.8mg/hr
	DV: opioid requirements & opioid use reduction		Post-SAPB	1.6mg/hr
			Hourly opioid use reduction: 58% SAPB reduced opioid requirements.	

IV: independent variable

DV: dependent variable

Min: minutes

Hr: hour

Conclusions

Ultrasound-guided SAPB is a safe and effective fascial plane block that can be advantageous in the management of pain due to multiple rib fractures. Adverse side effects associated with opioid analgesics have resulted in consideration of alternative pain management modalities. Unlike regional analgesia techniques, opioids can have negative consequences on the patient's minute ventilation and airway patency.³ Pain management in patients with MRFs is essential in optimizing pulmonary hygiene by providing the ability to take deeper breaths and avoid splinting.³ Additionally, SAPB allows for flexibility since it can be placed without the need for repositioning or halting anticoagulation therapy.² SAPB is a versatile technique that can be added to a multimodal treatment plan for patients experiencing rib fracture pain. In conclusion, SAPB has proven to be effective in decreasing rib fracture pain and opioid requirements.

References

1. McGuinness MJ, Ferguson LR, Watt I, Harmston C. Outcomes in patients with fractured ribs: middle aged at same risk of complications as the elderly. *N Z Med J.* 2021;134(1540):38-45.
2. Thiruvengatarajan V, Cruz Eng H, Adhikary SD. An update on regional analgesia for rib fractures. *Curr Opin Anaesthesiol.* 2018;31(5):601-607. doi: 10.1097/ACO.0000000000000637
3. Martin TJ, Eltorai AS, Dunn R, Varone A, Joyce MF, Kheirbek T, Adams C Jr, Daniels AH, Eltorai AEM. Clinical management of rib fractures and methods for prevention of pulmonary complications: A review. *Injury.* 2019;50(6):1159-1165. doi: 10.1016/j.injury.2019.04.020
4. Blanco R, Parras T, McDonnell JG, Prats-Galino A. Serratus plane block: a novel ultrasound-guided thoracic wall nerve block. *Anaesth.* 2013;68(11):1107-13. doi: 10.1111/anae.12344
5. Tekşen Ş, Öksüz G, Öksüz H, et al. Analgesic efficacy of the serratus anterior plane block in rib fractures pain: A randomized controlled trial. *Am J Emerg Med.* 2021;41:16-20. doi:10.1016/j.ajem.2020.12.041
6. El-Galil Abu-Elwafa WA, Ragab IA, Abdelrahman AH, Mahmoud WA. Comparative study between efficacy of serratus anterior muscle block as a regional analgesia technique and I.V morphine infusion in patient with fracture ribs. *Egypt J Hosp Med.* 2021;82(2):348-353

7. Diwan S, Nair A. A retrospective study comparing analgesic efficacy of ultrasound-guided serratus anterior plane block versus intravenous fentanyl infusion in patients with multiple rib fractures. *J Anaesthesiol Clin Pharmacol*. 2021;37(3):411-415. doi:10.4103/joacp.JOACP_349_19
8. Hernandez N, de Haan J, Clendeninn D, et al. Impact of serratus plane block on pain scores and incentive spirometry volumes after chest trauma. *Local Reg Anesth*. 2019;12:59-66. doi:10.2147/LRA.S207791
9. Martinez T, Belveyre T, Lopez A, et al. Serratus plane block is effective for pain control in patients with blunt chest trauma: A case series. *Pain Pract*. 2020;20(2):197-203. doi:10.1111/papr.12833
10. Kring RM, Mackenzie DC, Wilson CN, Rappold JF, Strout TD, Croft PE. Ultrasound-Guided serratus anterior plane block (SAPB) improves pain control in patients with rib fractures. *J Ultrasound Med*. 2022. doi:10.1002/jum.15953
11. Paul S, Bhoi S, Sinha T, Kumar G. Ultrasound-guided serratus anterior plane block for rib fracture-associated pain management in emergency department. *J Emerg Trauma Shock*. 2020;13(3):208-212. doi:10.4103/JETS.JETS_155_19
12. Schneckenger M, Mathew J, Fitzgerald M, Hendel S, Sekandarzad MW, Mitra B. Regional anaesthesia for rib fractures: A pilot study of serratus anterior plane block. *Emerg Med Australas*. 2021;33(5):788-793. doi:10.1111/1742-6723.13724
13. Singh P, Sakharpe A, Kaur J, et al. Efficacy of serratus anterior plane block in pain control in traumatic posterior rib fractures: A case series. *Trauma*. 2021:1. doi:10.1177/14604086211046779
14. Martel ML, Robidoux MR, Morris JL, Reardon RF. Feasibility and initial experience with continuous nerve blocks by emergency physicians. *Am J Emerg Med*. 2020;38(6):1203-1208. doi:10.1016/j.ajem.2020.02.038

Mentor: Sharon Hadenfeldt, PhD, CRNA

Education to Increase Train-of-Four Ratio Use by Anesthesia Practitioners

Frank Bougher, DNP
Barnes-Jewish College

Keywords: neuromuscular monitoring, residual neuromuscular blockade, delayed emergence from anesthesia, and objective monitoring

Introduction

The patient monitored without an accelerometer that produces a train-of-four ratio (TOFR) is at risk for residual neuromuscular blockade (rNMB). The occurrence of rNMB on arrival to the post-anesthesia care unit ranges from 20-40%.¹ There is a significant risk for pulmonary complications such as hypoxia and aspiration with the potential for fatality if not recognized.² With the utilization of TOFR, rNMB occurred in only 1.6% of patients compared to 32% without TOFR use.³ TOFR is superior to other monitoring techniques and reduces the incidence of complications related to rNMB, improving patient safety and outcomes.² The purpose of this project was to determine if an education intervention founded on evidence-based neuromuscular monitoring leads to increased use of TOFR

in practitioner practice, improved knowledge, and confidence in monitoring techniques. The goal of the project was to improve patient safety by reducing the risk of rNMB through increased TOFR knowledge and use.^{2,4,5}

Design and Methods

Participants were anesthesia practitioners in a large academic medical center, specifically in operating rooms with TOFR capabilities. Two weeks of recruitment with flyers and in-person engagement took place. Using a pre-intervention/post-intervention design, a custom survey was utilized to assess participant use, knowledge, and confidence regarding TOFR and neuromuscular monitoring. The intervention was a prerecorded PowerPoint presentation viewed by participants asynchronously during the intervention week. Intervention effectiveness was evaluated by comparison of pre/post mean scores of the participants. Additionally, a retrospective electronic health record (EHR) data extraction, for the thirty-day period prior to intervention, assessed the baseline TOFR use and was compared to 30-day and 60-day post-intervention TOFR rate of use.

Outcome

A total of 9 (53%) out of the initial 17 participants completed the study and were included in the statistical analysis. All the participants were CRNAs, the majority in the 30–39-year age group and full-time employment status. Participants reported the percentage of patients for which they used TOFR prior to extubation over the last 30 days. Mean scores (% of questions correct) for pre-intervention, post-intervention, 30-day post-intervention, and 60-day post-intervention were 69.23, 45.83, 75.0, and 72.22 respectively. Participant confidence level in applying and interpreting TOFR monitor mean scores for pre-intervention, post-intervention, 30-day post-intervention, and 60-day post-intervention were 94.23, 75.0, 75.0, and 91.67% respectively. Knowledge was assessed through 13 survey questions and the mean scores pre-intervention, post-intervention, 30-day post-intervention, and 60-day post-intervention were 52.05, 84.60, 83.07, and 81.19% respectively. The pre-intervention mean score was compared to post-intervention, 30-day post-intervention, and 60-day post-intervention mean scores using paired t-tests ($p < 0.05$).

The EHR data evaluated a total of 7,183 cases in which either rocuronium, vecuronium, or cisatracurium was administered. The TOFR rate of use for the 4-week pre-intervention and 8-week post-intervention periods were 0.15% (378/2525) and 0.14% (650/4658) respectively. A two-sample Z test compared the overall TOFR rate of use proportions ($p=.238$). Wilcoxon rank-sum test compared weekly TOFR rate of use pre-intervention and post-intervention ($p=.2141$).

Conclusion

New knowledge was gained by participants evidenced by significant change in survey mean scores pre-intervention versus post-intervention. There was no statistical difference in TOFR rate of use. A pre-recorded education is a practical way to present evidence-based education to increase knowledge of neuromuscular monitoring among practitioners. Limitations to this project include a small sample size and short time for data collection. Additionally, the study took place in a subset of operating rooms with TOFR capabilities, which limits its application to other operating rooms or hospitals. Recommendations include repeating the study with longer data collection periods, a larger group of participants, and including other hospitals.

References

1. Rudolph MI, Ng PY, Deng H, Scheffenbichler FT, Grabitz SD, Wanderer JP, Houle TT, Eikermann M. Comparison of a novel clinical score to estimate the risk of Residual neuromuscular block Prediction Score and the last train-of-four count documented in the electronic anaesthesia record: A retrospective cohort study of electronic data on file. *Eur J Anaesthesiol.* 2018;35(11):883-892. doi: 10.1097/EJA.0000000000000861.
2. Raval AD, Anupindi VR, Ferrufino CP, Arper DL, Bash LD, Brull SJ. Epidemiology and outcomes of residual neuromuscular blockade: A systematic review of observational studies. *J Clin Anesth.* 2020;66:109962. doi: 10.1016/j.jclinane.2020.109962.
3. Domenech G, Kampel MA, García Guzzo ME, Novas DS, Terrasa SA, Fornari GG. Usefulness of intra-operative neuromuscular blockade monitoring and reversal agents for postoperative residual neuromuscular blockade: a retrospective observational study. *BMC Anesthesiol.* 2019;19(1):143. doi: 10.1186/s12871-019-0817-4.
4. Saager L, Maiese EM, Bash LD, Meyer TA, Minkowitz H, Groudine S, Philip BK, Tanaka P, Gan TJ, Rodriguez-Blanco Y, Soto R, Heisel O. Incidence, risk factors, and consequences of residual neuromuscular block in the United States: The prospective, observational, multicenter RECITE-US study. *J Clin Anesth.* 2019;55:33-41. doi: 10.1016/j.jclinane.2018.12.042.
5. Stewart PA, Liang SS, Li QS, Huang ML, Bilgin AB, Kim D, Phillips S. The impact of residual neuromuscular blockade, oversedation, and hypothermia on adverse respiratory events in a postanesthetic care unit: A prospective study of prevalence, predictors, and outcomes. *Anesth Analg.* 2016;123(4):859-68. doi: 10.1213/ANE.0000000000001513.

Mentor: Abby Bisch, DNP, CRNA

Goal-Directed Fluid Therapy for Colorectal Surgery

Sarah Cantrell, BSN, Karli Nihei, BSN, Susanna Smith, BSN
Kaiser Permanente School of Anesthesia

Keywords: goal-directed fluid therapy, colorectal surgery, surgical site infection

Introduction

Colorectal surgery is associated with adverse outcomes, including an over 30% incidence of surgical site infection (SSI).¹⁻² Anesthesia practitioners can reduce the incidence of SSI through preventative measures such as goal-directed fluid therapy (GDFT).³⁻⁵ GDFT utilizes dynamic indices of fluid status, such as stroke volume variation and plethysmography variability index, to guide fluid resuscitation and prevent complications associated with improper fluid management.⁴⁻⁵ The purpose of this project was to evaluate the compliance of anesthesia practitioners in using GDFT following an educational training module. Secondary outcomes included the rate of SSI, other surgical complications, and length of hospital stay.

Design and Methods

An education training module and fluid therapy decision tool for colorectal surgery patients were presented to anesthesia practitioners at a single-site acute care hospital. A subsequent retrospective chart review was conducted. The final sample size was 20 patients and included adult colorectal surgery cases that met the criteria for GDFT between December 2021 and May 2022. Anesthesia practitioner compliance with the clinical decision support tool was analyzed using descriptive analysis. Fisher's exact test compared secondary outcomes in patients that received < 2500 mL and those that received \geq 2500 mL of crystalloid fluid. Fisher's exact test also compared secondary outcomes in patients that received any blood product and those that did not. Spearman rank-order correlation coefficient analysis explored associations between patients' American Society of Anesthesia (ASA) Physical Status Classification and length of stay.

Outcome

There was a lack of anesthesia practitioner compliance with GDFT. Although one patient had documented dynamic indices of fluid status, the patient was administered an inappropriate crystalloid fluid volume (\geq 2500 mL). The rate of SSI and other complications were not associated with the fluid volume administered. Post hoc analysis found a significant association between fluid volume administered and bleeding requiring intraoperative blood transfusion ($p = .018$). There was a significant association between blood product administration and postoperative kidney complications ($p = .013$). A strong, positive correlation was found between the assigned ASA Physical Status Classification level and the length of hospital stay ($r = .646, p = .002$).

Conclusion

The lack of anesthesia practitioner compliance with GDFT was attributed to an inadequate familiarity with the clinical decision support tool and resources for monitoring. This project found a significant association between fluid volume and bleeding requiring blood product transfusion. This can be attributed to the nature of intravascular volume replacement. However, the hemodilution of intravascular procoagulants necessitating blood product transfusion should also be considered. Anesthesia practitioners must remain mindful of the significant relationship between blood product administration and kidney complications. Lastly, higher ASA Physical Status Classifications should alert the anesthesia practitioner to the possibility of prolonged hospitalization in colorectal surgery patients. This project was limited by sample size and a lack of practitioner proficiency with equipment function.

References

1. Caroff DA, Wang R, Zhang Z, et al. The limited utility of ranking hospitals based on their colon surgery infection rates. *Clin Infect Dis*. 2021;72(1):90-98. doi:10.1093/cid/ciaa01
2. Zywot A, Lau CSM, Fletcher HS, Paul S. Bundles prevent surgical site infections after colorectal surgery: meta-analysis and systematic review. *J Gastrointest Surg*. 2017;21(11):1915-1930. doi:10.1007/s11605-017-3465-3

3. Turner MC, Migaly J. Surgical site infection: The clinical and economic impact. *Clin Colon Rectal Surg.* 2019;32(3):157-165. doi:10.1055/s-0038-1677002
4. Ansari BM, Zochios V, Falter F, Klein AA. Physiological controversies and methods used to determine fluid responsiveness: a qualitative systematic review. *Anaesthesia.* 2016;71(1):94-105. doi:10.1111/anae.13246
5. Cesur S, Çardaközü T, Kuş A, Türkyılmaz N, Yavuz Ö. Comparison of conventional fluid management with PVI-based goal-directed fluid management in elective colorectal surgery. *J Clin Monit Comput.* 2019;33(2):249-257. doi:10.1007/s10877-018-0163-y

Mentor: Mark Gabot, DNP, CRNA, FAANA

Editorial

Having traveled to Seattle, Washington for the 2023 AANA Annual Congress last month, I am reminded of how grateful I am to be a part of this great profession. I appreciate all of the hard work by our association's leadership and staff in orchestrating this event. Having the opportunity to meet face-to-face with the people responsible for representing and supporting our practice and educational programs in so many ways inspires me, and reinforces the idea that we are all working together toward a common goal. The support I have received from my fellow CRNAs in sustaining and growing this student journal is an example of that.

To those of you reading this now, just by doing so you affirm this work - spread the word! Join as a reviewer, mentor a student, or encourage a classmate to submit a report. It's hard to believe Ron Van Nest started this gem over twenty years ago – let's keep it going for another 20 and beyond!

Sincerely,



Vicki Callan, PhD, CRNA, CHSE, FAANA
Editor

INTERNATIONAL STUDENT JOURNAL OF NURSE ANESTHESIA GUIDE FOR AUTHORS

MISSION STATEMENT

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

ITEM PREPARATION & SUBMISSION

Case reports, research abstracts, evidence-based practice (EBP) analysis reports, evidence-based practice project abstracts, and letters to the editor may be submitted. These items must be authored by a student under the guidance of an anesthesia practitioner mentor (CRNA or physician). Case reports must be single-authored, while EBP analysis reports and abstracts may have multiple authors. Submissions may list only one mentor. **Mentors should take an active role** in reviewing the item to ensure appropriate content, writing style, and format prior to submission. The mentor must submit the item for the student and serve as the contact person during the review process. Items submitted to this journal should not be under consideration with another journal. Authors and mentors should critically evaluate the topic and quality of the writing – multiple reviews of the item by the mentor, faculty, and peers (fellow graduate students) prior to submission is recommended. If the topic and written presentation are beyond the introductory publication level we strongly suggest that the article be submitted to a more prestigious publication such as the *AANA Journal*.

The journal is committed to publishing the work of nurse anesthesia students. The review process is always initiated with the following rare exceptions. We are conservative in accepting reports where the patient has expired, realizing that you can do everything right and still have a negative outcome. Submissions that report a case demonstrating failure to meet the standard of care (by any practitioner involved in the case) will not be accepted. Unfortunately, while the experiences in these cases can offer valuable insight, these submissions will not be accepted for review due to potential legal risks to the author, journal, and anyone else involved in evaluating the report.

It is the intent of this journal to publish items while the author is still a student. In order to consistently meet this goal, all submissions must be received by the editor at least **3 months prior** (4-6 months recommended) to the author's date of graduation. Manuscripts must be submitted by the mentor of the student author via e-mail to **INTSJNA@aol.com** as an attachment. The subject line of the e-mail should use the following format: ISJNA Submission_submission type_author last name_mentor last name. The item should be saved in the following format – two-three word descriptor of the article_author's last name_school abbreviation_mentor's last name_date (e.g. PedsPain_Smyth_GU_Pearson_5.19.09)

REVIEW PROCESS

Items submitted for publication are initially reviewed by the chief editor. If the chief editor does not acknowledge receipt of the item within two weeks, please inquire to ensure receipt. Upon receipt, the chief editor will review the submission for compliance with the Guide to Authors. If proper format has not been followed, the item will be returned to the mentor for correction. This is very important as all reviewers serve on a volunteer basis. Their time should be spent ensuring appropriate content, not making format corrections. It is the mentor and author's responsibility to ensure formatting guidelines have been followed prior to submission.

All accepted submissions undergo a formal process of blind review by at least two reviewers. After review, items may be accepted without revision, accepted with revision, or rejected with comments. Once the item has been accepted for review the chief editor will assign a submission number and send a blinded copy to an editor, who will then coordinate a blinded review by two reviewers who are not affiliated with the originating program. Submissions are reviewed using the Track Changes function of Word. The editor will return the item to the chief editor, who will return it to the mentor for appropriate action. **The mentor should guide the author through the revision process. The revised copy must be returned clean (no comments or Track Changes) with the original submission number in the filename and subject line of the email.** Every effort is made to complete the process in an efficient, timely matter. Again, the goal is for all articles submitted by students to be published while the author is still a student. If an item is not ready for publication within 6 months after the student author has graduated it will no longer be eligible for publication. Mentors will be listed as contributing editors for the issue in which the item is published.

PHOTOS

Photos of students for the front cover of the Journal are welcome. Please contact the chief editor at intsjina@aol.com to submit photos for consideration. Only digital photos of high quality will be accepted. If the photo is accepted, consent forms must be completed and returned by all identifiable individuals in the photo, and the individual who took the photo.

ACADEMIC INTEGRITY

Issues of academic integrity are the responsibility of the author and mentor. Accurate and appropriate acknowledgement of sources is expected. The two most common breaches of academic integrity that have been identified in submissions to this journal are (AMA 11th ed., 5.4.2):

1. Direct plagiarism: verbatim lifting of passages without enclosing the borrowed material in quotation marks and crediting the original author.
2. Paraphrase: restating a phrase or passage, providing the same meaning but in a different form without attribution to the original author.

Please note that changing one or two words in a reference source passage (e.g. 'of' for 'in', or 'classified' for 'categorized') and then citing it as a paraphrase or summary is also not appropriate, and still falls within the definition of direct plagiarism. If plagiarism in any form is identified, review of the item will be suspended and it will be returned to the mentor. Repeated instances of plagiarism will result in rejection of the item.

Plagiarism detection software (Scribbr, TurnItIn, PlagScan, SafeAssign, etc . . .) can be used to analyze the document prior to submission to ensure proper citation and referencing, but is not required.

“Plagiarism is the presentation of someone else’s ideas, writings, or statements as one’s own. Plagiarism is a serious breach of academic integrity, and anyone who is found to have committed plagiarism will be subject to disciplinary action.

Paraphrase is the act of putting someone else’s ideas into one’s own words. The use of paraphrase can be an acceptable practice under some circumstances if it is used sparingly and if the original text is properly acknowledged. Unacknowledged paraphrase, like plagiarism, is a serious breach of academic integrity. Any improper use of sources may constitute plagiarism. Every quotation from another source, whether written, spoken, or electronic, must be bound by quotation marks and be properly cited. Mere citation alone is not sufficient when a scholar has used another person’s words. Similarly, every paraphrase or summary (a more concise restatement of another's ideas) must be properly cited.”

<https://sites.google.com/a/georgetown.edu/gsas-graduate-bulletin/vi-academic-integrity-policies-procedures>

GENERAL GUIDELINES

Items for publication **must adhere to the *American Medical Association Manual of Style*** (AMA 11th ed., the same guide utilized by the *AANA Journal* and such prominent textbooks as *Nurse Anesthesia* by Nagelhout and Elisha). Section numbers from the online version are provided for easy reference in the AMA Manual of Style throughout this document. The review process will not be initiated on items submitted with incorrect formatting and will be returned to the mentor for revision.

Reference: Christiansen S, Iverson C, Flanagan A, et al. *AMA Manual of Style: A Guide for Authors and Editors*. 11th ed. Oxford University Press; 2020.

Please note the following:

1. Use complete sentences.
2. Acronyms/Initialisms (2.1.5, 10.6, 13.9) - spell out with first use, do not capitalize the words from which the acronym/initialism is derived unless it is a proper noun or official name. If you are using the phrase only once, do not list the acronym/initialism at all. Avoid beginning sentences with acronym/initialisms.
3. Abbreviations (13.0)
4. Use *Index Medicus* journal title abbreviations (3.11.2, <http://www.ncbi.nlm.nih.gov/nlmcatalog/journals>)
5. Always provide units of measure (17.0). In most cases The International System of Units (SI) is used. Abbreviations for units of measure do not need to be spelled out with first use. Report height in cm, weight in kg, temperature in °C, pressure in mm Hg or cm H₂O. Report heart and respiratory rate as X/min (e.g. the patient’s heart rate increased to 145/min). The manual includes a complete list of SI units (17.1 – 17.5).

6. In general, first use of pulmonary/respiratory abbreviations should be expanded, with the following exceptions: O₂, CO₂, PCO₂, PaCO₂, PO₂, PaO₂, EtCO₂, N₂O. Please use SpO₂ for oxygen saturation as measured by pulse oximetry.
7. Use the nonproprietary (generic) name of drugs (2.1.3, 10.3.5) - avoid proprietary (brand) names. Type generic names in lowercase. When discussing dosages state the name of the drug, *then* the dosage (midazolam 2 mg).
8. Use of descriptive terms for equipment and devices is preferred. If the use of a proprietary name is necessary (for clarity, or if more than one type is being discussed), give the name followed by the manufacturer in parenthesis (e.g. a GlideScope (Verathon Inc.) was used) (14.5.1). Please note, TM and ® symbols are not used per the AMA manual.
9. Infusion rates and gas flow rates:
 - a. Use mcg/kg/min or mg/kg/min for infusion rates. In some cases it may be appropriate to report dose or quantity/hr (i.e. insulin, hyperalimentation). If a mixture of drugs is being infused give the concentration of each drug and report the infusion rate in mL/min.
 - b. Report gas flow of O₂, N₂O and Air in L/min (not %) and volatile agents in % as inspired or expired concentration (e.g. General anesthesia was maintained with sevoflurane 3% inspired concentration in a mixture of O₂ 1 L/min and air 1 L/min.)
10. Only Microsoft Word file formats will be accepted with the following criteria:
 - a. Font - 12 point, Times New Roman
 - b. Single-spacing (except where indicated), paragraphs separated with a double space (do not indent)
 - c. One-inch margins
 - d. End the sentence with the period before placing the superscript number for the reference.
 - e. Do not use columns, bolds (except where indicated), or unconventional lettering styles or fonts.
 - f. Do not use endnote/footnote formats.
11. If referencing software is used (Endnote, Zotero, etc.), any embedded formatting must be removed prior to submission.
12. Remove all hyperlinks within the text.
13. Avoid jargon and slang terms. Use professional, scholarly, scientific language.
 - a. *'The patient was reversed'* - Did you physically turn the patient around and point him in the opposite direction? "Neuromuscular blockade was antagonized."
 - b. *The patient was put on oxygen.* "Oxygen 2 L/min was administered via face mask."
 - c. *The patient was intubated and put on a ventilator.* "The trachea was intubated and mechanical ventilation was initiated."
 - d. *An IV drip was started.* "An intravenous infusion was initiated."
 - e. Avoid the term "MAC" when referring to a sedation technique - the term sedation (light, moderate, heavy, unconscious) may be used. Since all anesthesia administration is monitored, pharmacologic, rather than reimbursement, terminology should be used.
14. Direct quotes are discouraged for reports of this length – please express in your own words.
15. Use the words "anesthesia professionals" or "anesthesia practitioners" when discussing all persons who administer anesthesia (avoid the reimbursement term "anesthesia providers").
16. Do not include ASA Physical Status unless it is germane to the report.
17. Do not use the phrase "ASA standard monitors were applied". Instead, "standard noninvasive monitors" is acceptable – additional monitoring can be detailed as needed.
18. References
 - a. The **AMA Manual of Style must be adhered to** for reference formatting.
 - b. All sources should be published within the past 8 years. Seminal works essential to the topic being presented will be considered.
 - c. Primary sources are preferred.
 - d. **A maximum of one textbook (must be most recent edition available) may be used as reference for case report submissions only.**
 - e. All items cited must be from peer-reviewed sources – use of sources found on the internet must be carefully considered in this regard. URLs must be current and take the reader directly to the referenced source.

Heading – for all submission types (Case Report, Abstract, EBPA Report) use the following format.

1. **Title** is bolded, centered, 70 characters (including spaces) or less
2. Author name (academic credentials only) and NAP are centered, normal font
3. *Graduation date and email address* are centered, italicized, and will be removed prior to publication)
4. **Keywords** is left-justified, bolded – list keywords that can be used to identify the report in an internet search

Title
Author Name
Name of Nurse Anesthesia Program
Anticipated date of graduation
E-mail address

Keywords: keyword one, keyword two, etc.

Case Reports - The student author must have had a significant role in the conduct of the case. The total word count should be between 1200 – 1400 words (references not counted). Case reports with greater than 1400 words will be returned to the mentor for revision prior to initiation of the review process. The following template demonstrates the required format for case report submission.

Heading (see above)

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

Case Report (400-600 words)

This portion discusses the case performed and is written in the *past tense*. Do not justify actions or behaviors in this section; simply report the events as they unfolded. Present the case in an orderly sequence. Some aspects need considerable elaboration and others only a cursory mention. Under most circumstances if findings/actions are normal or not contributory to the case then they should not be described. Events significant to the focus of the report should be discussed in greater detail. The purpose of the case report is to set the stage (and 'hook' the reader) for the heart of your paper which is the discussion and teaching/learning derived from the case.

- Give dosage and schedule only if that information is pertinent to the consequences of the case.
- **Significant** laboratory values, x-rays or other diagnostic testing pertinent to the case. Give the units of measure after the values (eg. Mmol/L or mg/dL).
- Physical examination/pre-anesthesia evaluation - **significant** findings only.
- Anesthetic management (patient preparation, induction, maintenance, emergence, post-operative recovery).

Discussion (600-800 words)

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

References

A minimum of 5 references is recommended, with a maximum of 8 allowed. One textbook may be used as a reference – it must be the most recent edition. All references should be no older than 8 years, except for seminal works essential to the topic. This is also an exercise in searching for and evaluating current literature.

Mentor: mentor name, credentials

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

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

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

The same general format guidelines apply with the exception of the section headings as below. Textbooks and non-peer reviewed internet sources may not be used, and sources of reference should be less than 8 years old unless they are seminal works specifically related to your topic of inquiry. A maximum of 16 references is allowed.

Heading

Introduction (bold)

Briefly introduce the reader to the practice issue or controversy, describe the scope or significance or problem, and identify the purpose of your analysis. Describe the theoretical, conceptual, or scientific framework that supports your inquiry.

Methods (bold)

Include the format used for formulating the specific question you seek to answer, search terms and methods used, and levels of evidence.

Literature Analysis (bold)

Analyze and critique the literature relevant to your question, determining scientific credibility and limitations of studies reviewed. Your synthesis table is included in this section. Please follow AMA formatting guidelines for your table (4.1.2, 10.2.3). Your review and discussion of the literature should logically lead to support a practice recommendation. Subheadings may be used if desired.

Conclusions (bold)

Summarize the salient points that support the practice recommendation and make research-supported recommendations that should improve the practice issue, while also acknowledging any limitations or weaknesses

[space]

References (bold, 16 maximum)

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

E-mail address: (normal text, will be removed prior to publication)

Evidence Based Practice Project Abstracts - Evidence-based practice project abstracts are limited to 600 words. References do not impact the word count - a maximum of 5 are allowed. Note that the abstract is different from a project proposal. The following format should be used:

Heading

Introduction (bold)

A brief introductory paragraph including purpose (what change is intended) and rationale (why change is needed/evidence to support the change) here.

Design and Methods (bold)

Include population, intervention, and measures

Outcome (bold)

Present results from statistical analysis – do not justify or discuss here.

Conclusion (bold)

Discuss results (implications). Optionally include limitations, suggestions for future projects/research.

References (bold, 5 maximum)

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

E-mail address: (normal text, will be removed prior to publication)

Research Abstracts - Research abstracts are limited to 600 words. References do not impact the word count - a maximum of 5 are allowed. Note that the abstract is different from a research proposal. The following format should be used:

Heading

Introduction (bold)

A brief introductory paragraph including purpose and hypotheses.

Methods (bold)

Include sample and research design

Results (bold)

Present results from statistical analysis – do not justify or discuss here.

Discussion (bold)

Discuss results (implications, limitations, suggestions for future research)

References (bold, 5 maximum)

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

E-mail address: (normal text, will be removed prior to publication)

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

AMA MANUAL OF STYLE

The following is brief introduction to the *AMA Manual of Style* reference format along with some links to basic, helpful guides on the internet. The website for the text is <http://www.amamanualofstyle.com/oso/public/index.html>. It is likely your institution's library has a copy on reserve. Journal names should be in italics and abbreviated according to the listing in the [PubMed Journals Database](#). PubMed can also be used to perform a search: <http://www.ncbi.nlm.nih.gov/pubmed>. The International Student Journal of Nurse Anesthesia (ISJNA) is not listed in the PubMed Database. For the purpose of citing the ISJNA *in this Journal* use "**Int Student J Nurse Anesth**" as the abbreviation.

Journals (3.11) - A comma is placed after the first initials until the last author, which has a period. If there are six or less authors **cite all six**. If there are more than six authors **cite only the first three** followed by "et al." Only the first word of the title of the article is capitalized. The first letters of the major words of the journal title are capitalized. There is no space between the year, volume number, issue number, and page numbers. If there is no volume or issue number, use the month. If there is an issue number but no volume number use only the issue number (in parentheses). Page numbers are inclusive - **do not omit digits** (note - some online journals do not use page numbers). Some journals may be available both as hard copies and online. When referencing a journal that has been accessed online, the DOI (digital object identifier) or PMID (PubMed identification number, 3.15.2) should be included (see examples below).

Journal, 6 or fewer authors:

Han B, Liu Y, Zhang X, Wang J. Three-dimensional printing as an aid to airway evaluation after tracheotomy in a patient with laryngeal carcinoma. *BMC Anesthesiol*. 2016;16(6). doi:10.1186/s12871-015-0170-1

Journal, more than 6 authors:

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

Elayi CS, Biasse L, Bai R, et al. Administration of isoproterenol and adenosine to guide supplemental ablation after pulmonary vein antrum isolation. *J Cardiovasc Electrophysiol*. 2013;24(11):1199-1206. doi: 10.1111/jce.12252

Electronic references (3.15) - Only established, peer-reviewed sources may be referenced. Please do not reference brochures, fact sheets, or informational websites where a peer-review process cannot be confirmed. The accessed date may be the only date available. The URL must be functional and take the reader directly to the source of the information cited.

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

Examples:

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

Howlader N, Noone AM, Krapcho M, Garshell J, Miller D, et al. SEER Cancer statistics review, 1975-2012. National Cancer Institute. Published April 2015. Updated November 18, 2015. Accessed February 29, 2016. http://seer.cancer.gov/csr/1975_2012

Textbooks (3.12) - There are two types of books – 1) those that are fully authored by one or more individuals, and 2) those that are edited by one or more individuals, with chapters authored by different individuals. Edited textbooks give primary credit to the chapter authors, who are listed first, and the inclusive page numbers of the entire chapter are provided at the end. Textbooks that are authored do not have different chapter authors and the chapter titles are

not listed, but the inclusive page numbers where the information was found are provided, unless the entire book is cited.

Authored text:

Shubert D, Leyba J, Niemann S. *Chemistry and Physics for Nurse Anesthesia*. 3rd ed. Springer; 2017:405-430.

Chapter from an edited text (3.12.4):

Pellegrini JE. Regional anesthesia. In Nagelhout JJ, Elisha S, eds. *Nurse Anesthesia*. 6th ed. Elsevier; 2017:1015-1041.

International Student Journal of Nurse Anesthesia
SUBMISSION CHECKLIST

- Adheres to AMA Manual of Style and all other format instructions**
- The item is one continuous Word document without artificially created page breaks
- All matters that are not common knowledge to the author are referenced appropriately
- Generic names for drugs and products are used throughout and spelled correctly in lower-case
- Units are designated for all dosages, physical findings, and laboratory results
- Endnotes, footnotes not used
- Jargon/slang is absent
- Heading**
- Concise title less than 70 characters long (including spaces)
- Author name, credentials, nurse anesthesia program, graduation date, and email are included
- Three to five **Keywords** are provided
- Case Report**
- Total word count <1400, Introduction < 100, Case Report 400-600, Discussion 600-800.
- Case Report section states only those facts vital to the account (no opinions or rationale)
- Discussion of the case management is based on a review of current literature
- Discussion concludes with lessons learned and how the case might be better managed in the future
- Abstracts**
- Total word count <600
- Appropriate format used depending on type of abstract (research vs. EBP/QI project)
- EBPA Report**
- Total word count <3000
- A critical evaluation of a practice pattern in the form of a precise clinical question about a specific intervention, population, and outcome is presented
- A focused foreground question following either the PICO or SPICE format is used
- The Literature Analysis section has a synthesis table
- References**
- Adheres to AMA Style format
- Reference numbers are sequenced beginning with 1 and superscripted
- References are from anesthesia and other current (within the past 8 years) primary source literature
- Journal titles are abbreviated as they appear in the PubMed Journals Database
- Number of references adheres to specific item guidelines (one textbook allowed for case reports only)
- Internet sources are currently accessible, reputable, and peer-reviewed
- Submission**
- The article is sent as an attachment to **INTSJNA@AOL.COM**
- Item is submitted by the mentor
- The filename is correctly formatted (e.g., PedsPain_Smyth_GU_Pearson_5.19.23)
- Email Subject heading format - ISJNA Submission_submission type_author last name_mentor last name (e.g., ISJNA Submission_Case Report_Smyth_Pearson_5.19.23)