Interscalene Nerve Block Catheter for Pain Control After Shoulder Surgery in an Obese Diabetic With Obstructive Sleep Apnea

Colby Parks, M.D.
Kristopher M. Schroeder, M.D.
University of Wisconsin, Madison, WI

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Stem Case and Key Questions Content
A 67-year-old man with a past medical history significant for obesity (BMI 40), obstructive sleep apnea, and insulin dependent diabetes mellitus presents for ambulatory shoulder arthroscopy. The patient has no past surgical history and laboratory analysis is unremarkable.

Describe the pathophysiology and typical presentation of OSA?
What is the prevalence of OSA?
What is the danger of undiagnosed or untreated sleep apnea?
How does OSA impact the risk of a perioperative adverse event?
How does/should the diagnoses of OSA impact scheduling of shoulder arthroscopy in this patient? Is the ambulatory setting appropriate?

The patient has had the diagnosis of OSA for 5 years. The patient reports that he religiously uses CPAP therapy at home. The patient’s spouse reports that prior to CPAP therapy, the patient experienced significant periods of apnea. In the preoperative area, the patient asks about postoperative analgesic options.

What perioperative agents might work to decrease the need for opioid analgesics?
What are options for postoperative analgesia following shoulder arthroscopy?
What are the risks of interscalene nerve blockade and interscalene catheter placement?
How does the patient’s diagnosis of OSA impact the decision to insert a peripheral nerve catheter?
How does the volume of injection impact the duration and degree of phrenic nerve blockade following interscalene nerve blockade?
Would a suprascapular or supraclavicular nerve block be appropriate?
The patient's wife is a nurse and she asks about a new kind of local anesthetic that "lasts for days." What are the potential dangers associated with the off-label use of liposomal bupivacaine formulations for interscalene blockade? What, if any, local anesthetic additives might be appropriate to prolong the duration of analgesia from a single-shot interscalene block?

Ultimately the decision is made to insert an interscalene catheter. Following catheter placement and negative test dose, the catheter is dosed with 10 ml 0.5% bupivacaine. The patient is then sent home with an infusion of ropivacaine 0.2% at a basal rate of 6 ml/hr with the ability to provide a 3 ml bolus every 30 minutes. The patient is given instructions and is discharged home with 1/10 pain.

The night of POD #0, the patient calls with increasing pain. The pump appears to be functioning normally. How would you evaluate and treat?

On POD #1, the patient complains of subjective dyspnea. How would you evaluate/treat? Despite turning off the infusion for 3 hours, the patient continues to complain of dyspnea. How would you now evaluate? What is the risk of DVT/PE in ambulatory/orthopedic patients?

On POD #3 during attempted catheter removal, the patient complains of paresthesias that radiate into the thumb. What might be happening, how can this risk be minimized and how should this catheter be removed?

**Model Discussion Content**

Pathophysiology of OSA

Obstructive sleep apnea (OSA) is a sleep disorder of the upper airway that results in periodic airway obstruction, hypercapnea and blood oxygen desaturation. OSA plagues an increasingly large population of patients presenting for ambulatory surgery. This is at least partly related to the ongoing obesity epidemic where one-third of all adults are now obese. The prevalence of OSA in the general population aged 30-70 is 5% in women and 14% in men. The incidence of OSA in surgical patients is likely higher (10-20%) than the general population and many of these patients, while symptomatic, may not carry a diagnosis of OSA. In fact, 75-80% of patients with OSA may be undiagnosed and therefore untreated.

In obese patients, 40% likely carry a diagnosis of OSA and 70% of those with OSA are obese. Furthermore, the incidence of OSA in patients presenting for weight loss surgery is 70%. There are multiple other factors associated with increased incidence of OSA including craniofacial deformities (macroglossia, retroglossia, acromegaly, Down syndrome, achondroplasia), ENT conditions (septal deviation, tonsillar and adenoidal hypertrophy, laryngomalacia, tracheomalacia), endocrine diseases (Cushing disease, hypothyroidism), connective tissue diseases (Marfan syndrome), male gender, age >50 years of age, female menopause, neck circumference greater than 40 cm, positive family history,
smoking and alcohol consumption. Unfortunately for patients with OSA, this condition can be associated with a number of adverse medical outcomes including myocardial ischemia, heart failure, hypertension, arrhythmias, cerebrovascular disease, metabolic syndrome, insulin resistance, gastroesophageal reflux and obesity.

OSA is definitively diagnosed via either overnight polysomnography or sleep study. The apnea hypopnea index (AHI) is used during these tests to determine the number of sleep related events per night (apneic event defined as cessation of airflow for >10 seconds or with blood oxygen desaturation of 4% or greater). The American Academy of Sleep Medicine has determined that 5 sleep related events per hour is sufficient to warrant a diagnosis of mild OSA, 15-30 events corresponds to moderate OSA and greater than 30 events per hour indicates severe OSA. The presence of OSA related symptoms (daytime sleepiness, loud snoring or observed obstruction) may influence the classification of OSA. Since sleep studies can be costly, questionnaires have been developed to screen patients to determine their risk for significant sleep apnea symptoms. There are a number of available questionnaires and most have a high sensitivity but low specificity for the prediction of OSA. One of these is the STOP-BANG questionnaire. Patients with a STOP-BANG questionnaire score of 0-2 are said to be at low risk, 3-4 at intermediate risk and 5-8 at high risk for OSA. Use of the STOP-BANG questionnaire is 84%, 93% and 95% sensitive for detecting mild, moderate and severe OSA.

STOP-BANG Screening Questionnaire (yes/no)

- S Snoring: Do you snore loudly (louder than talking or loud enough to be heard through closed doors)?
- T Tired: Do you often feel tired, fatigued or sleepy during the daytime?
- O Observed: Has anyone observed you stop breathing during your sleep?
- P Blood Pressure: Do you have or are you being treated for high blood pressure?
- B BMI: BMI >35 kg/m²?
- A Age: Age >50 years?
- N Neck Circumference: Neck circumference >40 cm?
- G Gender: Male?

Anesthesia and OSA

Patients presenting for surgery with a diagnosis of OSA have an increased incidence of a number of comorbid medical conditions including hypertension, diabetes mellitus, pulmonary arterial hypertension and congestive heart failure. These conditions should be investigated via review of the patient’s medical record and a thorough history and physical. Patients with OSA presenting for surgery have an elevated risk for postoperative hypoxemia, multiple laryngoscopy attempts, more difficult laryngoscope view grades, fiberoptic intubation, intraoperative hemodynamic instability (increased administration of ephedrine, metoprolol, and labetalol), delirium and prolonged hospital admissions. More serious perioperative events including higher re-intubation rates, cardiac arrhythmias, myocardial injury, unanticipated ICU admission and perioperative death have also been

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associated with OSA. The mechanism of increased perioperative risk may be alterations in the systemic inflammatory process, oxidative stress, endothelial dysfunction and imbalance in sympathetic/parasympathetic activities. 4,8 Appropriate CPAP therapy prior to surgery may reduce the risk of postoperative complications; therefore, appropriate preoperative diagnosis and treatment of OSA is imperative. 9

Should general anesthesia be required, difficulty with airway management should be anticipated. Consideration should be given to adequate preoxygenation (potentially delivered with the addition of CPAP), optimal positioning (i.e. ramp or reverse trendelenberg positioning) and ensuring back-up airway securement devices (i.e. videolaryngoscopes, bronchoscopes) are available. Gastric acid/content reduction strategies (antacids, prokinetics, etc) and rapid sequence intubation may also be appropriate. In addition, efforts should be made to utilize short-acting opioids and inhaled agents. Agents that minimize perioperative opioid requirements including NSAIDs, COX-2, inhibitors, ketamine and acetaminophen should be strongly considered. Gabapentin and alpha-2 agonists may also be useful but the risk of sedation should be considered. Regional anesthesia techniques may allow for the avoidance of airway manipulation and greatly reduce perioperative opioid requirements. However, phrenic nerve paralysis may be tolerated poorly in patients with severe obesity or OSA. Therefore, ultrasound guidance, minimizing the volume of local anesthetic injected, catheter techniques and distal approaches to the brachial plexus (i.e. axillary block or suprascapular block when appropriate) that result in phrenic nerve sparing should be considered. 10 Research that focuses specifically on regional anesthesia techniques in patients with OSA is scanty published. In a database analysis of 30,000 patients with OSA undergoing hip or knee arthroplasty, those who received a neuraxial anesthetic suffered fewer pulmonary complications, blood transfusions, need for mechanical ventilation and ICU admission. 11

Emergence from general anesthesia in patients with severe OSA can be complicated by difficulty with airway patency. Whenever possible, these patients should be extubated awake, with full reversal of muscle relaxation and in a semi-upright position. CPAP therapy should be promptly provided following general anesthesia. Instructing patients to bring their own CPAP machines may decrease the need for respiratory therapist involvement. Extended postoperative monitoring may be appropriate in patients with severe OSA or in those experiencing perioperative OSA related events (apnea/desaturation). Sleeping in a semi-upright position and application of prescribed CPAP therapy should be strongly encouraged following anesthesia.

The ability to perform ambulatory surgery in patients with OSA is likely dependent on a number of patient and surgical factors. Patient comorbidities, severity of sleep apnea and likelihood of compliance with pre-/postoperative CPAP therapy should strongly influence decision-making regarding the safety of ambulatory surgery in OSA patients. The type of surgery can impact the safety of ambulatory surgery in OSA patients in a number of ways. Airway surgery (i.e. sinus surgery) that does not allow the use of postoperative CPAP may be an indication for postoperative hospital
admission to ensure adequate ventilation following surgery. The severity of postoperative pain and the requirement for opioid therapy may also strongly impact the ability to perform ambulatory surgery in OSA patients. Finally, the support system and monitoring capabilities of those responsible for caring for a patient after discharge may impact the appropriateness of ambulatory surgery. The American Society of Anesthesiologists has published guidelines to assist in decision making when attempting to determine if patients are appropriate for ambulatory surgery. 6,12,13 In any case, patients with OSA require longer postoperative monitoring prior to discharge home to ensure that no difficulties with pain management or airway obstruction occur.

Interscalene Nerve Blocks and Catheters for Shoulder Surgery

Interscalene nerve blocks are commonly used for post-operative pain control after shoulder surgery. Typically, they are used in conjunction with a general anesthetic, but they can be used as the primary anesthetic as well. Interscalene nerve blocks have been repeatedly shown to improve pain scores, decrease opioid requirements, shorten PACU stay and accelerate discharge when compared to other methods such as subacromial infusions or multimodal techniques using opioids, acetaminophen and NSAIDS. 14,15 While single injection techniques have been successfully utilized for a number of years, there is some evidence suggesting that continuous catheter infusion techniques may result in improved pain control, decreased opioid consumption and increased patient satisfaction. 16 A continuous infusion may be more beneficial in patients with more invasive procedures such as open rotator cuff repair, as opposed to arthroscopy. 14,17,18

While effective, the placement of a catheter carries risk of additional complications beyond those of single injection interscalene block techniques. These may include catheter dislodgement, pain at insertion site, pump malfunction, infection, noncompliance and difficult removal (retained catheter). However, a retrospective review of 509 catheter placements found an overall adverse outcome in only 6.7% of patients, a majority of which were pain related. Only one serious complication occurred, a pneumothorax, and there were no infections. 19

There have been several case reports of retained ambulatory nerve block catheters. 20,21 The overall incidence of this rare complication is unknown. It is thought to occur more frequently in patients who have a stimulating catheter in place and are removing the catheter themselves at home versus having the catheter removed by a medical provider. 21 Some of the difficulties in removal have been attributed to knotting or kinking of the catheter. Other possible causes may include inflammation/adhesions around the catheter tip or tissue becoming pinched between the wire coils of the catheter tip. 21,22 Additionally, the catheter may simply cause irritation on attempted removal, causing the patient pain and the perception that it is difficult to remove. In any case, the patient should been seen promptly by a medical provider with experience removing catheters who can facilitate imaging and surgical consultation if necessary. A small bolus of saline through the catheter or a dilator over the catheter will often dislodge it, but sedation or an operative procedure may be necessary. 20,21 Potential strategies to avoid retained catheters may include: limiting the length of the catheter to
3-5 cm beyond the needle tip, avoiding stimulating catheters or having the catheter removed at a surgical follow-up appointment within a few days post-operatively.

Volume of Injection of Local Anesthetic for Interscalene Nerve Block
Interscalene blocks have traditionally been performed using high volumes (30-40 ml) of local anesthetic. However, through the use of ultrasound guidance, there has been recent emphasis on using lower volumes in an attempt to avoid complications. For example, the incidence of hemidiaphragmatic paralysis is 100% after high-volume interscalene block. Two studies have reported using less than 1 ml volumes of 0.5% bupivacaine for successful interscalene block using ultrasound guidance. Falcão et al. estimated that volumes less than 4.3 ml would reliably avoid hemidiaphragmatic paralysis. In addition, Vandepitte et al. achieved a 100% success rate for surgical anesthesia with 7 ml ropivacaine 0.75% through an interscalene catheter. Avoiding respiratory complications by using smaller volumes of local anesthetic may prove useful when treating post-op shoulder pain for patients with significant respiratory disease.

Additives to Local Anesthetics
A large number of agents have been evaluated as additives to local anesthetics in an effort to increase duration or quality of anesthesia. In addition to the more common additives discussed below, other possible additives may include ketamine, dexmedetomidine, magnesium, tramadol, neostigmine or midazolam.

Epinephrine is routinely used to prolong duration of an interscalene nerve block. This is primarily achieved by local vasoconstriction leading to decreased absorption and removal of local anesthetic from the site of action. Typical doses are 2.5-5 mcg/ml. This effect is more pronounced with lidocaine and mepivacaine compared to ropivacaine or bupivacaine.

Buprenorphine is a partial mu opioid agonist that has been used at doses of 150-300 mcg to prolong peripheral nerve blockade including interscalene block. There seems to be a greater effect when buprenorphine is administered perineurally rather than intramuscularly or intravenously. This supports the theory that the drug has a direct effect on neural tissue in addition to its mu agonist properties. Dexamethasone, a glucocorticoid, has been used to significantly lengthen interscalene block. In some studies with bupivacaine and ropivacaine, dexamethasone has almost doubled the duration of anesthesia. Typical doses are 4-8 mg. Dexamethasone does have an analgesic effect when administered intravenously as well.

Clonidine is an alpha-two agonist that has been shown to prolong peripheral nerve blockade by approximately two hours. The most common dose reported is 150 mcg. Unfortunately, the hemodynamic effects of clonidine may limit its use.

Optimizing the Home-going/Ambulatory Peripheral Nerve Catheter Program
1. Appropriate patient selection
   a. General patient compliance
   b. Patient willingness to have catheter placed and in place for several days at home
   c. Patient (or caregiver) willingness and ability to care for catheter at home
   d. Patient (or caregiver) ability to communicate with providers
   e. Consideration of patient comorbidities

2. Patient Education
   a. Protection and inspection of insensate limb
   b. Dressing and catheter care
   c. Infusion pump function
   d. Pain management and use of rescue medications
   e. Management of adverse effects
   f. Written informational literature

3. Accurate placement by experienced providers

4. Appropriate selection of local anesthetic, infusion rate, bolus amount and bolus frequency

5. Easy to use and reliable infusion pump

6. Call system in place allowing access to a knowledgeable provider 24 hours/day

7. Structured system for follow-up

References