Case Information

- Hypospadias Repair
- 7 month old
- 8.6 kg
- Male
- ASA 1
- Medications: No home medications
- Allergies: NKDA
- Labs/Tests: None drawn

Past Medical History:
- Hypospadias, cephalohematoma at birth, umbilical hernia, and born preterm (35 weeks)

Surgical History:
- No prior surgical hx

Airway evaluation:
- Unable to be determined due to child's age and cooperativeness

Intraoperative Issues

- Upon completion of the procedure, sevo was discontinued and the patient was placed on 100% FiO2. Within seconds after discontinuing the sevo, the patient's oxygen saturations decreased from 100% to 75%
- It was determined that the patient was experiencing a bronchospasm and epinephrine 10 mcg IV push was given and the patient was manually ventilated via the ETT
- Approximately two minutes later, the patient again experienced a bronchospasm. The ETT was still in place at this time. Oxygen saturations quickly dropped to around 20% despite treatment with epinephrine

Anesthetic Course

- Induction:
  - An inhalational induction was utilized with 70% nitrous oxide, 30% oxygen, and sevoflurane at 8%
  - 24 gauge IV started, gas reduced to 5% and 10 mcg of fentanyl and 10 mg propofol given
  - Intubated with a 3.5 cuffed ETT

- Maintenance:
  - Expiratory sevoflurane concentration ranged from 2.5-3.5% throughout the case
  - PCV utilized with tidal volumes ranging from 50-70 mL

- Intra-op Meds:
  - Zofran 1 mg
  - Ancef 245 mg
  - LR 250 mL
  - Surgeon performed penile block; therefore no additional narcotics needed

Risk factors for developing a perioperative bronchospasm

- Higher ASA classification
- Recent upper respiratory tract infection
- Prematurity
- Low birth weight
- Children age 0 to 9 years; with highest incidence occurring in children 0 to 3 months old
- History of asthma
- Previous or current eczema
- Family history of eczema, asthma or hay fever in two or more relatives
- Wheezing occurring more than three times during the previous 12 months
- Exposure to passive smoke
- Type of anesthetic
- Type of procedure


Kayla Stiles, SRNA

UND Nurse Anesthesia Student Presentations
2016 Fall Educational Meeting
North Dakota Association of Nurse Anesthetists
Bismarck, ND

Identifying Risk Factors for Bronchospasms in the Pediatric Patient
Passive Smoke Exposure

- Children exposed long term to second-hand smoke are 3.5 times more likely to have airway and pulmonary complications such as bronchospasm, wheezing, coughing, stridor, increased mucus production, and oxygen desaturation following anesthesia.
- During anesthesia, the incidence of bronchospasm in patients not exposed to second-hand smoke compared to those exposed to passive smoke increased from 0.8% to 8.3%. In the recovery room, the incidence of bronchospasm in patients not exposed to second-hand smoke versus those exposed to passive smoked increased from 1.3% to 6.5%.

Upper Respiratory Tract Infection

- Causes increased airway reactivity, a propensity for the development of atelectasis and mucous plugging of the airways, and an increased likelihood for developing postoperative arterial hypoxemia.
- In children with a URI, the risk of developing adverse respiratory events, such as bronchospasm, laryngospasm, hypoxemia, atelectasis, croup, and stridor, is increased by as much as two to seven times.
- Most URI's are viral in origin; When the virus penetrates the epithelium and mucosa, the development of airway inflammation, edema, and bronchoconstriction occurs making the airway more sensitive to secretions and volatile agents.
- How long to postpone surgery???

Asthma

- One of the most common chronic diseases in the world with the incidence increasing.
- The degree of airway inflammation and remodeling of the airways varies in each patient who suffers from asthma.
- The incidence of perioperative adverse respiratory events are increased in children with asthma compared to adults with asthma: 1. Increased airflow obstruction can occur due to reduced airway diameter and 2. Increased and more viscous mucous secretions along with epithelial damage and shedding can clog their airways.

Miscellaneous Risk Factors

- One study found that factors easily obtained from a preoperative assessment, including respiratory symptoms, eczema, or a family history of asthma, rhinitis, eczema, or exposure to second-hand smoke, were associated with an increased risk for the occurrence of perioperative adverse respiratory events.
- The risk of bronchospasm was ten times higher in patients with a nocturnal dry cough than in patients without.
- When sevoflurane was used to maintain anesthesia, the incidence of bronchospasm was increased by 10% versus if sevoflurane was used.
- A history of wheezing with exercise or more than three episodes in the past 12 months was associated with a greater risk of perioperative bronchospasm compared with the presence of a recent URI.

Miscellaneous Risk Factors

- Eczema, rhinitis, or asthma in at least two family members increased the risk of potentially life threatening complications, such as laryngospasm and bronchospasm, by nearly three times.

Etiology

- Anaphylaxis to a medication that was given
- Reaction to blood products
- Possible latex allergy
- Inadequate depth of anesthesia
- Manipulation of the airway during times of light anesthesia
- Airway soiling due to secretions, blood, or aspiration
**Diagnosis**

Manifestations can vary significantly depending on the severity of the spasm
- May manifest as an audible wheeze
- An upward slope of the end-tidal carbon dioxide monitoring with a rise in end-tidal carbon dioxide may occur
- A decrease in oxygen saturations along with a decrease in tidal volume
- Manually ventilating these patients can become extremely difficult
- Might also see prolonged expiration and increased peak inspiratory pressures

**Differential Diagnosis**

- Endobronchial intubation
- Obstruction of the ETT secondary to increased secretions or blood
- Pulmonary aspiration
- Kinked ETT
- In non-intubated patients, acute laryngospasms can mimic bronchospasms and produce upper airway noise, reduced breath sounds, and difficulty in ventilation
- Other causes such as pulmonary edema or pneumothorax should also be considered

**Treatment**

1. Remove offending agent and start 100% FiO₂
2. Call additional staff if needed
3. Increase anesthetic depth via propofol, ketamine, or volatile agent
4. Verify correct position of ETT. Did it migrate distally?
5. Manually ventilate patient

**Recommendations**

- Choosing an anesthetic strategy that minimizes the risk of perioperative adverse respiratory events is key in patients with multiple risk factors
- In a study performed by von Ungern-Sternberg et al., (2009), premedication of the child with a beta 2 agonist such as albuterol has been demonstrated to be effective in preventing increases in total respiratory resistance and in decreasing the incidence of perioperative bronchospasm
- Children who presented with a moist cough in the two weeks prior to surgery who received a premedication with albuterol demonstrated a significant reduction in the incidence of perioperative bronchospasm (5.5% vs 11%) and severe coughing (5.5% vs 11.5%) compared with children who had a respiratory tract infection but did not receive albuterol

**Conclusion**

- It is important to remember that regardless of the patient’s medical history, severe bronchospasms can still occur despite the presence or absence of risk factors. However, awareness and identification of these risk factors along with pretreatment when applicable could result in fewer perioperative adverse respiratory events

_Sources: Dewachter et al., 2011; Fitzpatrick, 2006; Nagelhout & Planc, 2010; Plaus & von Ungern-Sternberg, 2013;
Linck, 2007; Linck, 2010; Plaus et al., 2011; Regli & von Ungern-Sternberg, 2010; von Ungern-Sternberg et al., 2006; von Ungern-Sternberg et al., 2011_
Anesthesia Management of a Cesarean Section Patient Following Failed Spinal Anesthesia

Katie Ryan, SRNA

Thank You
Are There Any Questions?

Anesthesia Management of a Cesarean Section Patient Following Failed Spinal Anesthesia

Katie Ryan, SRNA

Thank You
Are There Any Questions?

Introduction

• “Birth by cesarean section (C/S) accounts for over 30% of all deliveries and is performed over 1.5 million times annually in the United States.”

• Anesthetic of choice for parturients undergoing C/S

• Importance of determining the risk factors for spinal anesthesia failure and identify problems that are potentially correctable
  – Prevention & improvement in failure rates can be made to improve patient care, safety, and outcomes

References


References


Case Information

• Surgical Procedure: Cesarean Section (C/S) with Tubal Ligation
• Age: 25 year
• Weight: 74kg
• ASA: 1
Pre-Operative Evaluation

• Past Medical History: GERD & Asthma
• Surgical History: C/S (failed spinal)
• Pre-op VS: BP-116/78, HR-66, RR-16, T-36, SpO2-99%
• Pertinent labs/ EKG/chest X-ray, etc.: Platelets 242,000
• Airway evaluation: Mallampati I

Anesthetic Course

• Drugs: 1.4 ml of bupivacaine 0.75%, fentanyl 20 mcg, morphine 0.2 mg
• Technique:
  − L3-L4 interspace
  − Skin anesthetized with 3ml of 1% lidocaine
  − Mid-line approach with 25G Whitacre needle through introducer needle
  − Return of clear and free flow CSF

Intraoperative Issues

• Surgeon performed skin test → patient reported “a sharp pain”
• Lidocaine injected by surgeon at the surgical incision site
• 5 minutes later another skin test performed & patient denied any discomfort
• Tolerated incision & complained of only minor discomfort with pushing & pulling sensations that were “tolerable, but increasing”

Intraoperative Issues

• After delivery: Increasing complaints of pain and facial grimacing
• For last 45 minutes of the case, SAB supplemented with:
  − Fentanyl 325mcg, midazolam 2mg, & propofol infusion 50-75mcg/kg/min
  − Mixture of N20 5L/min & O2 3L/min via face mask
• Spontaneous ventilation maintained by patient without intervention

Discussion

• Characteristics of a successful spinal: right place, right drug, & right dose
  − Right place: Injection within the subarachnoid space in the CSF that is continuous with nerve structures (nerve roots, cauda equine, & medullary cone)
  − Facilitate penetration & action at the level of the axonal membrane
  − Blockade of dermatome level T4 is required for C/S (Prasad & Filho, 2010)

PACU

• Alert and oriented with O2 3L/min via nasal cannula
• Denied pain and nausea
• Stated lower extremities felt “weak and heavy”
• Fentanyl PCA started within 2 hours of arrival to the PACU for postoperative pain
• 24 hours later, the patient stated she had adequate pain control postoperatively with fentanyl PCA & denied paraesthesias/weakness to lower extremities
Discussion

Anesthetic of Choice
- General anesthesia
  - Less effective postoperative pain control
  - More residual sedation
  - Risk of maternal death is 16.7 times greater (Nagelhout & Plaus, 2014)
- Epidural Anesthesia:
  - Decreased risk of LAST (Nagelhout & Plaus, 2014)

Failed Spinal Anesthesia
- Definition
- Incidence
- Causes

Needle insertion & injection
- Consideration if attempting below 4th lumbar interspace: L.A. may become 'trapped' below natural lumbar curve of the spine, making injection attempts through the sacral segments (especially if the patient is in the sitting position) difficult.
- Rukew et al. (2015)
  - 3,568 cesarean deliveries: injection at the L4/5 interspace, rather than the L3/4 interspace, was more likely to result in failed spinal
- Imbelloni et al. (1995)
  - 778 spinal anesthetics: no association of failure with level of puncture site
- Luer connection

Needle Details
- Needle Length:
  - Longer needles & larger lateral holes associated with failed blocks as they are more likely to be only partially introduced into the subarachnoid space.
  - To prevent introduction of the needle a little deeper after the backflow of CSF is observed & observe the free flow of CSF before & intermittently during the injection (Praxedes & Filho, 2020).
- Needle gauge:
  - Imbelloni et al. (1995): 27 gauge needles associated with a significantly lower incidence of block failure when compared to 27 gauge and 29 gauge needles
- Needle type:
  - Rukew et al. (2015): Did not establish any association of type of needle (such as a Quincke vs Sprotte) with incidence of failure rate
  - Quincke vs Sprotte: higher incidence of block failure

Clear Fluid is Not CSF
- Flow of the L.A. from the epidural after 'loading up'
- Needle insertion into a congenital cyst (Arachnoid, synovial, ganglion, Torlov's & dermoid cysts, & cystic neumomas)
  - Torlov cysts: Estimated incidence 4.3-9% of the population & these % found to be increasing due to more frequent use of MRIs
  - Can obstruct continuity of the intrathecal space, even though contain CSF, injection of local anesthetic into a cyst will result in the block passing if the local anesthetic cannot reach the cauda equina
- Recommendations after failed spinal with CSF return:
  - Inject at a different level to avoid reentrance into the cyst
  - Perform epidural with use of a "top off" for C/S for L.A. to absorb past the dura to target nerves rather than risk administration into a cyst (Hoppe & Phippen, 2007)
Discussion

L.A. Resistance
- Genetic mutation of a sodium-channel that causes the local anesthetic to be ineffective
- Insulin-dependent diabetic patients considered to be among those with increased risk of local anesthetic resistance
  - Resistance to glycosylation of the nerve roots involved in the development of diabetic neuropathy vs increased difficulty of placement of neuralaxial blocks as more likely to be obese (Hoppe & Popham, 2007)

L.A. Failure
- Accidental use of the wrong solution
- Rukewe et al., 2015: Intrathecal opioids added to the local anesthetic were not found to increase the risk of failed spinals
- Kinsella (2008): found the use of opioid addition to the local anesthetic to decrease the incidence of block failure
- Prolonged Age & Storage

Discussion

Independent Risk Factors
- Sng et al. (2009)
  - 857 parturients
  - Found higher incidence of requiring supplemental intravenous fentanyl and/or nitrous oxide among patients of greater height, patients having post-operative sterilization, and patients who underwent surgical complications such as excessive bleeding
- Adesope, Eihorn, Olufolabi, Cooter, and Habib (2016)
  - 5,015 patients
  - Found incidence of failure higher in preterm (<6.1%) versus term (5.4%) parturients
  - Also found low birth weight significantly associated with failure
- Butwick, El-Sayed, Blumenfeld, Osmundson, and Weiniger (2015)
  - 11,539 women undergoing preterm C/S between 24 and 36 weeks
  - Found odds of needing to convert to general anesthesia increased by 13% for every one week decrease in gestational age at delivery

Discussion

Anatomical Abnormalities
- Ligaments and trabeculae within the subarachnoid space can act as barriers L.A. reaching target nerves
- Marfan’s syndrome/other connective tissue disorders: pathologic enlargement of the dura (dural ectasia) common-can limit L.A. spread (Fettes et al., 2009)

Recommendations

Keep in mind about the risk factors associated with failed spinal anesthesia:
Technical and administration factors:
- Use of L4/S interspace, multiple lumbar puncture attempts, and level of experience of the anesthesia provider (Rukewe et al., 2015)
- Use of smaller gauge needles (such as 27 and 29-gauge), positioning in sitting position (Imbelloni et al., 1995; Kinsella, 2008)
- No addition of intrathecal opioid to the anesthetic (Kinsella, 2008)
Possible parturient and fetal characteristics:
- Preterm & low birth weight (Adesope et al., 2016)
- Parturients with postpartum sterilization or intraoperative surgical complications, and parturients of greater height (Sng et al., 2009)

Future Research

References

References


References

Etomidate and Corticosteroid Administration in the Critically Ill Patient

Julie Honeyman, SRNA

History of Etomidate

- In 1965, Janssen Pharmaceuticals first introduced Etomidate as an antifungal agent
- Presented into clinical practice in 1972 as a hypnotic agent
- Most known for its stable hemodynamic properties
- Drug of choice for critically ill patients for this sole fact

References

Etomidate and Adrenal Suppression

- Adrenal suppression was discovered as an adverse effect
- Inhibits 11β-hydroxylase
- Persists 6-8 hours after a single-induction dose and more than 24 hours after an infusion
- Administration of corticosteroids has raised the attention of many researchers and clinicians
Review of Literature

- A review of literature was conducted using the Harley E. French Library to determine current recommendations on the following question:

  Should anesthesia providers administer corticosteroid replacement therapy after Etomidate administration and should Etomidate be used in critically ill patients?

Case Information

- **Surgical Procedure**: Exploratory laparotomy/bowel resection
- **Age**: 68 year-old
- **Weight/Height/BMI**: 75 kg, 163cm, 27.4kg/m²
- **Gender**: Male
- **Allergies**: Rosuvastatin, Morphine, Clopidogrel, Simvastatin, and nuts
- **ASA**: 4E

Preoperative Evaluation

- **Significant Medical History**: Sepsis due to gram-negative bacteria, diverticulitis of large colon with perforation, respiratory failure, hypokalemia, and CHF
- **Surgical History**: AAA repair and cardiac stents
- **Home Medications**: Acetylsalicylic acid, Famotidine, and Naproxen Sodium
- **Pre-op VS**: BP 100/65, HR 110, RR 23, SpO2 87%
- **Airway Evaluation**: M III, TM distance >3 FB, mouth opening >3 FB, and full neck ROM
- **Pertinent Laboratory Data**: K 2.6 mEq/L, pO2 50

Anesthetic Course

- **GETA with RSI (Emergent case)**
  - Midazolam 1 mg
  - Denitrogenation with bipap therapy
  - Fentanyl 50 mcg
  - Lidocaine 50 mg
  - Rocuronium 5 mg
  - Propofol 150 mg
  - Succinylcholine 140 mg
  - 8.0 ETT via Mac 3 blade
  - Desflurane 6.0%
  - Arterial line placed
  - Central line present
- **Additional Medications**:
  - Zosyn 3.375 g
  - Fentanyl
  - Rocuronium
  - Potassium Chloride
  - Albumin
  - Phenylephrine infusion
  - Ondansetron 4 mg
  - Dexamethasone 8 mg

Intraoperative & Postoperative

- **Intraoperative**:
  - Continued tachycardia → IV fluids and PRN fentanyl
  - Hypotension → IV fluids and phenylephrine infusion
  - Decreased SpO2 → 100% O2, ABG’s drawn (inadequate), and tentative plan to keep patient intubated at the end of the procedure
- **Postoperative**:
  - Transferred to SCU where he remained intubated 4 days due to hypoxic respiratory failure
  - Transferred to medical floor for 4 additional days
  - Discharged home on post-operative day 8
- **Case Totals**:
  - UO: 250 mL
  - EBL: 175 mL
  - LR: 2.8 L
  - Case duration: 2.5 hours

Evidence - Etomidate

- During the 1980’s, Etomidate began to receive much attention regarding the adrenal suppression it produced
- A single dose has been found to block cortisol synthesis
- Adrenal insufficiency has been documented for up to 48 hours post-administration after a single dose
- In addition, an increased mortality rate was found in critically ill patients receiving infusions
- Interestingly, Etomidate has been known as a first-line anesthetic agent in hemodynamically unstable patients and as an agent of choice in critically ill individuals

References:

Payne et al., 2012; Ferraris, 2011; Nagelhout & Plaus, 2014
Evidence - Corticosteroids

- Adrenal cortex secretes three main types of hormones: mineralocorticoids, glucocorticoids, and androgenic hormones; All termed corticosteroids
- Mineralocorticoids influence the plasma concentration of sodium and potassium ions; Aldosterone is primary type
- Glucocorticoids influence carbohydrate, fat, and protein metabolism, as well as exhibiting anti-inflammatory effects; Cortisol is primary type

Evidence - Glucocorticoids

- Execute a crucial function in response to stress and are critical for survival
- When created as part of the stress response, they assist in regulating metabolic, immunologic, and anti-inflammatory functions
- Examples: Cortisol, Cortisone, Prednisone, Prednisolone, Methylprednisolone, and Dexamethasone
- Potency, duration of effect, and the overlapping mineralocorticoid potency vary between each drug
- Cortisol is the standard of comparison and hydrocortisone is the name used for pharmaceutical preparations of cortisol
- Hydrocortisone vs. Dexamethasone

Evidence - Etomidate and Corticosteroid Administration

- Payen study: Concluded critically ill patients without septic shock do not benefit from Hydrocortisone administration and replacement doses are not required after a single dose of Etomidate
- Dr. Mark and Dr. Dmello: Agreed with Payen and advised against the use of routine steroid supplementation
- Jung study: Suggested septic shock patients treated with Hydrocortisone after Etomidate was not associated with a decrease in life-threatening complications in comparison to other hypnotics
- CORTICUS study: Concluded supplementation of Hydrocortisone to compensate for the adrenal insufficiency caused by Etomidate is ineffective

Evidence - Etomidate and Critically Ill Patients

- Sunshine study: Concluded the relative risk of death among the Etomidate recipients was higher than that of subjects given an alternative agent
- Van Den Heuvel review: All three meta-analyses concluded findings of adrenal insufficiency and an increase in mortality
- Dr. Brian Fengler review: His summarized research indicated an association between a single induction dose of Etomidate in critically ill septic patient and sustained suppression of the adrenal axis with an increase in mortality
- Dr. Dean: Concluded Etomidate no longer has a role as the induction agent of choice in patients with septic shock

Recommendations

1. Overall, there is a lack of abundant studies indicating a potential benefit with corticosteroid use after Etomidate administration
2. Majority of studies advise against the use of Etomidate in critically ill individuals
3. Several studies suggest practitioners to seek out alternative induction techniques
4. It is essential for anesthesia providers to consider evidence-based recommendations to prevent potential adrenal insufficiency and increased mortality with Etomidate use

Conclusion

- Additional large, randomized controlled studies are needed to provide a definite conclusion
- The majority of recent research indicates corticosteroids will not aid in preventing adrenal insufficiency and anesthesia providers should consider completely eradicating the use of Etomidate in critically ill individuals
- In the aforementioned case study, Etomidate or corticosteroids were not used for these reasons
Thank You Are There Any Questions?

Thank You Are There Any Questions?

Introduction to Intranasal Fentanyl

- **BMT** is the most commonly performed surgical procedure among pediatric population in the US.
- **Indication**: Chronic serous otitis media & recurrent otitis media
- Anesthetic technique is fairly standardized, however use of analgesics greatly varies among anesthesia providers
- **Use of intra-nasal Fentanyl is somewhat controversial**
- Review of literature on use of INF (intra-nasal Fentanyl) in healthy pediatric patients (ASA 1 & 2) undergoing BMT will be examined

References

- Dean, P. (2012). Should etomidate be used for rapid-sequence induction in critically ill septic patients? Probably not. Critical Care Medicine, 40(6), 2003-2004

Intranasal Fentanyl in Pediatric Patients Undergoing Bilateral Myringotomy and Tympanostomy Tube Placement

Ivan Martic, SRNA

**Case Information**

- **Surgical Procedure**: bilateral myringotomy and PE (pressure equalization) tube placement
- **Age**: 26 month old
- **Weight**: 16 kg
- **Height**: 102 cm
- **Gender**: Male
- **ASA**: 2
**Pre-operative Evaluation**

- **Past Medical Hx:** 5 ear infections in the past 8 months.
- **Surgical hx:** None
- **Pre-op VS:** HR 97, SpO2 98% on RA
- **Pertinent test:** preoperative audiogram tympanogram = persistent left sided middle ear effusion & hearing loss
- **Airway evaluation:** Limited due to patient’s age
- **Current medications:** Albuterol 1.25mg/3ml PRN for SOB/wheezing.

**Anesthetic Course**

- **Technique:** masking technique - patient breathing spontaneously during the case
- **Induction:** Sevoflurane 8% and N2O at 50% (4lpm O2 and 4lpm N2O) Once anesthetized N2O turned off and anesthesia maintained with expSevo at 3.2%.
- **Drugs:** **12.5mcg Fentanyl (1.56 mcg/kg) applied to each nare** & Rectal Acetaminophen 240mg.

**Intraoperative Issues**

- Once the initial myringotomy incision was made patient’s heart rate increased from 95 to 110 beats per minute (bpm). After two minutes, the patient’s heart rate decreased to 98 bpm, while the second myringotomy incision did not cause any additional increase in heart rate.
- **No intraoperative issues noted**

**PACU**

- **Transport to the PACU was uneventful - patient transported with blow-by oxygen.**
- **Hemodynamically stable throughout stay in PACU**
  - SpO2 99% on RA HR 98
- **During the postoperative visit, no signs of respiratory depression, hypoxia, nausea or vomiting were noted.**

**IntraNasal Fentanyl??**

- Should we use intra-nasal Fentanyl in pediatric patients undergoing BMT procedures?
- Is it safe?
- What are the benefits of it?
- What are the possible side effects?
- What does the literature say?
- Alternative analgesics?

**INF**

- **Review of retrospective studies found that up to 70% of pediatric patients undergoing the procedure had either elevated heart rate, blood pressure, behavioral signs or complaints of pain** (Kampfiersad, Jimenez, Bradford, Seidel & Lynn, 2010).
- Pestieau et al. (2011) found rescue analgesia to be necessary in up to 87% of children undergoing BMT.
- More than 50% of children experience significant pain following myringotomy and tube placement (Kask, 2003).
### Bilateral Myringotomy Tube Placement

- Hippard et al. (2012) analyzed several studies to discover that IV access did not provide any advantage in healthy children undergoing BMT, and in some instances, patients without an IV access had less pain, faster recovery and higher parental satisfaction scores.
- Premedication with oral medications is unpredictable (delayed onset) + patients NPO.
- One of the most commonly administered analgesics is rectal Acetaminophen but....

### Rectal Acetaminophen

- When administered alone, it does not provide a sufficient analgesia (Dewhirst et al., 2014).
- The absorption of rectal Acetaminophen is highly variable, with an onset time of 45-60 minutes (Rampersad et al., 2010).
- Peak effect is not reached for 2-3 hours following the rectal administration (Finkel et al., 2001).
- Evidence suggests that a larger dose (up to 60mg/kg rectally) is needed to achieve a therapeutic effect (Finkel et al., 2001).

### The Intranasal Route

- It bypasses gastrointestinal first-pass metabolism, (rapid absorption into the systemic circulation via highly vascular nasal mucosa).
- The avoidance of first pass metabolism = greater bioavailability of administered medications (Corrigan, Wilson & Hampton, 2015).
- The respiratory mucosa contains the rich capillary network that receives more blood flow per unit of tissue compared to brain, liver or muscles (Corrigan, Wilson & Hampton, 2015).

### The Intranasal route

- Medications administered via intranasal route can be delivered directly to the cerebral spinal fluid and brain via the olfactory nerve pathway, which is located in the olfactory mucosa (Corrigan, Wilson & Hampton, 2015).
- The absorbed medication can produce serum concentrations similar to ones achieved with intravenous administration.

### The Intranasal Route

- Provides quick, painless and simple mode of medication administration.
- Presence of URI does not seem to have any effect on nasal absorption (Corrigan, Wilson & Hampton, 2015).
- Recent research describes intranasal delivery of medications as safe, effective and a convenient alternative to other routes of drug administration (Corrigan, Wilson & Hampton, 2015).

### Problems With IN Route & Recommendations:

- Nasal- septal abnormality along with copious amount of nasal secretions of blood or mucus may present a barrier to absorption
- **Laryngospasm** (PPV Vs Succinylcholine 4mg/kg IM) Galinkin et al. (2000) - 265 children received INF and there were no instances of laryngospasm
- **Goal**: minimize barriers to absorption, minimize the volume, and maximize the absorptive surface
IN Fentanyl Vs. IN Dexmedetomidine

<table>
<thead>
<tr>
<th>Variable</th>
<th>IN Fentanyl</th>
<th>IN Dexmedetomidine</th>
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<tbody>
<tr>
<td>Dose</td>
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<tr>
<td>Category</td>
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<td>Peak plasma concentration</td>
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<td>Onset</td>
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<tr>
<td>Peak</td>
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<td>1 minute</td>
</tr>
<tr>
<td>Duration</td>
<td>2mcg/kg</td>
<td>2mcg/kg</td>
</tr>
<tr>
<td>Side effects</td>
<td>N/V, Respiratory depression</td>
<td>N/V, Hypotension, prolonged PONV, status and need for prolonged monitoring</td>
</tr>
</tbody>
</table>

Review of Literature:
- Yoon, et al. (2000): Naloxone (1mg/ml) or IM Naloxone 0.8mg (recommended).

IntraNasal Fentanyl

- High lipophilicity of Fentanyl allows for rapid diffusion into the CNS structures via the largely lipophilic nasal mucosa.
- Rampersad et al. (2010): nausea and vomiting occurrence in 12% of individual receiving INF for BMT procedure.
- Pestieau et al. (2011): IN Fentanyl doses of 1mcg/kg = 3.9% incidence rate of vomiting, while INF 2mcg/kg = associated with 12% incidence of vomiting (significance?).
- Galinkin et al. (2000): incidence of PONV, hypoxemia and decreased respiratory rate has not increased with INF use.
- Main advantage: quick onset, short duration, no histamine release, minimal hemodynamic impact, decrease in post-operative agitation.

Alternative Pharmacological Options for BMT

- Oral or Rectal Acetaminophen
- Ibuprofen
- IM Ketorolac 1mg/kg (slow onset, controversy)
- PO/IM/IV Morphine
- 2% Lidocaine ear drops
- IN Dexmedetomidine
- Regional anesthesia...

Regional Anesthesia for BMT procedure?

- Nerve block of the auricular branch of the Vagus (Nerve of Arnold) using 0.2ml of 0.25% bupivacaine with 1:200 000 epinephrine.
- The auricular branch of the Vagus innervates the external auditory meatus and the inferior portion of the tympanic membrane, an area where incision for FE tube placement is carried out.

Recommendations

- Use mucosal atomization devices (minimize the potential of laryngospasm & turn patient’s head to the side).
- Administer the minimal amount of medication needed to achieve adequate analgesia (side effects such as nausea and vomiting, are associated with higher doses of INF).
- Use of INF in children with multiple comorbidities, impaired respiratory control, and airway obstruction should be evaluated on an individual basis.
- Standard monitors should be in place when administering opioids to pediatric patients undergoing BMT and frequent assessment of patient’s condition should be evaluated on a continuous basis.
Conclusion

- Administration of INF in healthy (ASA class 1 & 2) pediatric patients has been shown to be safe, effective, and well tolerated with minimal side effects when doses up to 2mg/kg are used.
- The intranasal route offers a time efficient, simple, fast and painless mode of medication delivery without the need of intravenous access.
- “Current evidence suggests that INF is a safe and effective method of pain management for children in a variety of clinical settings” (Mudd, 2011, p.116).

References


Thank You
Are There Any Questions?

Thank You
Are There Any Questions?

Utility of Dexmedetomidine for a Patient with Prolonged Tourniquet Time to Decrease Sympathetic Effects

Daniel Lund, SRNA

Introduction

- Prolonged tourniquet use > 45–60 minutes results in an increased SNS response and subsequently an increase in heart rate and blood pressure.
- This SNS response, also referred to as tourniquet pain, is resistant to narcotics and anesthetic gases.
- Significant increases in blood pressure and heart rate may not be tolerated by individuals with certain co-morbidities (e.g. congestive heart failure, coronary artery disease, abnormal bleeding, stroke ha).
- Dexmedetomidine is an alpha 2 adrenergic agonist with sedative properties, which also reduces the SNS response by decreasing the release of norepinephrine and epinephrine into the circulation, thus decreasing blood pressure and heart rate.
Case Information

- Open reduction and internal fixation (ORIF) of bilateral calcaneus fractures
- 48 year old
- 71 kg
- Male
- ASA 2

Pre-operative Evaluation

- Past Medical History
  - GERD
  - Anxiety and depression
  - Smoker 1 ppd
- Surgical History
  - Lumbar fusion post L2 burst fracture
  - Right tibia/fibula ORIF
- Anesthesia History
  - Patient stated he sometimes wakes up “wild”

Anesthetic Course

- Induction
  - The patient was connected to standard monitors, and received midafoxol 2mg and fentanyl 150 mcg IV
  - Preoxygenated with 100% oxygen via mask for approximately 4 minutes
  - Received the following medications: IV lidocaine 60 mg, fentanyl 100 mcg, propofol 180 mg, and remifentanil 50 mcg
  - Intubated utilizing a Macintosh #3 with a grade 1 view and a size 8.0 cuffed endotracheal tube was placed with no issues. Placement was confirmed with ETCO2 and auscultation of bilateral clear lung sounds
- Maintenance
  - Sevoflurane 2.2-3.0%
  - ETCO2 30-34
  - BP 105/50
  - PRN Fentanyl, Hydromorphone, Labetalol
  - Dexmedetomidine infusion (started prior to left calcaneus fixation).

Intraoperative Issues

- Left Calcaneus Fixation
  - During surgery, it was discussed with the surgeon that the left calcaneus was more extensively damaged and may require a longer tourniquet time. Due to the expected long tourniquet time and narcotic requirements of the patient, we decided to start a dexmedetomidine infusion prior to the ORIF of the left calcaneus
  - Dexmedetomidine infusion was started at 0.7 mcg/kg/hr. No bolus was given.
  - Total tourniquet time was 153 minutes for the left leg with a max BP of 148/82 and a max HR of 95
  - No additional narcotics or labetalol were given during the left calcaneus fixation
  - Sevoflurane was slowly decreased from 3.0% to 2.0% expired, with the BIS remaining 40-50.

- Right Calcaneus Fixation
  - Prior to incision an additional 250 mcg fentanyl was given for a total of 500 mcg. BP 122/66 with a HR of 76 beats/min at this time.
  - During the first 45 minutes of total tourniquet time 3mg hydromorphone was titrated on in response to increased blood pressure and heart rate. Max blood pressure and heart rate during this time was 162/82 and 105 respectively.
  - Tourniquet time 45 min BP 136/80, HR 84
  - Tourniquet time 104 min BP 164/91, HR 105
    - Labetalol 10 mg IV given resulting BP 147/79, HR 97
  - Tourniquet time 122 min BP 163/96, HR 104
    - Labetalol 5 mg IV given resulting BP 152/91, HR 99
  - BP and HR slowly increased to 164/94 and 105 respectively until the release of the tourniquet at a total tourniquet time of 151 minutes
  - Immediately upon tourniquet release the patient’s BP decreased to 124/72 and HR decreased to 82.

PACU

- Dexmedetomidine was discontinued at approximately 20 minutes prior to the end of the procedure. Ondansetron 4mg IV was given at this time.
- Prior to extubation the patient produced tidal volumes of 400-600 ml at a rate of 14 breaths/min and opened eyes periodically to voice
- The endotracheal tube was removed and oxygen at 4 LPM via nasal cannula was applied
- Upon entry to the PACU the patient was drowsy but denied pain
- One hour later, the patient was alert and calm rating pain 5/10, for which he was receiving IV fentanyl
- No emergence delirium was noted
Discussion

Tourniquet pain
• Tourniquet pain is the result of mechanical compression to the underlying muscles, nerves, and blood vessels, along with ischemia to the distal tissues.
• The specific metabolic and neuronal pathways that result in tourniquet pain are unknown
  — C-fibers = aching pain
  — A-delta fibers = burning/tingling pain
• Despite adequate depth of anesthesia, tourniquet pain typically presents with a dull aching pain (C-fiber pain) at about 45-60 minutes, which causes an increase in the SNS response and subsequent increase in BP and HR.
• Tourniquet pain is frequently refractory to narcotics and anesthetic gases
• Significant increases in blood pressure and heart rate may not be tolerated by individuals with certain co-morbidities (e.g. congestive heart failure, coronary artery disease, abnormal bleeding, stroke ha), which may lead to poor outcomes.

Dexmedetomidine
• Alpha 2 adrenergic agonist
• Sympatholytic effects by decreasing the release of norepinephrine and epinephrine, resulting in a decrease in BP and HR.
• Additional beneficial effects: sedation, analgesia, reduction of postoperative shivering, decrease in postoperative delirium, minimal respiratory effects, reduces ischemia/reperfusion injury markers due to prolonged tourniquet use.
• Main adverse effects: Severe bradycardia, heart block, hypotension
  — Dose dependent but can be damaging and potentially lethal
• Cost: $541.28 for 200 mcg in 50 ml normal saline

Dexmedetomidine Use in Surgery Requiring a Tourniquet
• Three separate, randomized, placebo controlled, double blinded studies on the sympatholytic effects of dexmedetomidine in patients undergoing general anesthesia for lower limb surgery requiring a tourniquet, determined that blood pressure and heart rate were significantly reduced in patients that received a dexmedetomidine infusion compared to the control groups who did not.
• Lao et al. (2013) Study, 72 adults
  — Dexmedetomidine group received 0.8 mcg/kg bolus over ten minutes followed by 0.4 mcg/kg/min infusion.
  — The average heart rate was 67-80 beats/min through tourniquet release in the dexmedetomidine group compared to 75-90 beat/min in the control group.
  — The average BP was 118/68 through tourniquet release in the dexmedetomidine group compared to 130/73 in the control group.

• Li et al. (2015) Study, 80 adults
  — 43 patients had a diagnosis of HTN and 37 did not.
  These two groups were separated equally into a control group and dexmedetomidine group that received 1 mcg/kg bolus over 20 minutes followed by a 0.4 mcg/kg/min infusion
  — HTN diagnosis: Incidence of hypertension between the control versus dexmedetomidine groups was 77.8% and 48.0%, respectively.
  — No HTN diagnosis: Incidence of hypertension between the control versus dexmedetomidine groups was 66.7% and 12.5%, respectively.

Discussion Cont’d

Lu et al. (2013) Study, 37 adults
• Dexmedetomidine group received 0.5 mcg/kg bolus over ten minutes with no continuous infusion
• There was no significant changes in HR between the control and dexmedetomidine groups until the 60 minute mark, where the average HR of the control group was approximately 90 beats/min and the dexmedetomidine group was 78 beats/min
• The blood pressure for the dexmedetomidine group was very stable at approximately 120/83 throughout the first 60 minutes and upon tourniquet release. Comparatively, the average SBP and DBP of the control group increased significantly at the 40, 50, and 60 minute marks with average pressures of 138/78, 142/81, and 150/90 respectively

Dexmedetomidine Use in Surgery Requiring a Tourniquet
• Most common side effects found in the literature were hypotension and bradycardia soon after the initial bolus
• Dexmedetomidine has a steady state volume of distribution of 118 Literature suggesting the need for a bolus prior to infusion
• The study by Lu et al. (2013) gave a 0.5 mcg/kg bolus over ten minutes prior to tourniquet inflation, and showed much less hypotension and bradycardia requiring intervention compared to the Lao et al. (2013) study which used a 0.8 mcg/kg bolus over ten minutes prior to tourniquet inflation. Both the studies had similar results in controlling BP and HR due to tourniquet pain.

Discussion Cont’d
Discussion Cont’d

Alternatives

- **Labetalol**
  - Beta blocker
  - Half life approximately 5.5 hours
  - $18.31 per 100 mg
  - Side effects: Hypotension and bradycardia
- **Esmolol**
  - Beta blocker
  - Half life 9 minutes
  - $63.05 per 100 mg
  - Side effects: Hypotension and bradycardia

- **Ketamine**
  - NMDA antagonist
  - Half life 10-15 minutes
  - $56.38 per 100 mg
  - Side effects: Tachycardia, arrhythmias, nausea/vomiting, hallucination, increased intra cranial pressure, tonic-clonic movements, and hyper salivation

Recommendations

• **Areas Where More Research Needed:**
  - Cost effectiveness of dexmedetomidine
  - Effects of dexmedetomidine on PACU length of stay
  - Comparison of beta blockers and/or ketamine administration in attenuating the SNS response in prolonged tourniquet use, compared to the addition of a dexmedetomidine infusion.

References


Conclusion

• The increased SNS response associated with tourniquet times >45-60 minutes is difficult to control. It is refractory to narcotics and inhaled anesthetics, and subsequently leads to hypertension and tachycardia, which can have a detrimental impact on morbidity and mortality.

• Dexmedetomidine infusions have been shown to attenuate the SNS response associated with tourniquet pain in the literature as well as with the patient in this case report.

References

References