Pediatric Anesthesia Concerns and Management for Orthopedic Procedures

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KEYWORDS

• Pediatric anesthesia • Local anesthetic • Caudal • Peripheral nerve block
• Pediatric fracture • SCFE • Club foot • Scoliosis

KEY POINTS

- Pain management for pediatric orthopedic patient includes a multimodal pharmacologic approach and regional anesthesia.
- Regional anesthesia performed on pediatric patient under general anesthesia has been shown to be safe.
- Anesthetic concerns during scoliosis surgery include optimizing neuromonitoring signals, blood loss management, positioning-related injuries, and postoperative visual loss.

INTRODUCTION

Anesthesiologists are presented with unique challenges when caring for pediatric patients undergoing orthopedic surgeries. The anesthetic approach must consider a child's psychological development and frequent predilection to respiratory infections. Surgeries can range from simple ambulatory procedures to complex and extensive operations. A large part of the anesthetic care includes pain management, management of concomitant disease, and risk reduction for adverse events. This article reviews select anesthetic perioperative concerns, discusses various methods of pain control used for orthopedic surgeries, and reviews anesthetic considerations for select pediatric orthopedic surgeries.

SELECT PEDIATRIC PERIOPERATIVE CONCERNS

Anxiety in the Pediatric Patient

Pediatric patients presenting for orthopedic surgery can express variable levels of anxiety and distress. Preoperative stressors can include new surroundings,

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procedures, hunger, anticipation of pain, and parental separation. Some risk factors for preoperative anxiety include the age group of 1 year olds to 5 year olds, shy temperament, poor prior medical experiences, high cognitive levels, and high parental anxiety.[1,2]

The degree of preoperative anxiety can have an impact on postoperative outcomes. Unrelieved anxiety can be associated with postoperative behavioral changes, including generalized anxiety, separation anxiety, aggression toward authorities, and nighttime crying.[3] These behaviors can persist up to 1 year after surgery.[4] Other postoperative outcomes can include higher pain scores and higher requirements of pain medications after surgery for at least 3 days postoperatively.[5]

Several strategies can be used to mitigate preoperative anxiety in children. Presurgical preparation programs can include site visits, videos, books, and child-life interventions. Parental presence during induction of anesthesia can allay separation anxiety. Pharmacologic intervention, such as oral midazolam, improves compliance and shows some reduction in negative behavior changes in the near term postoperatively.[6,7]

Upper Respiratory Tract Infections

The pediatric patient presenting for orthopedic surgery with a current or recent upper respiratory tract infection (URI) is a complicated dilemma for anesthesiologists and surgeons. Young children frequently are infected with a URI, presenting with runny nose, cough, and fever. Common implicating viruses include rhinoviruses, adenoviruses, and coronaviruses. Although the viral infection may reside in the nasopharynx, the lower respiratory tract can have increased sensitivity for up to 6 weeks after the URI symptoms have resolved.[8,9] Patients are at increased risk for perioperative laryngospasm, bronchospasm, and oxygen desaturation during this time with perhaps the greatest risk within the first 2 weeks after the URI has resolved.[8] Delaying surgery for 6 weeks after resolution of the URI is impractical because the child most likely will contract another URI.

For elective surgery, delaying surgery is prudent for severe symptoms, such as fever (>100.4°F), purulent nasal drainage, behavioral changes such as lethargy or poor feeding, and lower respiratory tract involvement such as wheezing.[10] In contrast, an uncomplicated URI limited to clear nasal discharge in an otherwise healthy patient usually can proceed with elective surgery. In-between these spectrums post a more difficult clinical decision-making challenge. Various factors are incorporated into determining postponing surgery, including age of patient, comorbidities, prior cancelations, complexity of surgery, and urgency of surgery. If elective surgery is delayed, most clinicians would postpone 2 weeks to 4 weeks after resolution of URI symptoms.[8,11]

For urgent surgeries, the risk of postponement should outweigh the increased respiratory risk of a sick child.

Induction of Anesthesia

Inhalational induction of anesthesia via a mask is a common approach to pediatric patients because it avoids the fear of IV placement. Sevoflurane is the primary volatile anesthetic used for inhalational induction. It is the least pungent of the modern inhaled anesthetics and the least irritating to the airway. The odor of sevoflurane, however, can still upset children. Nitrous oxide often is first administered because it is odorless and provides rapid anxiolysis and sedation. These effects can increase acceptance of increasing levels of sevoflurane.[12]

The progression of an inhalational induction to general anesthesia is a critical time. After the child becomes unconscious, the brain goes through a hyperreflexic, excitable phase of anesthesia before relaxation. Eyes may show nystagmus or may roll up. Respiratory patterns can change to rapid and shallow. Snoring may begin, signifying decreased muscle tone and ensuing partial upper airway obstruction. Sudden movements of the arms and legs can occur from the excited state.[12] External stimulation during this phase of anesthesia should be avoided. This includes tourniquet/IV placement, dressing changes, cast removal, or physical examinations. Such stimulation during the excitement phase may lead to laryngospasm.[13] IV placement and airway management are performed after the excitement phase has passed.

Contraindications to inhalational induction can include history of malignant hyperthermia, full stomach, difficult airway, and cardiac conditions. An IV placed prior to induction may be necessary.

STRATEGIES FOR PAIN MANAGEMENT

A multimodal strategy for perioperative pain management is often used for children undergoing orthopedic surgery. Pharmacologic adjuncts to narcotics act synergistically for enhanced analgesia, thus minimizing overall opioid use. Often these adjuncts are continued postoperatively as well. Regional anesthesia is invaluable to treat acute postoperative pain.[14] Blockage of pain conduction from the surgical site decreases the need for systemic pain medications. Decreased opioid use can minimize side effects and complications, such as nausea, vomiting, constipation, sedation, and apnea.

Acetaminophen

Acetaminophen is a widely used analgesic. Its mechanism of action is unclear and likely involves several pain pathways both peripherally and centrally. These include blocking prostaglandin synthesis by inhibiting a variant cyclooxygenase (COX) enzyme, enhancing the cannabinoid pathway, activating serotonergic pathways, and inhibiting the L-arginine/nitric oxide pathway.[15]

Overdosing of acetaminophen resulting in hepatic failure is always of concern. Acetaminophen can be administered orally, rectally, and IV. Oral narcotics often are formulated with an acetaminophen component so all previous forms of acetaminophen given must be confirmed prior to additional administration.

Nonsteroidal Anti-inflammatory Drugs

Nonsteroidal anti-inflammatory drugs (NSAIDs) are commonly used adjuncts, although as a class, their use is debatable for certain orthopedic surgeries. NSAIDs provide analgesia by reducing prostaglandin synthesis via inhibiting the COX pathway. Peripherally, at tissue injury sites, there is decreased inflammation.[14] There may be centrally mediated actions blocking hyperalgesic responses and activation of serotonin pathways.[16]

Ketorolac is a commonly used NSAID. It is usually administered IV and provides pain relief similar to opioids. Usage is limited to less than 5 days due to its reduction in renal blood flow.[14] Ibuprofen is one of the oldest used oral NSAIDs and is available IV as well.

NSAIDs use is not without risk. As a class, their use is debatable for certain orthopedic surgeries. They affect platelet adhesion and aggregation. Measured bleeding times are increased, although usually within normal range and clinically insignificant.[16] They should still be used with caution for surgeries with high risk for perioperative bleeding.

NSAIDs have the potential to affect bone formation via their action on prostaglandin. Thus, controversy exists using NSAIDs during orthopedic surgeries such as spinal fusion. Animal studies suggest altered bone healing after fractures and surgeries. NSAIDs have been used, however, after various orthopedic surgeries without adverse effects. In a subset of healthy children undergoing idiopathic scoliosis surgery, no adverse effects, such as curve progression, hardware failure, and reoperation, were found with ketorolac use.[17]

Opioids

Opioids often are required if postoperative pain is expected to be moderate to severe. Commonly used opioids include short-acting narcotics, like fentanyl, or longer-acting narcotics, like morphine or hydromorphone. IV dosing allows for close titration in the recovery room. Delivery postoperatively can be in the form of as-needed basis, nurse-controlled analgesia pump, or patient-controlled analgesia pump, depending on patient age and cognitive ability.[18]

Oral opioids usually are prescribed once the child tolerates oral intake. Commonly prescribed oral opioids, however, should be used with caution. Many oral opioids undergo metabolism through the hepatic cytochrome P450 2D6 (CYP2D6). Codeine, a prodrug, is metabolized into morphine through this pathway. Tramadol is converted to its active form O-desmethyltramadol. Polymorphisms of CPY2D6 can lead to poor metabolizers of codeine, leading to lack of efficacy. Ultrarapid metabolizers of codeine, however, result in higher than intended morphine formation and possible toxicity and respiratory depression.[19]

In 2013, the US Food and Drug Administration issued a boxed warning contraindication of using codeine for postoperative pain in a subset of children.[20] The Food and Drug Administration further restricted the use of codeine in 2017 and included tramadol. Codeine and tramadol are contraindicated in all children under 12 years old and recommended against their use for children 12 years old to 18 years old with obesity, sleep apnea, or severe lung disease.[21] Still in question are the safety profiles of hydrocodone and oxycodone in children. Currently, there is not enough evidence to conclude that ultrarapid metabolizing phenotypes of CYP2D6 are at increased risk with use of these 2 opioids.[19]

Regional Anesthesia

Regional anesthesia involves using local anesthetic agents, such as lidocaine, bupivacaine, and ropivacaine, to temporarily block nerve conduction from a specific part of the body. Sensory input is blunted, and motor blockade can be achieved as well. Immobility and muscle relaxation from an extremity can aid in providing optimal conditions for the orthopedic surgeon. Systemic anesthesia medications usually can be decreased. Duration of analgesia from a regional anesthetic depends on many factors, including type of local anesthetic, concentration used, volume used, and use of other pharmacologic additives. For multiday pain management, local anesthetics can be infused continuously via a catheter.

Caudal and lumbar epidural anesthesia

Neuraxial anesthesia is a form of regional anesthesia targeting nerves of the central nervous system (CNS). Such techniques include spinal, epidural, and caudal blocks. Contraindications include spina bifida, increased intracranial pressure, coagulopathy, or infection at the insertion site.

Caudal blocks are the most widely used regional technique in pediatric anesthesia and have been proved very safe.[22,23] It is appropriate for surgeries below the umbilicus, such as the hip, leg, knee, and foot. There is no laterality in this block; thus, both lower extremities are affected. A caudal block is performed by inserting a needle through the sacral hiatus and into the epidural space. The sacral hiatus is an opening at the caudad end of the sacrum and is due to a nonunion of the fifth sacral vertebral arch. Bordering the sacral hiatus laterally are the sacral cornu, which are bony prominences representing remnants of the inferior articular processes of the fifth sacral vertebra.[24] The sacral cornu are easily palpated in infants and younger children. Once a needle enters the epidural space, local anesthetic can be given as a single injection or a catheter can be threaded up to a desired epidural level to provide continuous analgesia.

Lumbar epidural catheters can also be placed if there is difficulty placing a catheter at the caudal level. The procedure in children is like that of adults. A Tuohy needle typically is used with a midline approach between the spinous processes of the targeted level. The needle with a syringe attached is advanced until a loss of resistance is felt from the syringe. This signifies that the tip of the Tuohy needle has entered the epidural space after passing the ligamentum flavum. An epidural catheter is then passed, or a single injection of local anesthetic is administered.[25]

Peripheral nerve blocks

Peripheral nerve blocks are techniques used to deliver local anesthetics to nerve bundles. Nerves can be localized with either nerve stimulation or ultrasound techniques. Nerve stimulation localizes nerve bundles using knowledge of anatomic landmarks along with an insulated needle with exposed metal at its tip to deliver electrical impulses. As the metal tip approaches the targeted nerve, the electrical impulse depolarizes the nerve and stimulates a muscle contraction. Once the expected muscle group is stimulated, local anesthetic is injected through the needle to surround the nerve bundle. A catheter can be placed as well.

The use of ultrasound is gaining popularity in pediatric regional anesthesia. It allows for visualization of the needle position in relation to the nerve bundle and of the distribution of local anesthetic. Compared with nerve stimulation techniques, the use of ultrasound has been shown to decrease the volume of medication needed for a successful block, thus decreasing risk of toxicity. Evidence has suggested increased rate of success, decreased procedure time, and decreased needle passes when using ultrasound guidance.[26,27]

Table 1 summarizes common peripheral nerve blocks, the location of surgery they can be used for and associated complications.[28,29]

Safety when performing regional techniques under general anesthesia

Approach to regional anesthesia is different between pediatric and adult patients. Regional anesthesia for adults is usually performed in an awake or mildly sedated state. This allows for feedback from the patient regarding paresthesia and pain during needling or local anesthetic injection. This may signify potential nerve injury. In contrast, pediatric patients may not have the cognitive ability to accurately report paresthesia. Poor patient cooperation, needle-phobia, and inability to lie still make regional anesthesia difficult to perform in awake or sedated children. Unexpected movements may cause inadvertent injuries or complications.[30] Thus, most regional anesthetics for pediatric patients have been performed after children are under general anesthesia.

Investigations have been done evaluating issues of safety and nerve injury while performing regional anesthesia in an unconscious pediatric patient. In 2014, the first

Table 1
Peripheral nerve blocks, usage, and complications

Nerve Block	Location of Surgery	Complications
Upper extremity		
Interscalene	Shoulder, upper arm	Spinal cord injury, intrathecal injection, pneumothorax, vertebral artery puncture, phrenic nerve blockade, Horner syndrome
Supraclavicular	Arm below shoulder, elbow, forearm, wrist, hand	Pneumothorax, phrenic nerve blockade, intravascular injection
Infraclavicular	Elbow, forearm, hand	Intravascular injection, pneumothorax
Axillary	Elbow, forearm, hand	intravascular injection
Lower extremity		
Lumbar plexus block	Hip, fractures femoral head/shaft, knee	Hematoma in muscle sheath, retroperitoneal space, or kidney; epidural spread
Fascia iliaca block	Hip surgery, femur	Intravascular injection
Femoral nerve block	Thigh, femur, knee	Intravascular injection; persistent strength deficits
Saphenous nerve block	Sensory medial lower leg, knee	Motor weakness with large volume; intravascular injection
Sciatic nerve block	Knee, leg, ankle, foot	Intravascular injection

Data from Flack S, Lang RS. Regional anesthesia. In: Davis PJ, Cladis FP, editors. Smith's anesthesia for infants and children, 9th edition. St. Louis: Elsevier; 2017. p. 487-506; and Gray AF, Collins AB, Eilers H. Peripheral nerve blocks. In: Stoelting RK, Miller RD, editors. Basics of anesthesia, 5th edition. Philadelphia: Churchill Livingstone; 2007. p. 276-86.

prospective study investigating this issue used data from 50,000 regional pediatric blocks from the Pediatric Regional Anesthesia Network database.[31] The study showed pediatric complication rates consistent with adult data. A follow-up study published in 2018 used data from 100,000 pediatric blocks.[22] More than 93% of patients were under general anesthesia during regional blockade. No permanent neurologic deficits were found. Transient neurologic deficits occurred in 2.4 of 10,000 patients. They were sensory in nature and resolved over weeks to months. Severe local anesthetic toxicity occurred in 0.76 of 10,000 patients, which is lower than reported adult data. Risk of neurologic and toxicity events were higher in the awake/sedated pediatric patient compared to that under general anesthesia. This study confirms safety of performing regional techniques in children under general anesthesia.[22]

Local anesthetic systemic toxicity

Local anesthetic systemic toxicity (LAST) produces serious reactions to the CNS and cardiovascular system. In general, lower plasma levels of local anesthetic produce CNS effects compared with higher plasma levels needed for cardiovascular effects. Thus, early signs of toxicity may include CNS signs, such as circumoral numbness, lightheadedness, dizziness, tinnitus, restlessness, and slurred speech. Increasing levels produce tonic-clonic seizures and eventual coma. As plasma levels further increase, cardiovascular signs develop. Short-acting local anesthetics like lidocaine tend to cause bradycardia and hypotension from vasodilation and myocardial depression. Cardiac arrest later ensues. Long-acting local anesthetics like bupivacaine and ropivacaine, however, may lead to ventricular arrythmias, peaked T waves, or complete cardiovascular collapse. Bupivacaine has a small threshold for cardiac toxicity and thus CNS and cardiovascular signs may occur simultaneously or, occasionally, cardiovascular signs may precede CNS signs.[32,33]

Because regional anesthesia for pediatric patients usually is performed under general anesthesia, seizure or cardiovascular signs like tachyarrhythmias or complete collapse is the first symptom of toxicity.[34] As discussed previously, severe local anesthetic toxicity is a rare event.[22] Adults can report early signs of CNS toxicity and have a tachycardic response when a local anesthetic and epinephrine test dose is initially injected. In the anesthetized pediatric patient, early signs of intravascular injection from a test dose can be EKG changes, such as peaked T waves or increased blood pressure.[35] Sensitivity and specificity of test dosing in pediatric patients under anesthesia, however, have not been conclusive and do not provide early warning signs of rapid local anesthetic intravascular absorption.[34] Pediatric patients at highest risk for severe LAST seem to be infants less than 6 month old, with all incidences associated with bolus dosing.[22] Some investigators advocate a 30% reduction in local anesthetic dosing in this population.[33]

Compartment syndrome

Compartment syndrome is a serious orthopedic emergency which, if unrecognized, can result in muscle ischemia or limb loss. Regional anesthesia often has been avoided in orthopedic patients with fractures due to the possibility of masking early signs of ensuing compartment syndrome. Classic signs include pain, pallor, paresthesia, paralysis, and pulselessness. The sensitivity and positive predictive value of these signs in children, however, are low. Some suggest signs of increased agitation, anxiety, and analgesia requirements are more useful in children.[36]

Currently, there is no evidence suggesting that regional anesthesia would delay the diagnosis of compartment syndrome in children. Increasing breakthrough pain from a working regional anesthetic, however, may be pathognomonic for acute compartment syndrome. Strategies to minimize complications include identifying high-risk patients, such as those undergoing tibial compartment surgery; using dilute solutions of local anesthetics and cautious use of additives to decrease the density of the block; appropriate monitoring of symptoms; and measurement of compartment pressure if compartment syndrome is suspected.[37,38]

SPECIAL CONSIDERATIONS FOR SELECT PEDIATRIC ORTHOPEDIC SURGERIES

Fractures and Trauma

An orthopedic fracture is one of the most common reasons for a pediatric emergency department visit. In one epidemiology study, the most common fracture in the pediatric population involves the forearm accounting for 17.8%, followed by the finger and the wrist. Few of these patients require anesthetic care, because only 1 of 18 fractures required hospitalization.[39] In contrast, of the pediatric traumas requiring inpatient care, femur fractures were the most common orthopedic injury, accounting for 21.7% of fractures, followed by tibia/fibula fractures (21.5%), humerus fractures (17%), and radius/ulna fractures (14.7%). These trauma patients have on average 3 concomitant injuries. Patients with pelvis or vertebral fractures have on average 5 concomitant injuries.[40] For infants presenting with a fracture, nonaccidental trauma should be considered because it accounts for approximately 25% of fractures under 1 year of age.[41]

Anesthetic care for pediatric orthopedic traumas should begin with a review of concomitant injuries. Potential intracranial, cervical, chest, or abdominal injuries should be evaluated. Bleeding and hypovolemia need to be assessed. Urgency of the orthopedic surgery must be determined and may take precedence over appropriate presurgical fasting times, thus placing patients at risk for aspiration during induction of anesthesia. Therefore, airway management with a rapid-sequence intubation may be needed. Pain management with a regional anesthetic should be discussed because it may interfere with postoperative evaluation of nerve injury and motor function.

Slipped Capital Femoral Epiphysis

Slipped capital femoral epiphysis (SCFE) is a common hip disorder of adolescence. There is a gradual or acute displacement of the femoral head from the femoral neck through the physis. Patients present with a limp and pain in the groin, anterior thigh, or knee. The average age of diagnosis is 12 years to 13 years, corresponding to a growth spurt.[42] Typical patients are obese, with approximately half of patients above the 95th percentile in weight.[43,44] SCFE is classified as stable or unstable based on the ability to bear weight. Surgical management usually involves in situ screw fixation to prevent further slippage.[42]

Anesthetic management may require a rapid-sequence intubation if a patient presents emergently. Underlying obstructive sleep apnea associated with obesity may make postoperative opioids problematic. A multimodal approach to pain management can reduce opioid requirements. Central or peripheral regional techniques have been used for pain management as well.

Club foot

Congenital club foot is a common deformity that is usually treated with the Ponseti method, which involves a series of foot manipulation and casting, an Achilles tenotomy, and bracing.[45] A percutaneous Achilles tenotomy is needed 80% to 90% of the time. It is performed at a mean age of 9.5 weeks, with a range of 4 weeks to 12 weeks of age.[45]

The Achilles tenotomy can be performed in an office on an awake infant with local anesthetics or in the operating room under anesthesia. Various methods of anesthesia have been used, including sedation, general anesthesia, and spinal anesthesia.[45–48] Caution for postoperative apnea regardless of anesthetic type should be taken for patients born full term but less than 30 days old or born preterm and less than 60 weeks postconceptual age.[49] Extended hospital stay or overnight stay should be planned in this subset of patients.

For club foot requiring more extensive surgery, postoperative pain is of concern. Anesthesia care usually involves general anesthesia combined with a neuraxial or sciatic block.

Scoliosis—Posterior Spinal Fusion

The anesthetic management of a patient undergoing posterior spinal fusion for scoliosis surgery is complex and extensive. Some issues are discussed, although this section is not meant to be comprehensive.

Neuromonitoring

Paralysis or sensory loss is one of the most devastating complications associated with scoliosis surgery. There are various causes for neural injury, including direct cord or nerve injury from instrumentation and pedicle screws, stretch injury from deformity correction, and spinal cord ischemia from poor perfusion.[50] Spinal cord and nerve root injuries have been reported to be between 0.26% and 1.75% for idiopathic scoliosis.[50] Intraoperative neuromonitoring allows for early detection of possible nerve injury, giving the surgeon and anesthesiologist a chance to reverse the cause of injury.

Neuromonitoring usually combines somatosensory evoked potentials (SSEPs), motor evoked potentials (MEPs), and electromyography. SSEPs involve peripheral nerve stimulation and measuring responses via scalp electrodes. MEPs involve transcranial stimulation of the motor cortex and tracking responses peripherally. Electromyography can monitor nerve roots during manipulation and instrumentation. Most anesthetic agents depress neuromonitoring signals, with inhalational anesthetics doing so to a greater extent. IV anesthetics are often used to minimize use of inhalational anesthetics.[51]

The wake-up test is the gold standard and still has a role intraoperatively. The wake-up test assesses gross motor function and may be used to confirm persistent SSEP and MEP changes.[51] The depth of anesthesia is reduced to allow patients to follow commands to move upper and lower extremities. Risks of extubation, intraoperative recall, and air embolism exist.

Blood management strategies

The anesthesiologist must be prepared for large blood loss and hemodynamic instability during scoliosis correction surgery. There are large areas of bone bleeding and constant venous oozing at osteotomy sites and around screws.[52] Identification of high-risk patients is crucial. Blood loss is estimated to be approximately 750 mL to 1500 mL for posterior spinal fusion for idiopathic scoliosis or 65 mL to 150 mL per vertebral level. Patients with cerebral palsy have slightly elevated blood loss of 1300 mL to 2200 mL or 100 mL to 190 mL per vertebral level. Duchenne muscular dystrophy patients have the highest blood loss of 2500 mL to 4000 mL or 200 mL to 280 mL per vertebral level.[53] Other factors associated with increased blood loss include male gender, degree of kyphosis, operative time, lower body mass index, number of levels fused, and Cobb angle greater than 50°.[54–56] Rate of blood loss was shown to be greatest during the reduction and deformity correction stage at 9.08 mL/min for idiopathic scoliosis versus 3.43 mL/min during exposure, 5.05 mL/min during screw placement, and 3.28 mL/min during closure.[52]

Several strategies are used to decrease blood loss and transfusion of allogenic blood products, including preoperative iron or erythropoietin, preoperative autologous blood donation, and intraoperative blood salvage. Strategies used by the anesthesiologist include controlled hypotension, normovolemic hemodilution, and use of antifibrinolytic agents. Controlled hypotension has been shown to decrease blood loss, although increases the risk of poor end-organ perfusion, including the spinal cord. Hemodilution techniques involve removing and storing patient's blood and replacing it with crystalloid/colloid prior to start of surgery. Fewer red cells are lost during surgical blood loss, and patient's own blood can be transfused intraoperatively when needed. Antifibrinolytic agents, such as epsilon-aminocaproic acid and tranexamic acid inhibit the degradation of fibrin. Their use have been shown to decrease intraoperative blood loss as well. Of these techniques, intraoperative blood salvage and antifibrinolytic agents are the most widely used.[57,58]

Positioning related injuries

Careful positioning of patients is paramount to reducing adverse events. Padding on pressure points from bony prominences is needed to minimize skin breakdown. Peripheral neuropathies, such as brachial plexopathy and ulnar nerve injury, usually are due to stretch or compression injury due to positioning.[59,60] Care must be taken to reevaluate the arms as positioning may change during surgery.

Visual loss

Visual loss is a rare and devastating complication. There are various causes of postoperative visual loss. Ischemic optic neuropathy, posterior greater than anterior, is the most common cause during spine surgery in the adult population.[61] It is thought to be due to decreased perfusion pressure of the optic nerve.[62] Retinal artery occlusion can be caused by direct pressure on the globe.[63] Lastly, cortical blindness is due to injury of the visual cortex, which may be prone to insult from hypoperfusion and ischemic injury to due to its watershed blood supply.[63]

Incidence of visual loss for pediatric spine surgery was estimated to be 0.29%.[62] A more recent study looking at more than 42,000 pediatric scoliosis patients found postoperative visual loss to be 0.16%.[63] Their findings showed cortical blindness as the predominant cause in the pediatric population. This contrasts with a study of predominantly adults where ischemic optic neuropathy accounted for 89% of visual losses in spine surgeries.[61] Risk factors for the pediatric patient included younger age, male gender, fusion of 8+ levels, and preexisting iron deficiency anemia.[63] Although there are no data supporting specific prevention strategies, it is suggested to avoid hypotension, anemia, increased crystalloid administration, long surgical time, and head down position.[63] Frequent checks on the eyes are needed to prevent inadvertent pressure on the globe.

SUMMARY

Anesthetic care for the pediatric orthopedic patients is uniquely challenging. Preoperative concerns include children's psychological development, heightened anxiety, and frequent predilection to respiratory infections. Pain management is an essential part of perioperative care and often involves a multimodal approach. The goal of minimizing opioid use is especially important given the concerns of unexpected metabolism of oral opioids. Regional anesthetic in the form of neuraxial or peripheral nerve blocks are valuable to combat perioperative pain. The safety in performing these blocks in the anesthetized pediatric patient has been confirmed in recent studies. Certain pediatric orthopedic surgeries can have unique anesthetic concerns. Understanding these concerns is necessary for optimal anesthetic care and outcomes.

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