Adverse Outcomes After Spine Surgery

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Complications and mortality after surgery for lumbar stenosis (Deyo et al, 2010): retrospective cohort analysis of Medicare claims from 2002 to 2007 in patients ≥65 yr of age undergoing surgery for lumbar stenosis; ≥2% of patients undergoing decompression had major cardiopulmonary complication or stroke (rate increases to >5% in patients with fusion, and can be as high as 20% with more complex fusion procedures); complication rates higher in patients >80 yr of age or with ≥3 comorbidities; mortality — 0.3% after decompression; increases to ≥2% with fusions, age >80 yr, and ≥3 comorbidities

Complications of cervical and lumbar procedures: in data from Closed Claims Project (2000 to present), spine procedures account for high proportion of claims for nerve injuries; some of these injuries surgical in nature, but position injuries, brachial plexopathy, and ulnar neuropathy make up majority; additionally, proportion of claims made for eye injury greater in spine surgeries than in other types of surgery; cervical spine procedures — difficult intubation more common than in lumbar or thoracic spine procedures; often associated with excessive use of sedation or failure to visualize vocal cords well; lumbar spine procedures — 15% of claims associated with hemorrhage; often results from “delay and denial” (eg, physician denies presence of hemorrhage in patient undergoing minimally invasive procedure; poor or inadequate treatment of hemorrhage results in patient injury); ≥25% of claims for lumbar and thoracic spine associated with positioning and padding injuries

Hemorrhage: spine procedures major source of cases with hemorrhage-associated complications Study (Dutton et al, 2014): causes of delay in treatment — difficulty in diagnosing hemorrhage during spine procedures; issues relating to transfusion (eg, lack of timely transfusion, possibly resulting from lack of foresight in ordering blood); inadequate intravenous (IV) access; failure to insert arterial lines during major cases; inadequate number of lines; failure to check hematocrit; ineffective communication between care providers; delays in return to operating room; recommendations — conglu- lopathy must be detected early and treated appropriately; use massive transfusion protocols and team training, and ensure rapid delivery of platelets and fresh frozen plasma

Complications resulting from positioning: Wilson frame holds head straight; if head turned, tension may be placed on opposite brachial plexus; arms may be positioned incorrectly (pushed back rather than forward); proper positioning should be checked preoperatively; during spine surgeries, neurophysiologists can monitor changes in motor evoked potentials and somatosensory evoked potentials in upper extremities, and prevent injuries by changing positioning; head holders — at speaker’s institution, blue sponge holder used for shorter procedures; use of Mayfield tongs for longer procedures reduces frequency with which eyes must be checked; malpractice literature supports documentation of eye checks every 15 to 20 min when head holders used

Embolic complications: case reports of venous air embolism, fat embolism, paradoxical air embolism, and cement embolism extremely rare; study (Takahashi et al, 2003) — with transoesoph- ageal echocardiography, found that insertion of pedicle screw may be related to particulate (probably fat) emboli in instrumented patients; if spine not instrumented, embolic events not seen

Visual Loss After Spine Surgery

Incidence: extremely rare; study (Shen et al, 2009) — in Nation- wide Inpatient Sample from Medicare data, overall incidence 1 in 1000; complex older patients with severe scoliosis at higher risk for visual loss after spinal surgery; incidence of perioperative visual loss appears to be decreasing over time (probably due to changes in practice); risk factors for visual loss after spine surgery include peripheral vascular disease, diabetes, hypotension, and anemia

Study (Lee et al, 2006): used data from 93 spine surgery cases voluntarily submitted to the American Society of Anesthesiologists (ASA) Postoperative Visual Loss Registry from patients, families, and malpractice files; 90% of complications ischemic optic neuropathy, but distinguishing anterior from posterior cases difficult on basis of records; central retinal artery occlusion — visual complication in ≥10% of cases; commonly unilateral; frequently associated with trauma around eye or rim of eye, and often related to use of horseshoe head frame; can be caused by pressure on globe (as opposed to ischemic optic neuropathy [does not occur through this mechanism, but exact cause unknown])

Arterial causes: minimal blood flows through pial plexus to optic nerve; this flow can change during surgery; study (Lee et al, 2008) — in pigs, no changes in blood flow seen if animal hypotensive but euvoicemic (changes in oxygen delivery to optic nerve not statistically significant); in hypovolemic (with low hemoglobin), hypotensive pigs, oxygen delivery to optic nerve reduced; results suggest that decrease in mean arterial pressure or decrease in hemoglobin can cause visual complications during surgery

Evaluative Objectives

The goals of this program are to improve prevention of anesthe- sia-related complications following spinal procedures, and decision making with regard to the appropriateness of perform- ing pediatric procedures in an outpatient or ambulatory setting. After hearing and assimilating this program, the clinician will be better able to:

1. Avoid delays in the treatment of intraoperative hemorrhage during spinal procedures.
2. Identify mechanisms by which damage to the optic nerve occurs during spinal surgery.
3. List risk factors for the development of perioperative visual loss.
4. Determine the appropriateness of surgery in outpatient or ambulatory settings for a pediatric patient.
5. Take appropriate precautions when performing elective surgery in children with various medical conditions.

Faculty Disclosure

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Patient-specific causes: development of ischemic optic neuropathy in patients undergoing, eg, open-heart surgery, liver transplantation, or after severe trauma, may be associated with vascular disease; vasopressors can help to avoid hypotension and improve perfusion to spinal cord during periods of distraction, but patients may have abnormalities of autoregulation; predisposing anatomic issues present in some patients, but these cannot be assessed; embolic phenomena may play role

Venous causes: swelling associated with use of large amounts of crystalloid may occur in airway or eyelids, but concern for visual loss caused by swelling at back of optic nerve, which increases venous pressure in this area; development of compartment syndrome possible in optic canal (bridged by bone); increased venous pressure secondary to swelling reduces flow through small pial vessels and may thereby cause visual loss

Risk factors for ischemic optic neuropathy after spinal surgery: assessed in multicenter case-control study by Postoperative Visual Loss Study Group (2012); include male sex, obesity, and use of Wilson frame (should be avoided in long procedures; ASA advisory group recommends keeping head higher than back if used), prolonged operating time (ie, >4 hr under anesthesia); use of colloid in addition to crystalloid with administered blood products reduces risk for ischemic optic neuropathy; neither reduction in mean arterial pressure during surgery (relative to preanesthesia level) nor hematocrit level found to be risk factor (majority of controls and cases had hematocrit <30%); patients having major spine surgery should be informed of these risk factors

ASA Practice Advisory for Perioperative Visual Loss Associated with Spine Surgery: informed consent should include risk for vision loss (critical to defense in malpractice cases); head should be kept neutral or at level of heart; deliberate hypotension not recommended; addition of colloids to crystalloids recommended for management of intraocular pressure; no comment made on use of vasopressors; staged procedures (ie, long procedure divided into 2 shorter procedures) recommended

Conclusion: most visual loss after prone spine surgery associated with long-duration instrumentation and fusions with large amounts of blood loss; ischemic optic neuropathy generally bilateral (not caused by pressure on globe, which usually produces unilateral vision loss) and associated with decreased perfusion pressure, with venous congestion playing some role; use of Wilson frame should be avoided; colloids should be used along with crystalloids

Choosing a Venue for Pediatric Elective Surgery

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Overview: between 2010 and 2014, 14.2 million anesthetics required, and of those, approximately 10% pediatric; predominant procedure tonsillectomy, followed by magnetic resonance imaging, endoscopy, and inguinal hernia repair; ≈95% of procedures used general anesthetics

Outpatient selection: American Association of Pediatrics, Society of Pediatric Anesthesia, and ASA recommend basing selection on age, length of procedure, amount of blood loss and type of postoperative complications expected, and qualifications of health care staff in preoperative, intraoperative, and postoperative periods

Agenesis of prematurity: may occur postoperatively in premature (or formerly premature) infants who received general anesthesia; study data (Côté et al, 1995) — in 255 formerly premature infants (<37 wk of gestation) undergoing hernia repair under general anesthesia, risk for postoperative agenesis (including agenesis >15 sec, or in presence of bradycardia, <15 sec) increased with degree of prematurity; risk increased in patients who experienced agenesis at home; anemia (hematocrit <30%) also a risk factor; risk for postoperative agenesis decreased to <1% at ≥55 wk postconceptual age; at time of study, most institutions instituted 60-wk postconceptual age cutoff for outpatient procedure, but recent advances in anesthesia (eg, use of multimodal therapy including acetaminophen, ketorolac, and regional anesthesia instead of opioids) have allowed guidelines to be updated; current guidelines — outpatient surgery may be considered for formerly premature infants at least 50 to 54 wk postconceptual age without major comorbidities, anemia, or family history of sudden infant death syndrome; full-term infants (born at >37 wk gestation) can be considered for outpatient surgery at ≥24 wk of age

Sleep-disordered breathing: obstructive sleep apnea (OSA) affects ≤20% of infants due to small and slightly hypertonic airways; however, incidence declines to <5% by 8 yr of age; most children with sleep-disordered breathing fatigued during daytime but some may be hyperactive (and thus may be wrongly diagnosed with attention-deficit/hyperactivity disorder); sleep studies — utility for determining, eg, need for admission, type of monitoring required, well-documented in adults but less so for pediatric patients; sleep studies recommended when need for tonsillectomy or adenoidectomy unclear, but unnecessary if patient absolutely needs procedure (consult with otolaryngologist to determine appropriateness of outpatient setting)

Tonsillectomy: study (Ross et al, 2002) — among patients <3 yr of age having procedure in outpatient setting, >25% hospitalized postoperatively for >1 day, and 16% required admission to intensive care unit, with airway intervention; in this population, performing tonsillectomy in office-based or ambulatory-based settings not advisable; study (Côté et al, 2014) — based on results from an electronic survey and data from the ASA Closed Claims Project; among >100 children who experienced adverse events during or after tonsillectomy, outcomes included death or severe neurologic impairment in 77% of cases

Obesity: may have same associated risks and complications in children as those seen in adults (eg, hypertension, OSA, asthma, type 2 diabetes); difficulty may be encountered when placing IV lines and during monitoring, and airway issues during anesthesia possible; guidelines suggest that practices determine upper body surface area and upper absolute weight limit for outpatient procedures in adult and pediatric populations

Trisomy 21: according to guidelines from Children’s Hospital of Philadelphia, in order for patient with trisomy 21 to be eligible for outpatient surgery, child must be ≥1 yr of age and have no active cardiac disease or instability of cervical spine; atlantoaxial instability — incidence ≤20% in this population, but only ≈1% have symptoms, such as neck pain, ataxia, gait disturbance, or incontinence; should be treated as potentially unstable neck during procedure (avoid rotatory motion as well as extension); comorbidities — endocrine issues (eg, thyroid, diabetes, obesity); incidence of OSA nearly 100%; risk for recurrent pulmonary infection increased 124-fold; difficult airway associated with limited ability to manipulate neck and large tongue (reducing size of endotracheal tube one-half to one full size recommended); congenital heart disease (before performing outpatient procedure, ensure that patient has no residual heart disease, current use of cardiac medications, or history of malignant arrhythmia)

Mitochondrial disorders: incidence increasing (estimated at 1 in 5000, but many cases undiagnosed until adulthood); associated with unpredictable reactions to volatile IV and local anesthetics; best anesthetics unclear, but propofol infusion should be avoided; due to unpredictability of reactions to anesthetics, patients with mitochondrial disorders should not undergo procedures in freestanding outpatient setting

Asthma: according to guidelines from Children’s Hospital of Philadelphia, anesthesia contraindicated until ≥1 mo has elapsed since last exacerbation; patients should have no respiratory comorbidities and normal oxygen saturation; consider patient characteristics and procedure being undertaken when determining appropriateness of outpatient care

Malignant hyperthermia: incidence ≈1 in 15,000 anesthetics for children and ≈1 in 50,000 in adults; anesthetizing patients
susceptible to malignant hyperthermia may be appropriate in outpatient settings, with precautions; manpower capacity must be considered, and laboratory facilities to evaluate blood gases must be available; rapid transfer of patient to another institution, if needed, with ongoing treatment, should be available.

**Respiratory tract infection (RTI):** elective procedures should not be performed in patients with symptoms of lower RTI or fever; in otherwise healthy children with rhinorrhea, procedures may be performed with appropriate precautions; however, when general anesthesia used, respiratory events (ie, bronchospasm, laryngospasm, or oxygen desaturation) 2 to 3 times more likely in such patients; while risk for morbidity increased, no increase seen in risk for mortality.

**Other contraindications to outpatient surgery:** severe cerebral palsy; difficult-to-intubate patients; cystic fibrosis; diabetes; sickle cell disease; coagulation disorders.

**Conclusion:** establish guidelines, including minimum age and procedures acceptable for outpatient or ambulatory setting; ensure staffing adequate; preanesthesia screening important; establish transfer agreement with nearby institutions for cases in which patients must be admitted.

**Acknowledgments**

Dr. Domino and Dr. Ehlers were recorded at the 68th Annual Postgraduate Assembly in Anesthesiology, presented by the New York State Society of Anesthesiologists, and held December 12-16, 2014, in New York, NY. For information about upcoming CME meetings from the New York State Society of Anesthesiologists, please visit NYSSA-PGA.org. The Audio Digest Foundation thanks the speakers and the sponsors for their cooperation in the production of this program.

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ADVERSE OUTCOMES AFTER SPINE SURGERY/PEDIATRIC AMBULATORY SURGERY

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1. In the Closed Claims Project database, 15% of claims associated with lumbar spine procedures were related to complications of:
   (A) Hemorrhage ** (C) Padding and positioning injuries
   (B) Nerve injury (D) Embolic events

2. It is prudent to perform and document eye checks every _______ when head holders are being used during spinal procedures.
   (A) 15 to 20 min ** (C) 60 to 70 mins
   (B) 30 to 45 min (D) 1 to 2 hr

3. The incidence of perioperative visual loss appears to be _______ among patients undergoing spinal surgery.
   (A) Remaining stable (B) Increasing ** (C) Decreasing

4. According to a 2012 study by the Postoperative Visual Loss Study Group, which of the following are risk factors for ischemic optic neuropathy?
   1. Low hematocrit
   2. Male sex
   3. Obesity
   4. Reduced preoperative mean arterial pressure during surgery
   5. Use of Wilson frame
   (A) 1, 2, 3 (B) 3, 4, 5 (C) 1, 2, 5 ** (D) 2, 3, 5

5. Which of the following volume replacement strategies was recommended to reduce the risk for increased intraocular pressure during spine surgery?
   (A) Whole blood only ** (C) Colloid only
   (B) Crystalloid only (D) Addition of crystalloid to colloid

6. Guidelines for avoiding postoperative apnea of prematurity recommend that formerly premature infants be at least _______ postconceptual age before considering an outpatient procedure.
   (A) 38 to 40 wk ** (C) 50 to 54 wk
   (B) 45 to 48 wk (D) 75 to 80 wk

7. Sleep studies are unnecessary prior to a tonsillectomy or adenoidectomy procedure when:
   (A) There is no question about the necessity of the surgery ** (B) Patient is <3 yr of age
   (C) Patient’s parents have witnessed apneic episodes (D) Patient was born at >37 wk gestation

   (A) Most children with atlantoaxial instability are symptomatic
   (B) Extension of the neck should be avoided in patients with atlantoaxial instability, but rotatory motions are safe
   (C) The incidence of obstructive sleep apnea is nearly 100% ** (D) Outpatient surgery can be performed in patients taking cardiac medications

9. Which of the following conditions is an absolute contraindication to surgery in an outpatient setting?
   (A) Mitochondrial disorders (C) Rhinorrhea
   (B) Obesity ** (D) Risk for malignant hyperthermia

10. Children with asthma should not undergo anesthesia until at least _______ has(have) elapsed since their last asthma exacerbation.
    (A) 1 wk (B) 3 wk (C) 1 mo ** (D) 3 mo

Answers to Audio Digest Anesthesiology Volume 57, Issue 18: 1-D, 2-C, 3-B, 4-C, 5-A, 6-C, 7-C, 8-D, 9-C, 10-A