Anesthesia for Spine Fusion – Intraoperative Management

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General

IV Access: consider two IVs if no CVP

Noninvasive Monitoring:

- Urine Output:
  - >0.5 cc/kg/hr indicates adequate perfusion in patients with normal renal function
  - <0.5cc/kg/hr indicates inadequate perfusion, not a furosemide deficit, until proven otherwise
- Blood Loss:
  - EBV = 70 cc/kg
  - EBL of 50% of EBV triggers evaluation for transfusion of RBCs and / or coagulation factors

Invasive Monitoring:

- Arterial BP: consider for freq sampling, aggressive BP mgt, or comorbitidies
- CVP: consider esp. for re-do, cardiac or renal dysfunction, or difficult IV access

Positioning: document regular eye / face checks

Neurodiagnostic Monitoring

Degree of Interference	**Inhaled gases**	**Muscle relaxants**	**Propofol, narcotics, benzodiazepines, dexmedetomidine**
SSEP	Dose-related	Minor or none	Minor or none
MEP	Dose-related	Complete	Minor or none
EMG	Minor or none	Complete	Minor or none
Pedicle screw EMG	Minor or none	Complete	Minor or none
Vocal cord EMG	Minor or none	Complete	Minor or none

Types of Monitoring

SSEPs: Stim peripheral n. → dorsal column sensory tract → cortical (EEG) monitoring
- Up to 15 min delay from injury to detection
- Affected by inhaled anesth agents, temp, BP
- Nearly all IV anesthetics OK except propofol in very high doses
- Unaffected by muscle relaxants

TC-MEPs: Stim motor cortex → motor tracts → record at peripheral nerves or muscles
- Instantaneous response to injury
- Even more sensitive to GA than SSEP
- Blocked by muscle relaxants
- Case reports show interference by dexmedetomidine[1]

EMG: Monitors electrical activity in muscles, either ambient or triggered
- Unaffected by GA, but blocked by muscle relaxants
- <u>Pedicle screw monitoring</u>: Triggered EMG with stim. at pedicle screw
  - Blocked by muscle relaxants, unaffected by GA
- <u>Vocal cord monitoring</u>: Ambient EMG in CN-X distribution
  - Blocked by muscle relaxants, unaffected by GA

Conduct of Anesthesia:

If in doubt, check with surgeon to ascertain which monitoring modalities are actually important for a particular case

For pedicle screw monitoring, there is often a lengthy exposure time during which pt. may be allowed to recover from initial muscle relaxants

SSEP and MEP: consider establishing a baseline <u>low</u> level of inhaled agent, supplemented by IV agents
- Adjust anesth depth using IV infusion agents, esp. propofol

EMG (incl ped screw and vocal cord):
- Use short acting relaxants for intubation
- For prone cases, consider rocuronium to prevent coughing / extubation during turning

Transfusion Reduction Strategies

Deliberate Hypotension (MAP 60-70)
- Benefit: not well established; most surgical bleeding is venous, not arterial
- Safety beyond moderate range: not well established, especially if combined with acute normovolemic hemodilution
- Agents:
  - Nitroglycerine: available as 200 mcg/ml bottle; 10-50 mcg/min; no adjustment for renal insufficiency
  - Nicardipine: dilute to 0.1 mg/ml; load at 5→10→15 mg/hr until BP target reached, then 3-5 mg/hr; no adjustment for renal insufficiency
  - Esmolol: dilute to 10 mg/ml; 0.5-1 mg/kg load (optional), then 100-500 mcg/kg/min; no adjustment for renal insufficiency

Acute Normovolemic Hemodilution
- Probably reduces transfusions when hard transfusion triggers are used, but less clear benefit in real life
- Similar efficacy to preop autologous transfusion, but much cheaper
- Use of large amounts of colloid may compromise coagulation

Temperature Management: Mild hypothermia (< 1°C) increases both blood loss and transfusion requirement (Shown by meta-analysis, not prospective trial)[2]

Eye Care[3]

Mechanisms:
- Ischemic Optic Neuropathy (ION), Central Retinal Artery Occlusion (CRAO)

"At Risk" patients:
- ↑ in prolonged surgery, substantial blood loss, or both
- No known patient characteristics
- No established risk thresholds for: Hb, CVP or intravascular volume, BP, or vasoconstrictor use

Positioning:
- ION: no known effect
- CRAO: avoid direct ocular pressure; position head level with or above heart if possible

Glucose Management

"Tight" glucose control (150-180 mg/dl): benefits well established for cardiac surgery; less established for noncardiac surgery

"Tighter" control (80-100 mg/dl): risks, incl stroke, may be elevated, at least in cardiac surgery[4]; benefits not established

Monitoring frequency: suggest once / hour during steady state insulin infusion

Transfusion Thresholds[5]

PRBCs
- Rarely needed if Hb > 10 g/dl
- Usually needed if Hb < 6 g/dl
- Average transfusion volume = 1-2 units PRBCs

Platelets
- Consider checking when EBL > ½ EBV
- Rarely needed if plt > 100k
- Usually needed of plt < 50k
- Average transfusion volume = 6 units, or 1 unit / 10 kg

Anticoagulation Management

Amicar (ε-aminocaproic acid):
- 5gm load over 30-60 min.; 1 gm/hr for remainder of case;

Inhibits fibrinolysis;
Reduce dose in renal insufficiency; no quantitative info available
Questionable value in spine surgery[6]

FFP
Consider checking PT, PTT, fibrinogen when EBL > ½ EBV
Indicated for correction of excessive bleeding AND:
INR 2.0, or PTT 2X normal, or s/p transfusion > 70 ml/kg
Average transfusion volume = 2 units, or 10-15 ml / kg

Cryoprecipitate
Rarely needed if fibrinogen > 150 mg/dl
Usually needed if fibrinogen < 100 mg/dl, or s/p massive transfusion
Average transfusion volume = 8-10 units, or 1 unit / 10 kg

Desmopressin (a.k.a. DDAVP), (not *vasopressin*):
Consider "when excessive bleeding occurs," or to treat hetastarch-related platelet dysfunction
Dose = 0.3 mcg / kg, diluted, over 15-30 min

Recombinant factor VII
Consider when all else fails, and money is no object
Average dose = 100 mcg / kg; may repeat in 30 min

Colloid Administration[7] (Hespan)

Volume expansion must be balanced against effects on coagulation
Negatively affects F-VII, VWF, and platelet function (reduced Gp IIb-IIIa expression), even at recommended doses;
Generally imitates and accelerates dilutional coagulopathy
Prolongs PTT, TEG measures of clot formation and strength
Effects may be offset by desmopressin (0.3 µg/kg), cryoprecipitate, F-VIII concentrate, or platelet transfusion

Nonroutine Anesthetic Agents

Propofol infusion: large bottles available

Dexmedetomidine infusion:
Prepared as 4mcg / ml in NS
0.2 - 0.7 mcg/kg/hr (optional bolus 1 mcg/kg)
Hepatic metabolism
Moderate amnesia, little analgesia
Consider using for tube tolerance during "wake-up vent"

Ketamine
May enhance SSEPs
May reduce narcotic requirement, but also increase PONV
3 mcg/kg/min = low-dose infusion rate

Fentanyl infusion
Infusion rate = 1-4 mcg / kg / hr; varies with concomitant agents
Fentanyl plasma $t_{1/2}$ greatly prolonged with infusions over 1 hour; little need for end-of-case narcotics

[1] Mahmoud, et. al. Loss of Transcranial Electric Motor Evoked Potentials during Pediatric Spine Surgery with Dexmedetomidine. Anesthesiology 2007; 106: 393-6.
[2] Rajagopalan, et. al. The Effects of Mild Perioperative Hypothermia on Blood Loss and Transfusion Requirement. Anesthesiology 2008; 108:71-7.
[3] ASA Task Force on Perioperative Blindness. Anesthesiology 2006; 104: 1319-28.
[4] Gandhl, et. al. Intensive Intraoperative Insulin Therapy versus Conventional Glucose Management during Cardiac Surgery. Annals of Internal Medicine 2007; 146: 233-43.
[5] Practice Guidelines for Perioperative Blood Transfusion and Adjuvant Therapies. American Society of Anesthesiologists Task Force on Perioperative Blood Transfusion and Adjuvant Therapies
[6] Zufferey, et. al. Do Antifibrinolytics Reduce Allogeneic Blood Transfusion in Orthopedic Surgery? Anesthesiology 2006; 105: 1034-46.
[7] Kozek-Langenecker. Effects of Hydroxyethyl Starch Solutions on Hemostasis. Anesthesiology 2005; 103: 654-60.