

# Anesthesia For Spinal Surgery

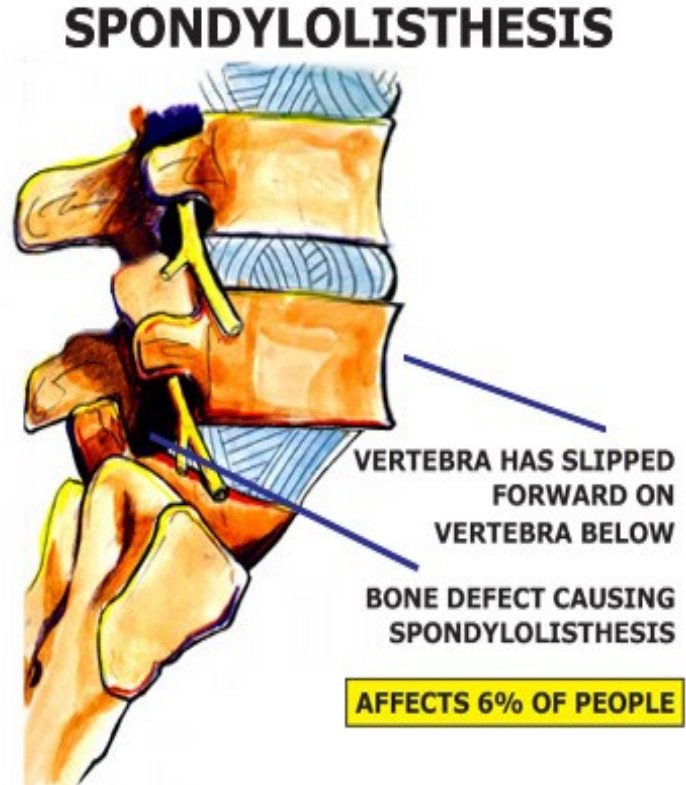
Dr. Ashish

Moderator: Dr. R. Tope

- **Spinal conditions requiring spinal surgery**
- **Surgical procedures**
- **Anesthetic considerations**
- **Unique challenges for spinal surgery**

# Spinal conditions requiring spinal surgery

## Intervertebral disc lesions

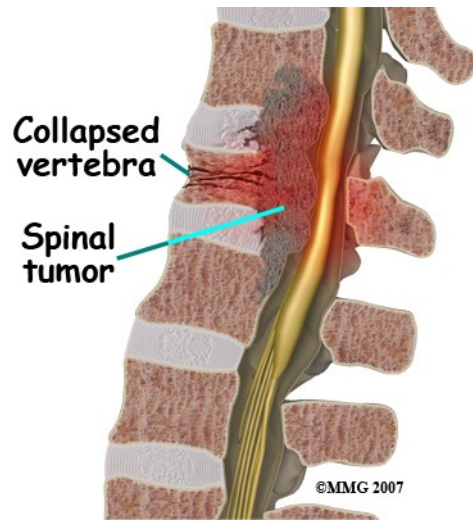


# Spinal conditions requiring spinal surgery

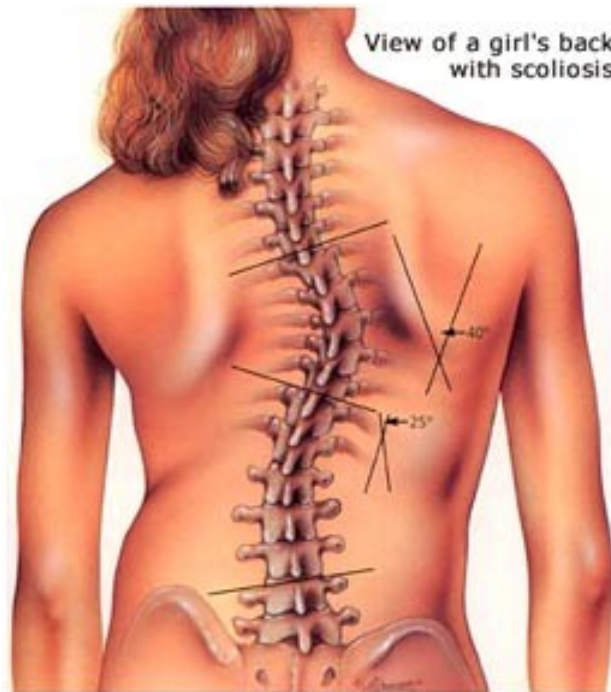
## Spinal stenosis



## Spinal tumor



## Scoliosis



## Kyphosis



## Lordosis





# Scoliosis

- Deformity of spine
- Lateral curvature+vertebral body rotation+deformity of rib cage
- Idiopathic: 75-90%
- Others: Congenital,neuromascular, traumatic, syndromal,TB
- Respiratory: V/Q mismatch,

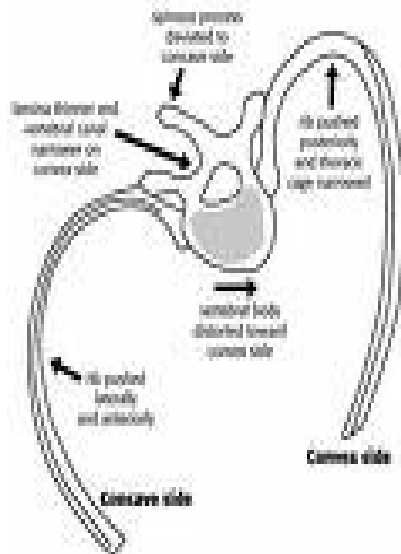
Dec VC, FRC, RV, TLC

Dec compliance

Hypoxemia,

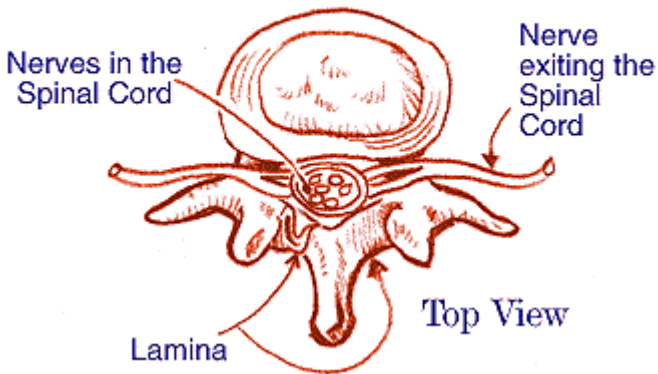
hypercapnia

Pulmonary HTn

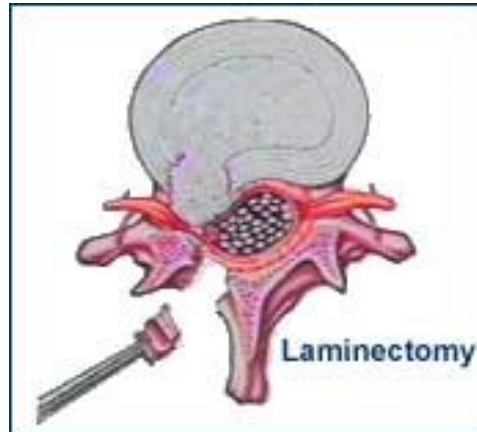


# Surgical procedures

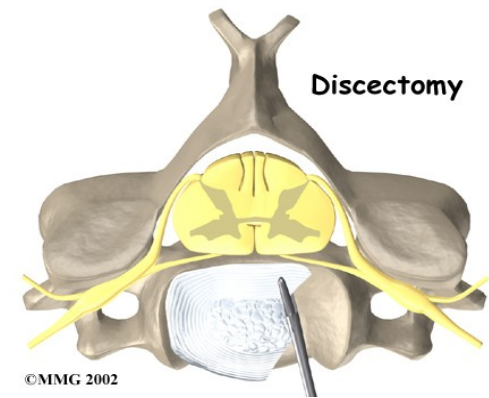
## Laminotomy



## Laminectomy



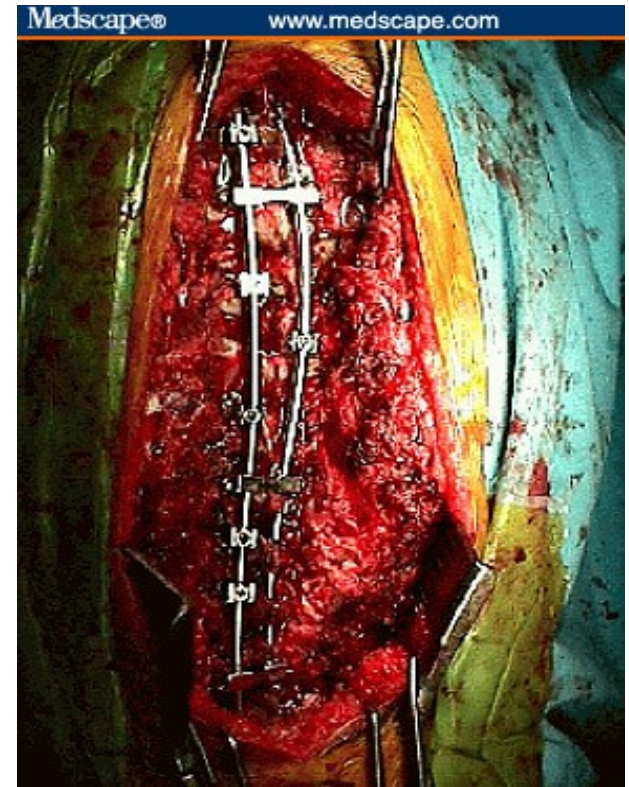
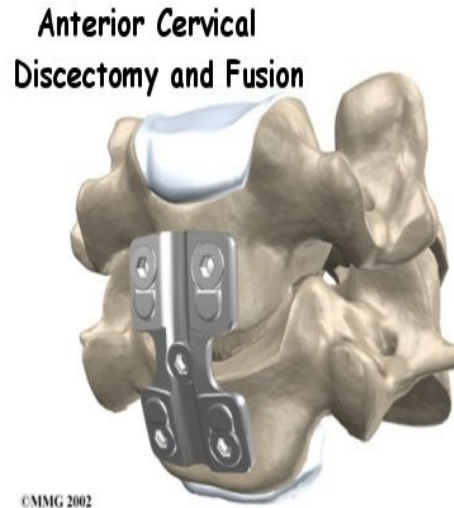
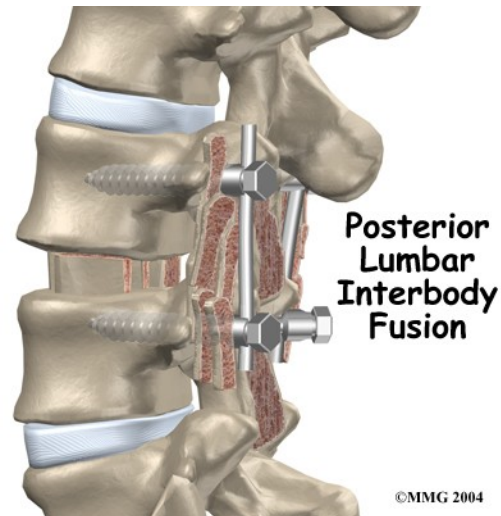
## Discectomy



# Surgical procedures

## Instrumentation

### Fusion and Fixation



# **Anesthetic considerations**

- **Pre-Operative Assessment**

## **Airway Assessment:**

**AWC, TMD, Mouth opening**

**Previous difficulty in intubation**

**Restriction of neck movement**

**Stability of the cervical spine**

**It is essential to discuss preoperatively the stability of the spine with the surgeon.**

- **Respiratory System**

**History: focus on functional impairment**

**PE: any signs of pulmonary infection  
severity of the spine deformities**

**CXR**

**PFTs: scoliosis**

**ABG**

- **Cardiovascular System**

**History: HTN, DM, CHF, CAD**

**PE: any signs of CHF**

**ECG**

**Stress test/Echo: in pts with limited ET**

# **Suggested preoperative investigations before major spinal surgery**

## **Minimum investigations**

## **Optional investigations**

- |                                                                          |                                                                                                            |                           |
|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|---------------------------|
| <ul style="list-style-type: none"><li>• <b>Airway</b></li></ul>          | <b>Cervical spine lateral x-rays with flexion/extension views (for patients with rheumatoid arthritis)</b> | <b>CT scan</b>            |
| <ul style="list-style-type: none"><li>• <b>Pulmonary tests</b></li></ul> | <b>CXR</b>                                                                                                 | <b>Pulmonary function</b> |
| <ul style="list-style-type: none"><li>• <b>reversibility)</b></li></ul>  | <b>ABG</b>                                                                                                 | <b>(bronchodilator</b>    |
|                                                                          | <b>Spirometry (FEV1, FVC)</b>                                                                              |                           |
| <ul style="list-style-type: none"><li>• <b>CVS</b></li></ul>             | <b>EKG</b>                                                                                                 | <b>Dobutamine-stress</b>  |
| <ul style="list-style-type: none"><li>• <b>Echo</b></li></ul>            | <b>Echocardiography</b>                                                                                    |                           |
| <ul style="list-style-type: none"><li>• <b>Blood tests</b></li></ul>     | <b>CBC, electrolytes,Cr<br/>BUN, PT/PTT<br/>Albumin, calcium (neoplastic disease)</b>                      | <b>LFTs</b>               |

# **Neurological assessment**

**Full neurological assessment should be documented.**

- C-spine surgery - avoid further neurological deterioration during maneuvers such as intubation and pt positioning.**
- Muscular dystrophies may involve bulbar muscles, increase risk of postoperative aspiration.**
- level of injury and time elapsed since insult are predictors of the physiological derangements of the cvs and r/s systems which occur perioperatively.**
- < 3 weeks of the injury, spinal shock may still be present.**
- After this time, autonomic dysreflexia may occur.**

# Anesthesia technique

## Induction:

Choice of induction technique:

**i.v. or inhalation ?**

Pt's medical condition

Airway

C-spine stability

Choice of muscle relaxants:

**Succinylcholine or NDNMBs ?**

Pt's medical condition

Airway

Risk of aspiration

Intra-operative monitoring

# Anesthesia technique

## Intubation

**Awake or asleep?**

**Awake intubation:**

**Risk of aspiration**

**Neuro assessment after intubation: an unstable c-spine**

**Presence of a neck stabilization device: halo traction**

**Direct or fiber-optic laryngoscopy?**

**Direct laryngoscopy:**

**Intubation can be achieved without any neck movement**

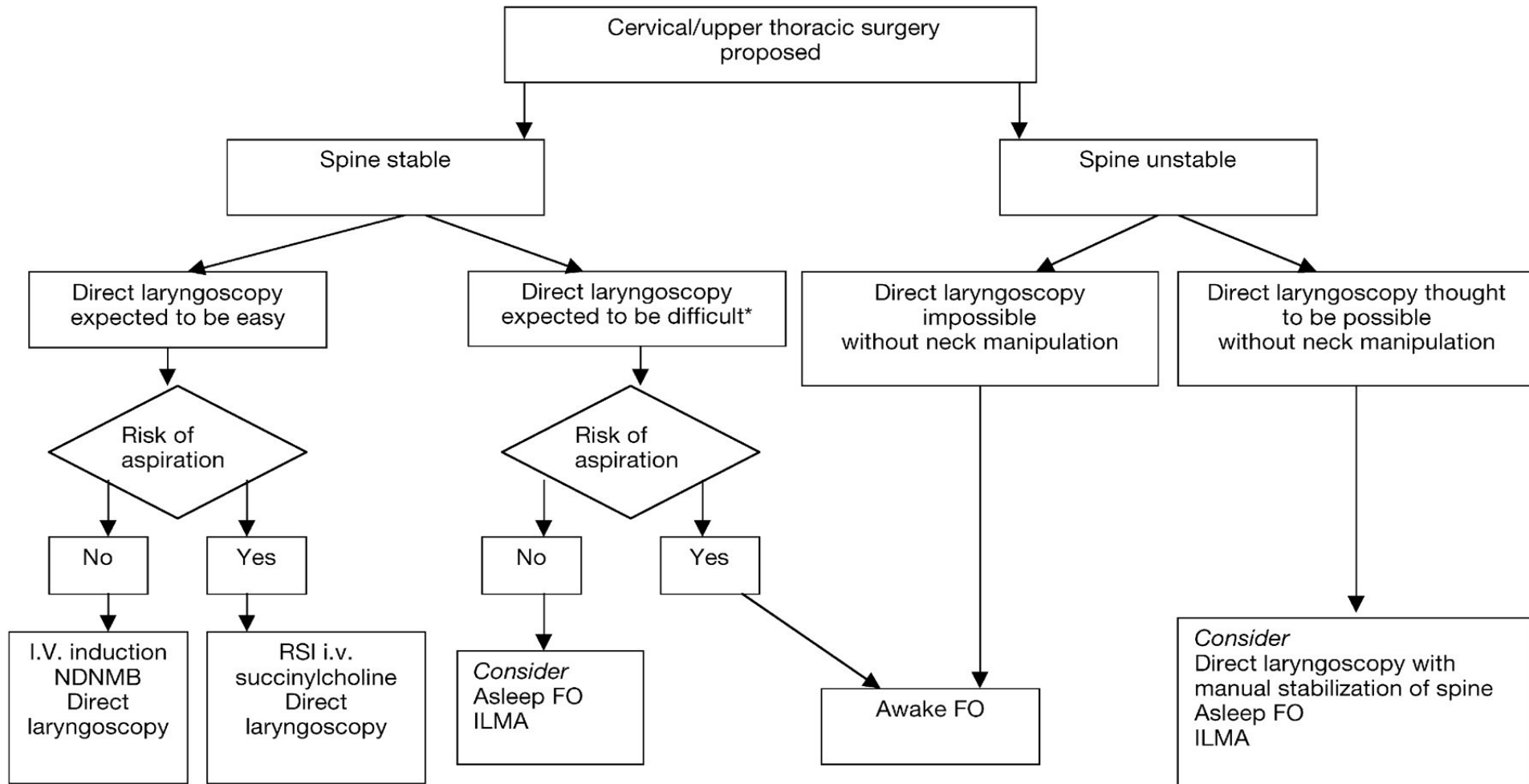
**(manual in-line stabilization or a hard collar)**

**Fiber-optic laryngoscopy:**

**Fixed flexion deformities: involving upper T-spine/c-spine**

**Pts wearing stabilization devices such as halo vests**  
**Anatomical reasons: micrognathia, limited mouth opening**

# Algorithm for decision making when intubating a pt for proposed surgery involving the upper T or cervical spine



\*e.g. presence of: halo vest  
severe kyphoscoliosis  
anatomical variance: micrognathia, restricted mouth opening

# Cervical spine involvement

2% victims of trauma

6% craniofacial injury,

Glasgow scale <8

## **Spine protection measures**

- **MILS:** Preferred
- Semi rigid collar
- Lateral head support

## **MILS vs Collar**

Collar: not complete protection  
complicate airway during CPR  
increase ICP, in head injury  
interfere with intubation effort

# Airway Intervention

- Maintaining Spinal Precautions
    - Supine position
  - Maintain neutral C-spine
    - Remove rigid collar and sandbags
    - Manually stabilize C-spine
- 2 person technique:
- 1st person to provide manual in-line stabilization (not traction) of C-spine
  - 2nd person intubates

# MILS



# MILS



# Anesthesia technique

## Maintenance

**Maintain a stable anesthetic depth**

**Avoid sudden changes in anesthetic depth or**

**BP**

**Maintain a constant depth of NMB**

**Common practice: 0.5 MAC Iso or sevo**

**continuous infusion of**

**propofol**

**continuous remifentanyl or bolus opioids**

## Emergence

**Extubation: Fully awake**

**Responding to commands**

**Able to manage his/her own airway**

**Patent airway**

# **Unique challenges for spinal surgery**

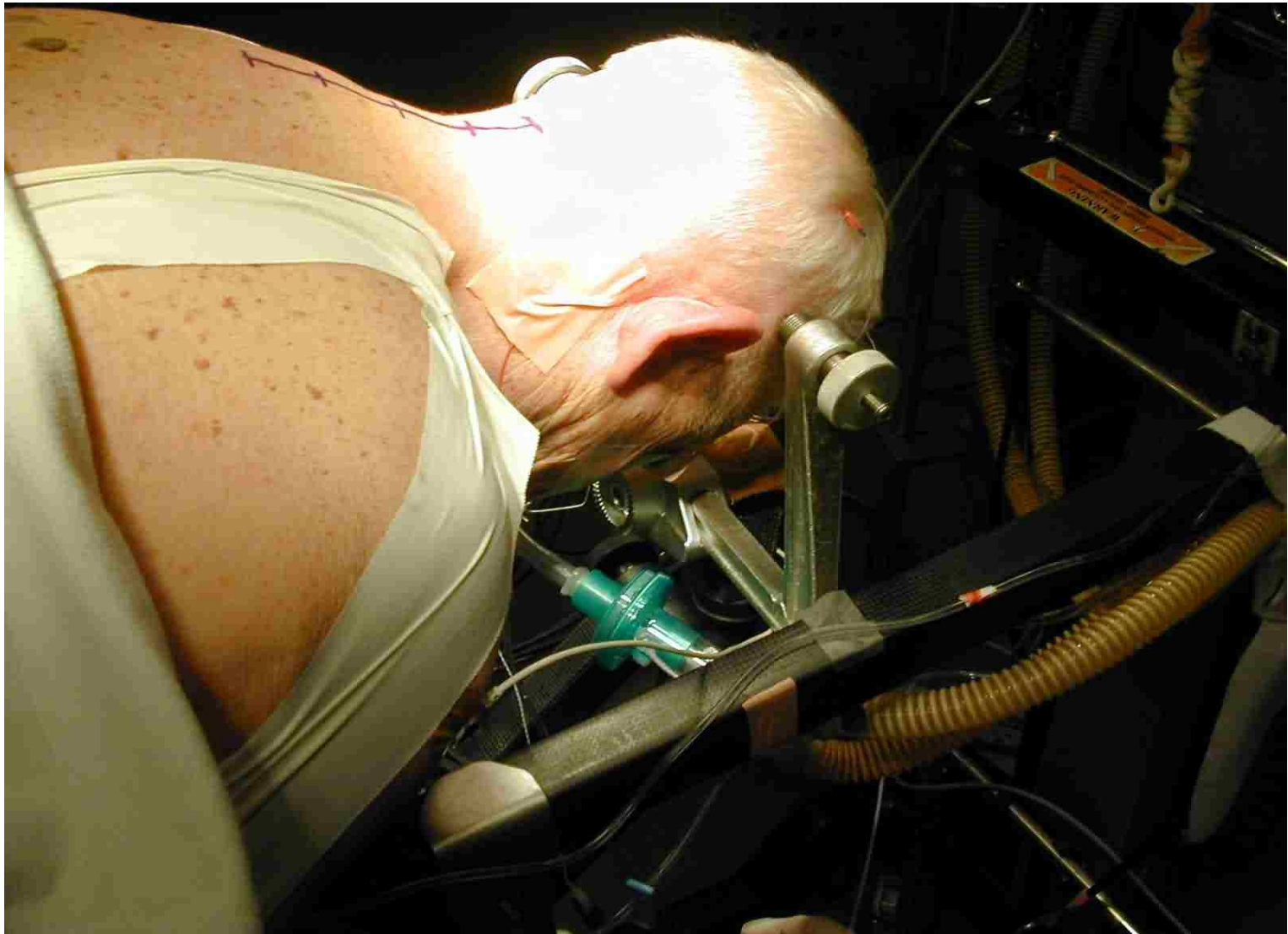
**Positioning**

**Intra-operative monitoring**

**Spinal cord injury**

**Post-operative visual loss (POVL)**

# Positioning



Prone position for C-spine procedure

# Anesthetic problems of the prone position

## Airway:

- ET tube kinking or dislodgement
- Edema of upper airway in prolonged cases

## Blood Vessels:

- Arterial or venous occlusion of the upper extremity
- Kinking of femoral vein with marked flexion of the hips, ↑ DVP
- ↑ abdominal pressure: ↑ epidural venous pressure → bleeding

## Nerves:

- Brachial plexus stretch or compression
- Ulnar N compression: pressure to the olecranon
- Peroneal N compression: pressure over the head of the fibula
- Lateral femoral cutaneous N trauma: pressure over the iliac crest

## Head and Neck:

- Gross hyperflexion or hyperextension of the neck
- External pressure over the eyes: retinal injury
- Lack of lubrication or coverage of eyes: corneal abrasion
- Headrest may cause pressure injury of supraorbital N.
- Excessive rotation of the neck: brachial plexus problems
  - kinking of the vertebral artery
- L-spine excessive lordosis may lead to neurologic injury

# Intra-operative monitoring

**Wake-up test**

**SSEPs**

**MEPs**

# Wake-up test

**Lightening anesthesia at an appropriate point during the procedure and observing the patient's ability to move to command. It evaluates the gross functional integrity of the motor pathway. It was first described in 1973.**

## **Anesthesia requirements:**

|                 |                                             |
|-----------------|---------------------------------------------|
| <b>possible</b> | <b>As easy and as rapid to institute as</b> |
|                 | <b>Reliable but quickly antagonized</b>     |
|                 | <b>Wakening should be smooth</b>            |
|                 | <b>No pain during the test</b>              |
|                 | <b>No recall</b>                            |

# Wake-up test

## Anesthetic techniques:

- Volatile-based anesthesia

- Midazolam-based anesthesia

- Propofol-based anesthesia

- Remifentanyl-based anesthesia

## Disadvantages:

- Requires pt's co-operation
- Poses risks to pt: falling from the table and extubation
- Requires practice
- Prolong the duration of surgery
- Provides information at the time of the wake-up only
- Does not assess sensory pathways

## Wake up test:

After complete surgical correction stop volatile

Allow NMB to wear off

Ensure adequate analgesia (opioids)

Switch off N2O

Address Pt by name

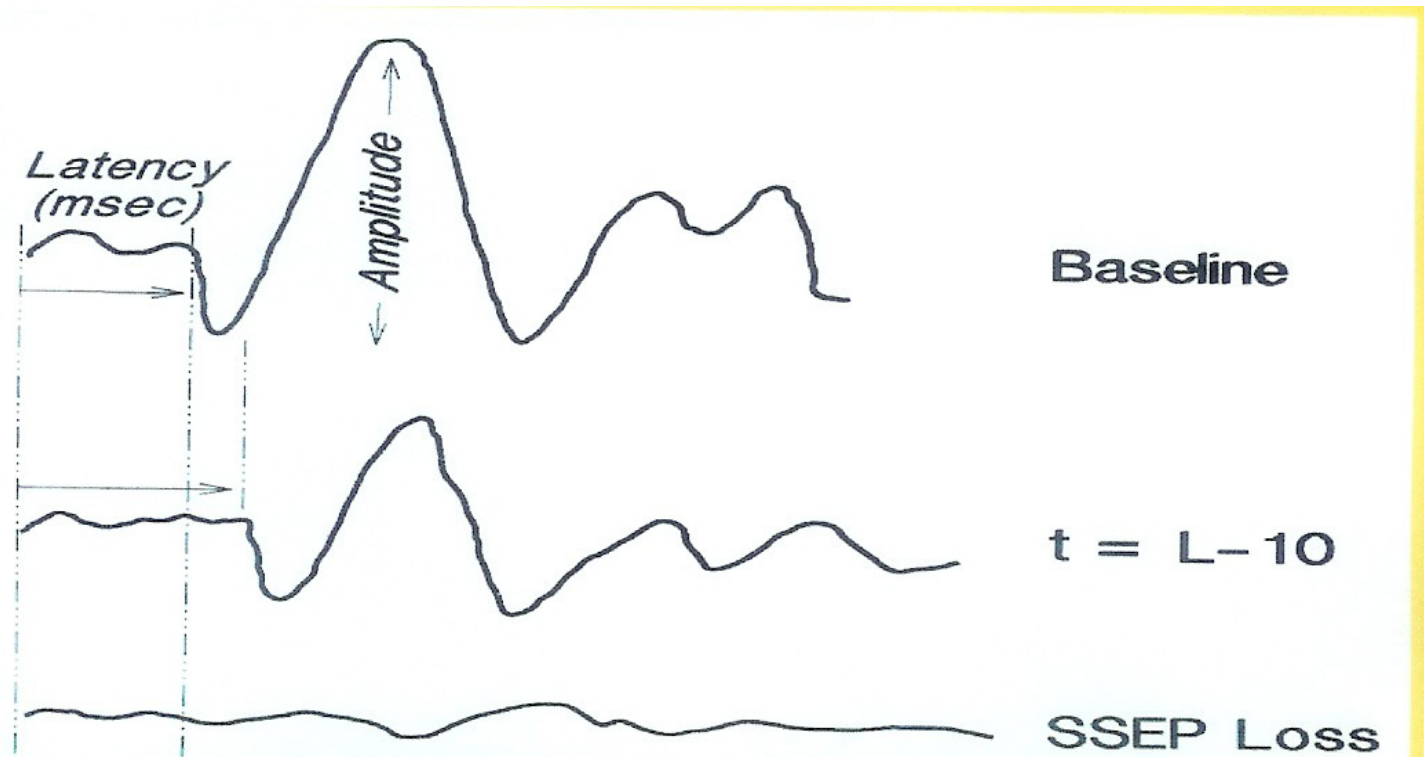
First move UL

Next move feet (wriggle toes)

# SSEPs

1. **The most common neurophysiological method for monitoring the intra-operative spinal functional integrity**
2. **The stimulus applied to the peripheral N (tibial or ulnar)**
3. **The recording electrodes placed: cervical region, scalp, or epidural space during surgery**
4. **Baseline data obtained after skin incision**
5. **Responses are recorded intermittently during surgery**
6. **A reduction in the amplitude by 50% and an increase in the latency by 10% are considered significant.**

# Typical tracing and L-10



1. SSEPs provides an indirect way of monitoring adjacent motor pathways because more acute impairment affects function of many adjacent pathways, not just the posterior column. However, this cannot be guaranteed.
2. The blood supply of the corticospinal motor tracts differs from that of the dorsomedial sensory tracts. It is possible to have normal SSEPs recordings throughout surgery but to have a

# Anesthetics and SSEPs

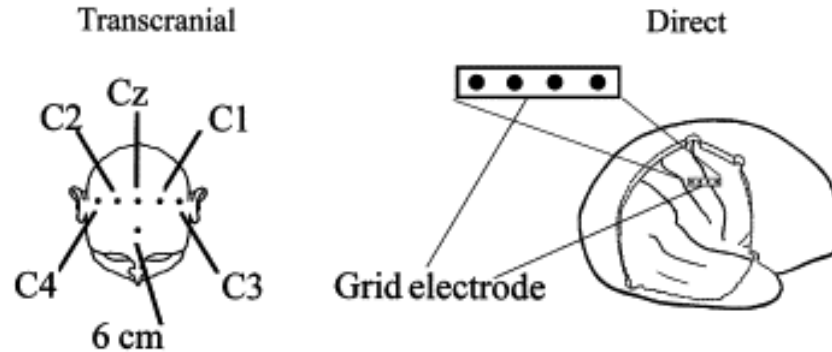
- Satisfactory monitoring of early cortical SSEPs is possible with 0.5-1.0 MAC isoflurane, desflurane and sevoflurane.
- Nitrous oxide potentiates the depressant effect of volatile anesthetics
- Intravenous anesthetics generally affect SSEPs less than inhaled anesthetics
- Etomidate and ketamine increases cortical SSEP amplitude
- Clinically unimportant changes in SSEP latency and amplitude after the administration of opioids

# **Implication for SSEPs Monitoring**

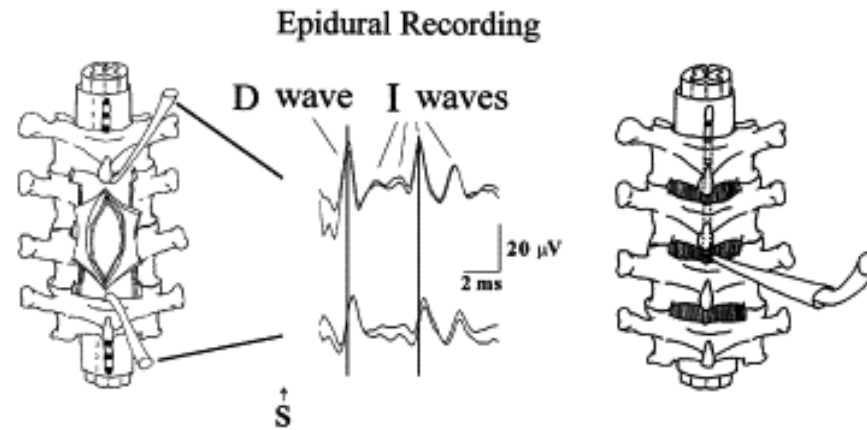
- **Eliminating N<sub>2</sub>O from the background anesthetic has been shown to improve cortical amplitude sufficiently to make monitoring more reliable**
- **SSEP latency will take 5-8 min to stabilize after the step changes in volatile anesthetic concentration**
- **Adding etomidate, propofol or opioids is preferable to beginning N<sub>2</sub>O or increasing volatile anesthetic concentrations when anesthetic depth is inadequate**
- **If a volatile anesthetic is nevertheless needed rapidly, sevoflurane permits faster SSEP recovery after the acute need for volatile anesthetic has been resolved**
- **It is critical to avoid sudden changes in volatile anesthetic depth or bolus administration of intravenous anesthetics during surgical manipulations that could jeopardize the integrity of the neural pathways being monitored**

# MEPs

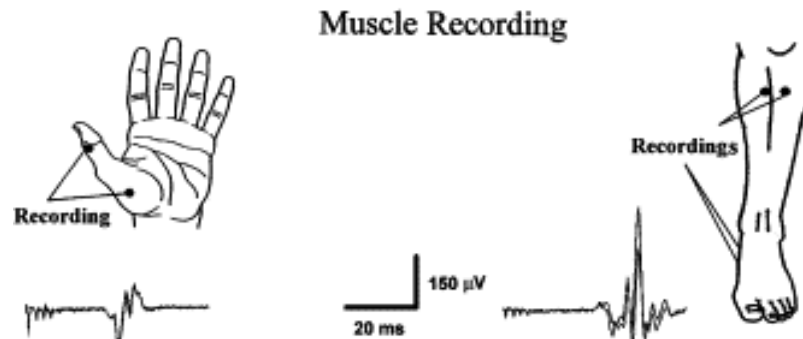
Motor cortex stimulated  
by electrical or magnetic  
means



Neurogenic responses:  
peripheral N or spinal cord



Myogenic responses



# Anesthetics and MEPs

- **Inhalational anesthetics suppress myogenic MEPs in a dose-dependent manner**
- **Paired pulses or a train of pulses cannot overcome the suppressive effects**
- **Should be avoided, or limited to a very low concentration during the monitoring of myogenic MEPs**
- **N2O appears to be less suppressive than other inhaled agents. Moderate doses of up to 50% N2O have been used successfully to supplement other agents during myogenic MEP monitoring.**
- **Fentanyl, etomidate, and ketamine have little or no effect on myogenic MEP and are compatible with intra-operative recording.**
- **Benzodiazepines, barbiturates, and propofol also produce marked depression of myogenic MEP. However, successful recordings have been obtained during propofol anesthesia by controlling serum propofol concentrations and increasing stimuli rates.**

# Spinal cord injury

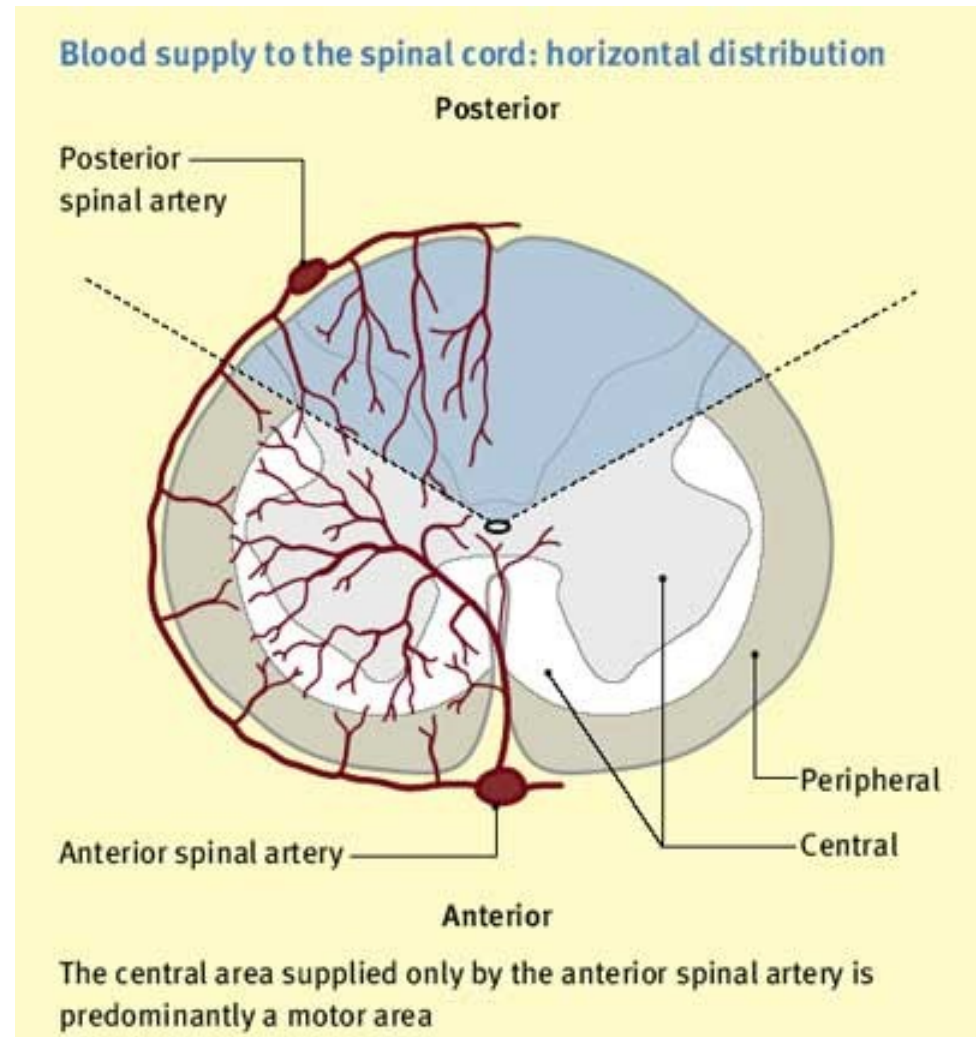
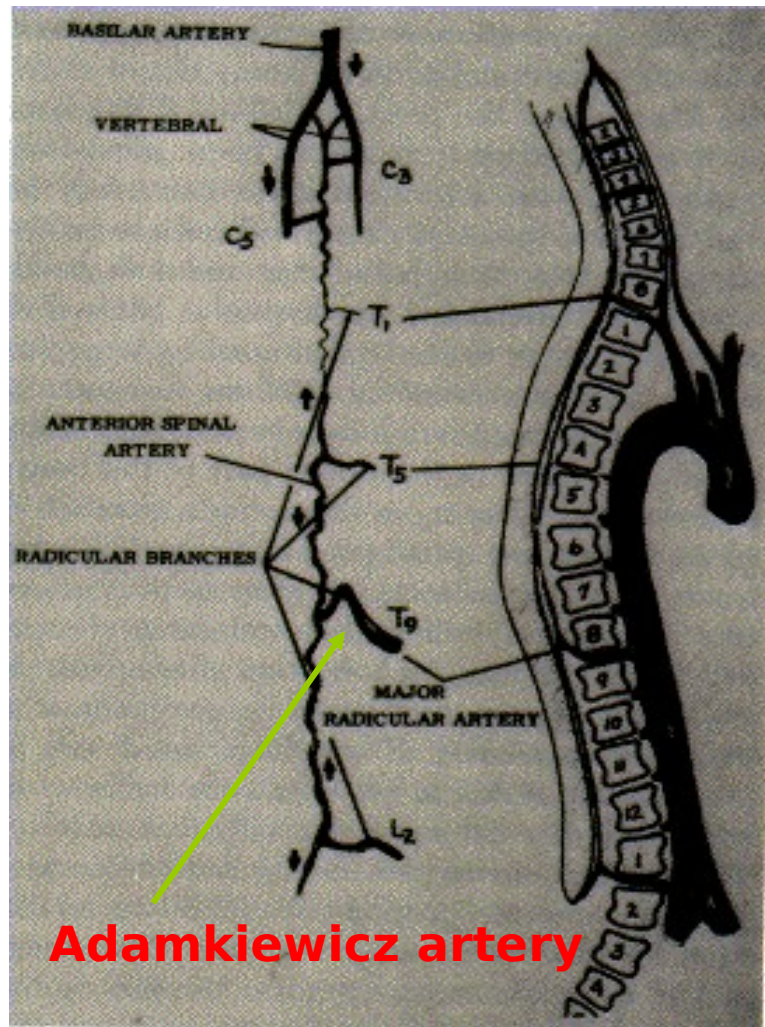
- 1. Neurological damage during surgery and anesthesia is not limited to the site of surgery.**
- 2. Paraplegia and quadriplegia have been reported as a result of poor pt positioning.**
- 3. There are reports of pts with spinal disease who have suffered neurological damage either at level remote from the site of surgery or during surgery unconnected with their spinal disease.**
- 4. Neurological damage is more likely at or near the site of surgery on the spine.**

# Spinal cord injury

## **Risk factors:**

- **Length and type of surgical procedure**
- **Spinal cord perfusion pressure**
- **Underlying spinal pathology**
- **Pressure on neural tissue during surgery**

# Spinal cord injury



# Spinal cord injury

## Risk minimized by:

- Careful positioning
- Maintaining SCPP: **SCPP = MAP - CSFP**

CSFP can be reduced by CSF  
drainage

MAP manipulated by anesthetist  
? keep systolic blood pressure > 90  
mm Hg

- Drugs: ?methylprednisolone, NMDA  
antagonists

(ketamine, magnesium)

- Prevention of hematoma formation  
careful hemostasis

stop anti-platelet medication

# Post-operative visual loss (POVL)

- **POVL is a rare but devastating complication**
- **1/1100 after prone spinal surgery**
- **Causes:**
  - Ischemic optic neuropathy (ION) (81%)**
  - Central retinal artery occlusion (13%)**
  - Unknown diagnosis (6%).**

# Ischemic Optic Neuropathy (ION)

**Etiology:** unclear but directly related to a change in retinal and/or

optic nerve perfusion

**Ocular perfusion pressure (OPP):**

$$\text{OPP} = \text{MAP} - \text{IOP}.$$

**OPP ↓ : MAP ↓ and /or ↑ IOP**

OPP ↓ → hypoperfusion of the eye → an ocular infarction at the level of the retina or optic nerve → visual loss (bilateral and irreversible).

**Risk factors:**

**Pt factors:** obesity

hypertension

diabetes

low preoperative hematocrit

**Surgical factors:** prolonged procedure

large blood loss

prone position

deliberate hypotension

# Ischemic Optic Neuropathy (ION)

## **ION not associated with direct pressure:**

ION occurs in pts who had their heads suspended in Mayfield tongs (18% of ION cases), actually no external pressure.

58% of these pts had b/l disease, making direct pressure less likely

**Prevention:** Maintain stable Hct  
Maintain MAP  
Avoid overhydration

**All patients undergoing spine surgery should be informed about the low but definite risk of this condition**

# Central retinal artery occlusion

1. Manifestations: periorbital edema, a cherry red spot at the fovea and monocular blindness
2. Cause: direct prolonged extraocular pressure on the globe
3. Preventable
4. Direct pressure on the eye is the etiology most often mentioned by spine surgeons in an attempt to explain all forms of POVL

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# Thank You

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