Spinal Cord Injury

Epidemiology and Pathophysiology

Forrest Hsu and Dr. Hurlbert
University of Calgary Neurosurgery Halfday
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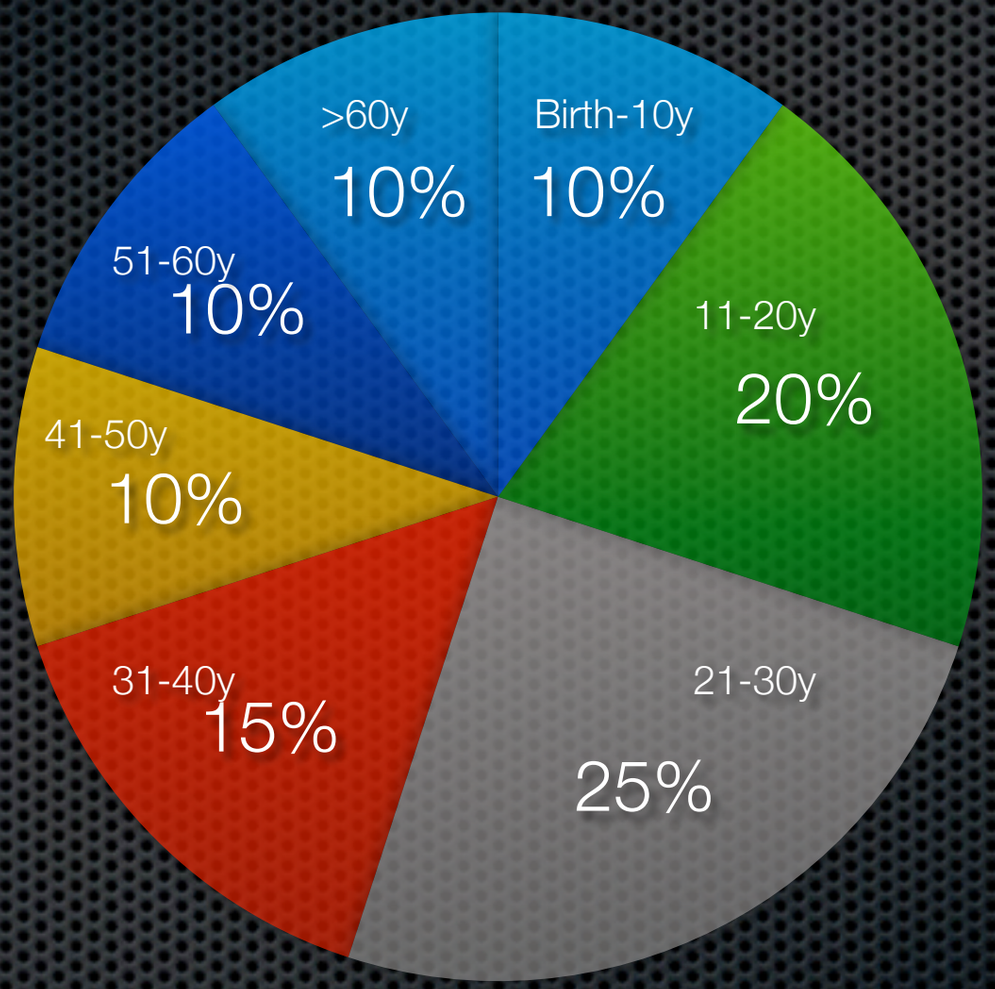
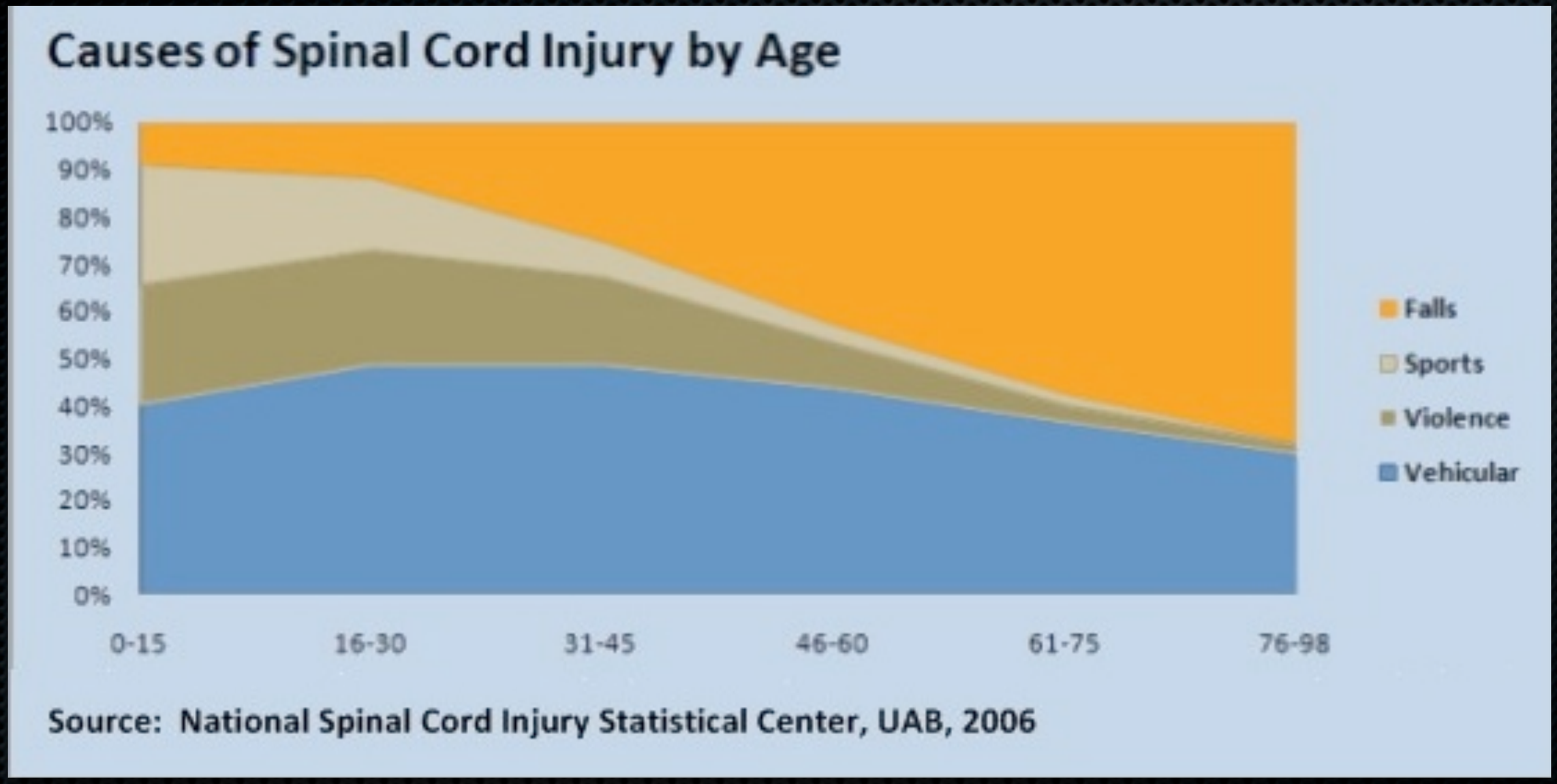
Acute SCI Epidemiology

Acute SCI prevalent among the young



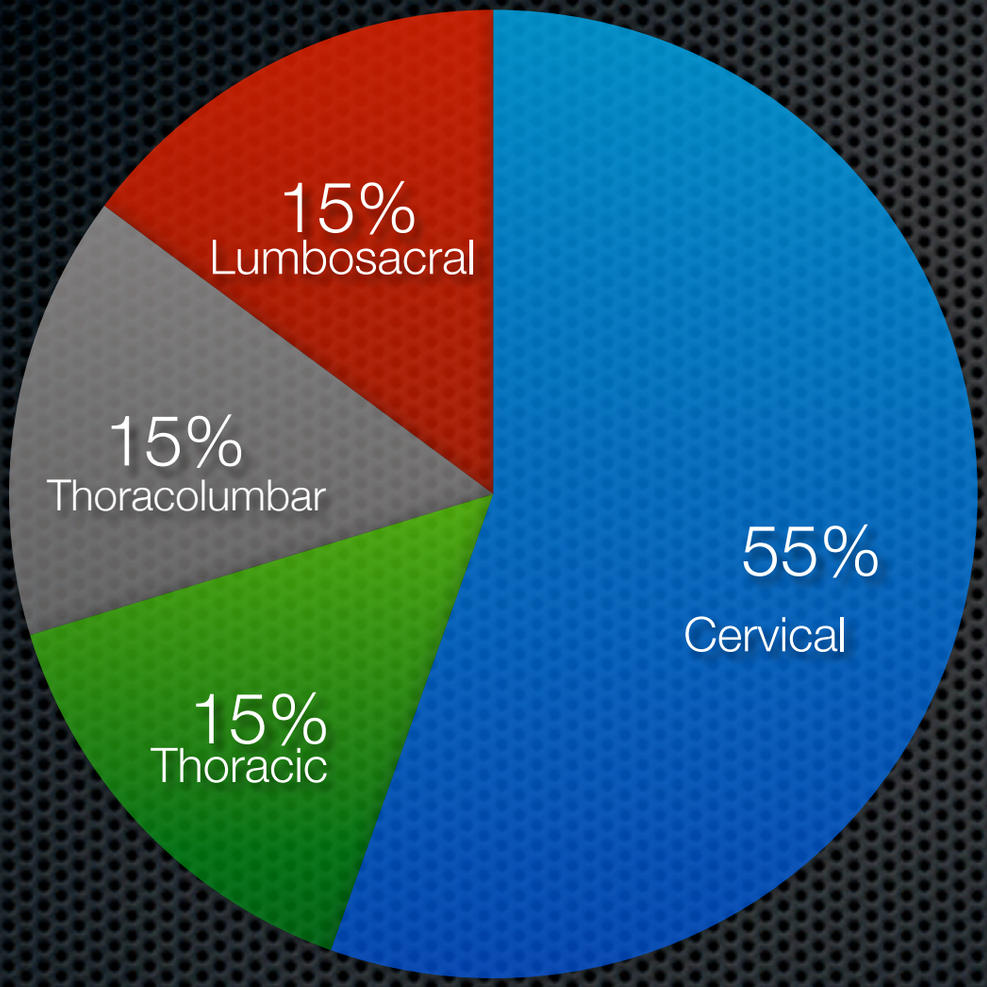
55% Age < 30yrs 80-85% are male

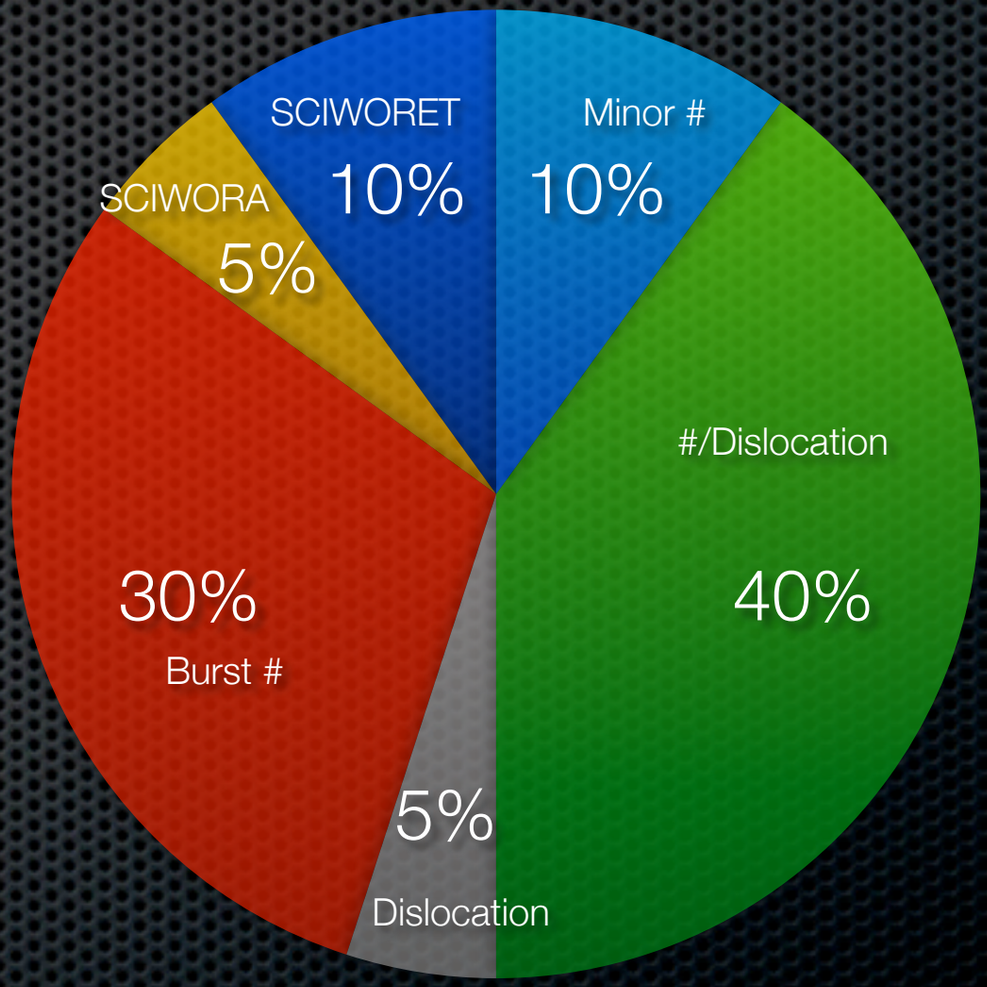
adapted from Sekhon et al. *Spine* 26(24s)S2-S12, 2001.



60-70% of all SCI are traffic accidents and falls

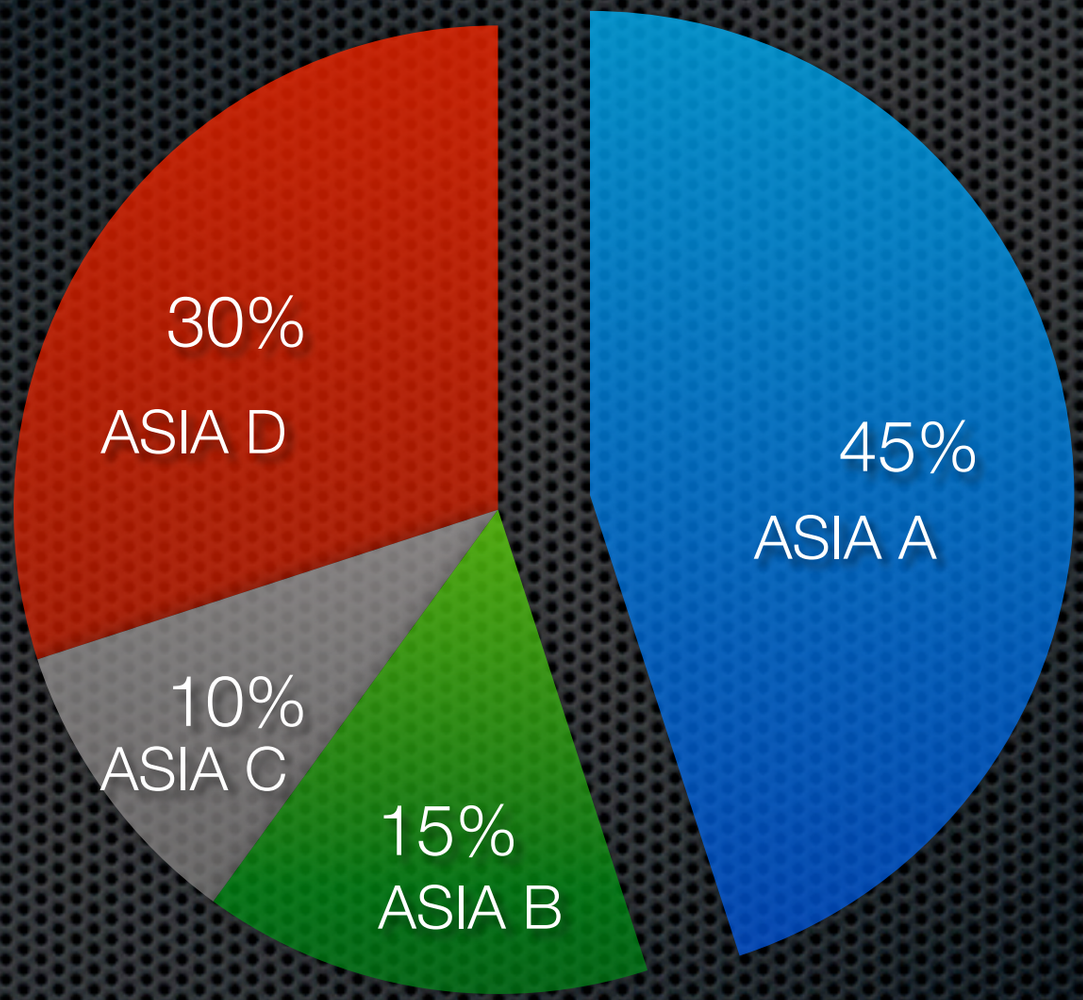
Acute SCI are predominantly cervical fracture dislocations





adapted from Sekhon et al. *Spine* 26(24s)S2-S12, 2001.

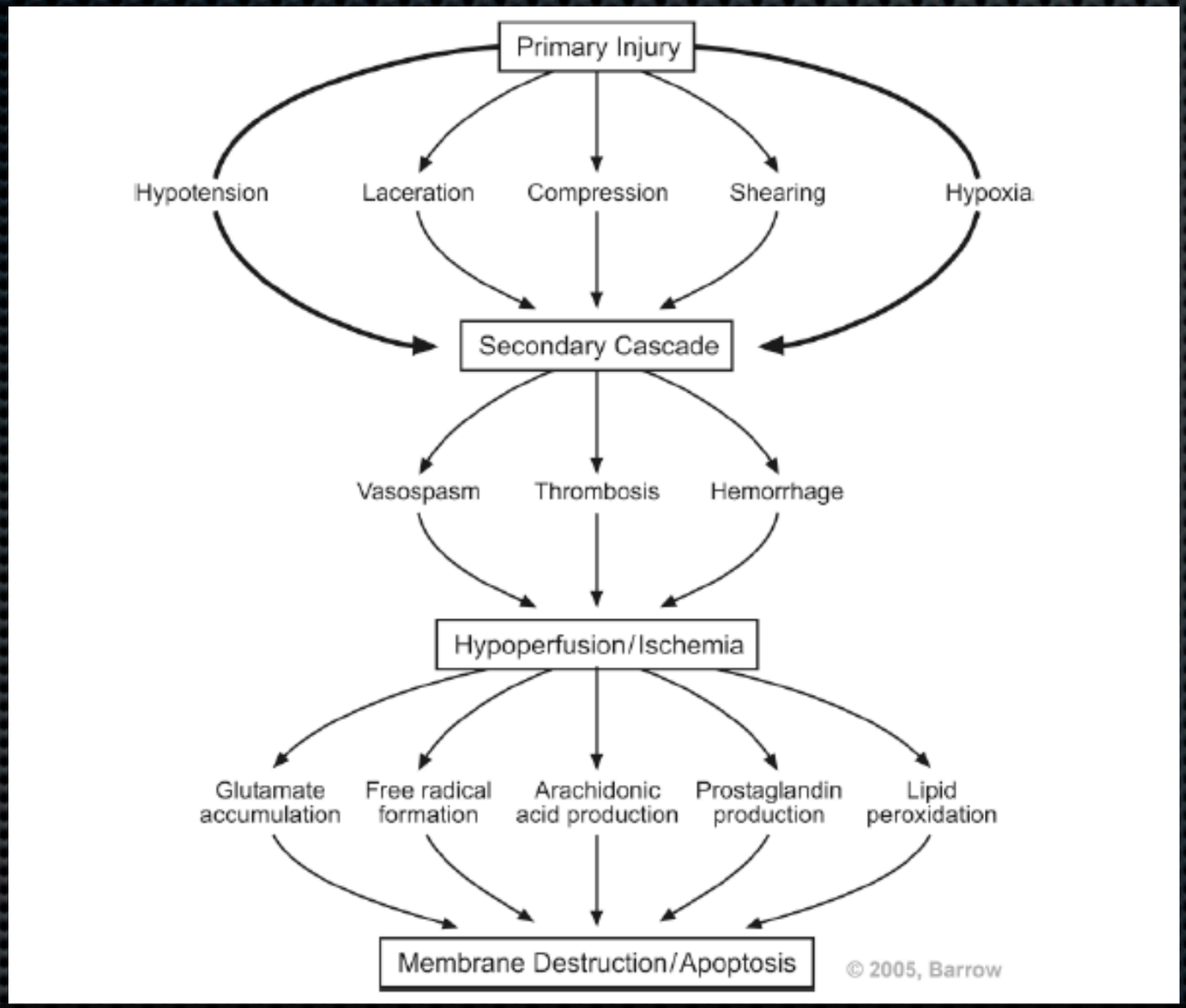
Incomplete SCI are most common



Complete SCI are more likely Thoracic > Cervical or Lumbar injuries
Potential for Recovery from Complete SCI: Cervical > Thoracic > Lumbar

adapted from Sekhon et al. *Spine* 26(24s)S2-S12, 2001.

Acute SCI Pathophysiology



Sonntag et al. Rothman-Simeone the Spine 2005.

The Cascade of Acute Spinal Cord Injury

Mechanisms of Primary SCI

Impact w/ persistent compression

- Burst # w/ canal compromise
- #/Dislocation
- acute disc ruptures
- most common SCI (young, high nrg)

Impact w/ transient compression

- hyperextension w/ underlying spondylosis
- central cord syndrome
- 2nd most common (older, low nrg)

Distraction

- stretch/shear injury of cord and vascular supply
- SCIWORA
- Spinal Cord Concussion/Central Cord

Laceration/Transection

- Missile injury / Bony Fragment injury

Dumont & Hurlbert et al. *Clinical Neuropharmacology* 24(5):254-264 2001.

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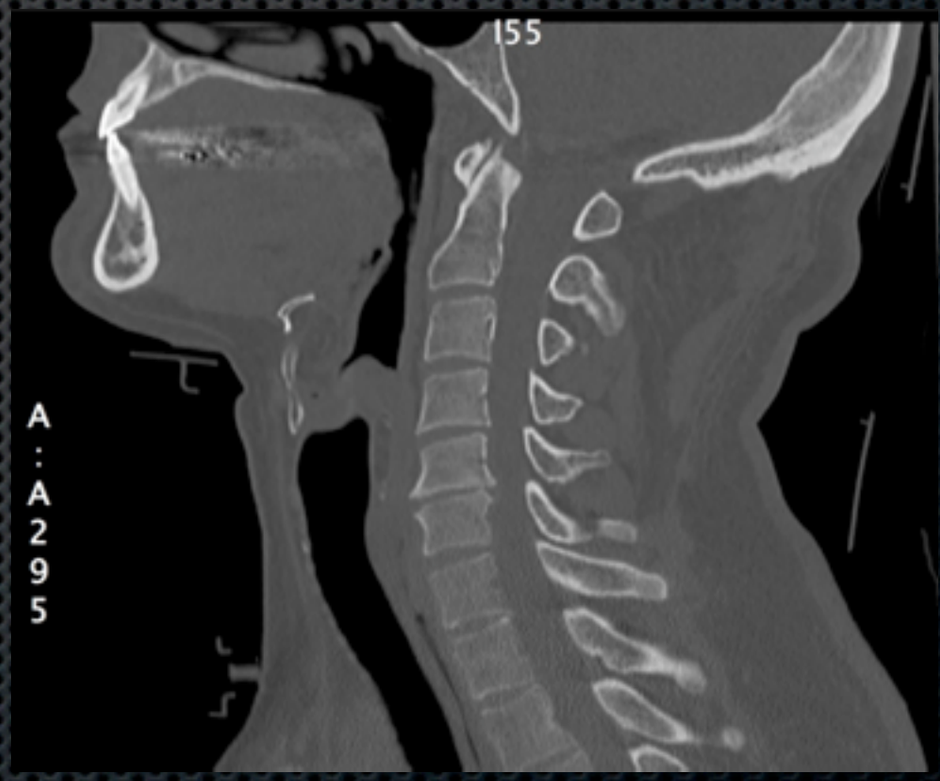

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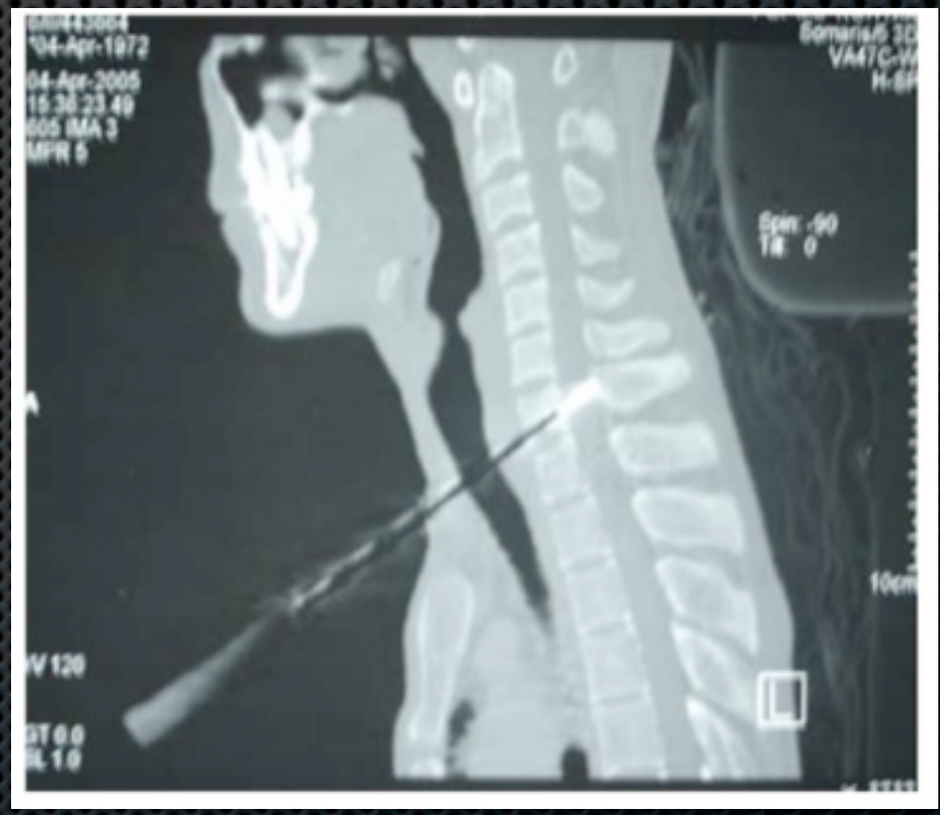

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Mechanical SCI primarily injures grey matter

- Relative sparing of white vs grey matter tracts in mechanical injury
- grey matter softer, more vascular, more metabolically active
- Extrapolation from CBF Grey matter =75-80 vs White matter 20-30 cc/100gm tissue/min

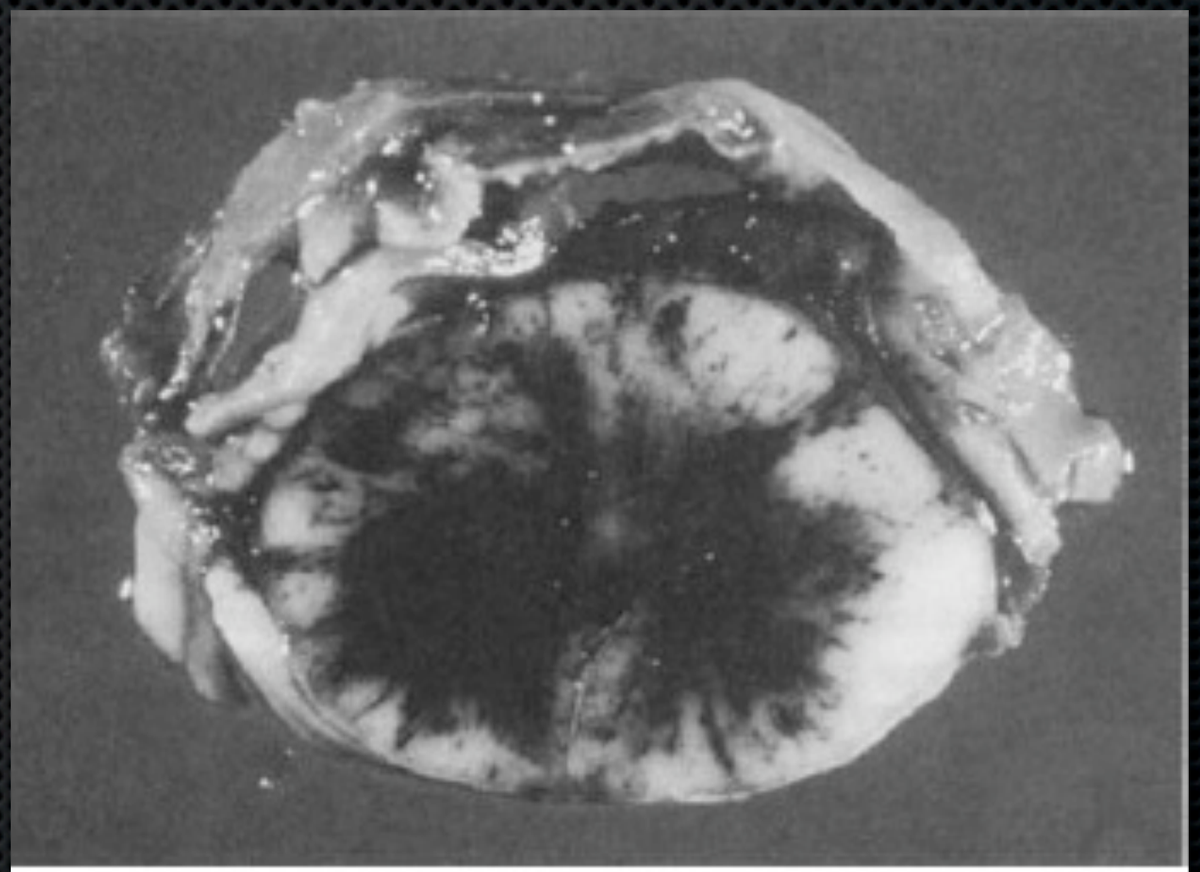


Figure 2 Human cervical spinal cord at site of injury. The patient died on the day of injury. The ventral dura was removed at autopsy. Almost the entire grey matter is hemorrhagic, including the dorsal and ventral horns. The hemorrhages have also extended into the white matter.

Hickey et al. Stroke 17:1183, 1986

Tator CH *Brain Pathology* 5:407-413, 1995.

Spinal cord autoregulation is impaired in acute SCI

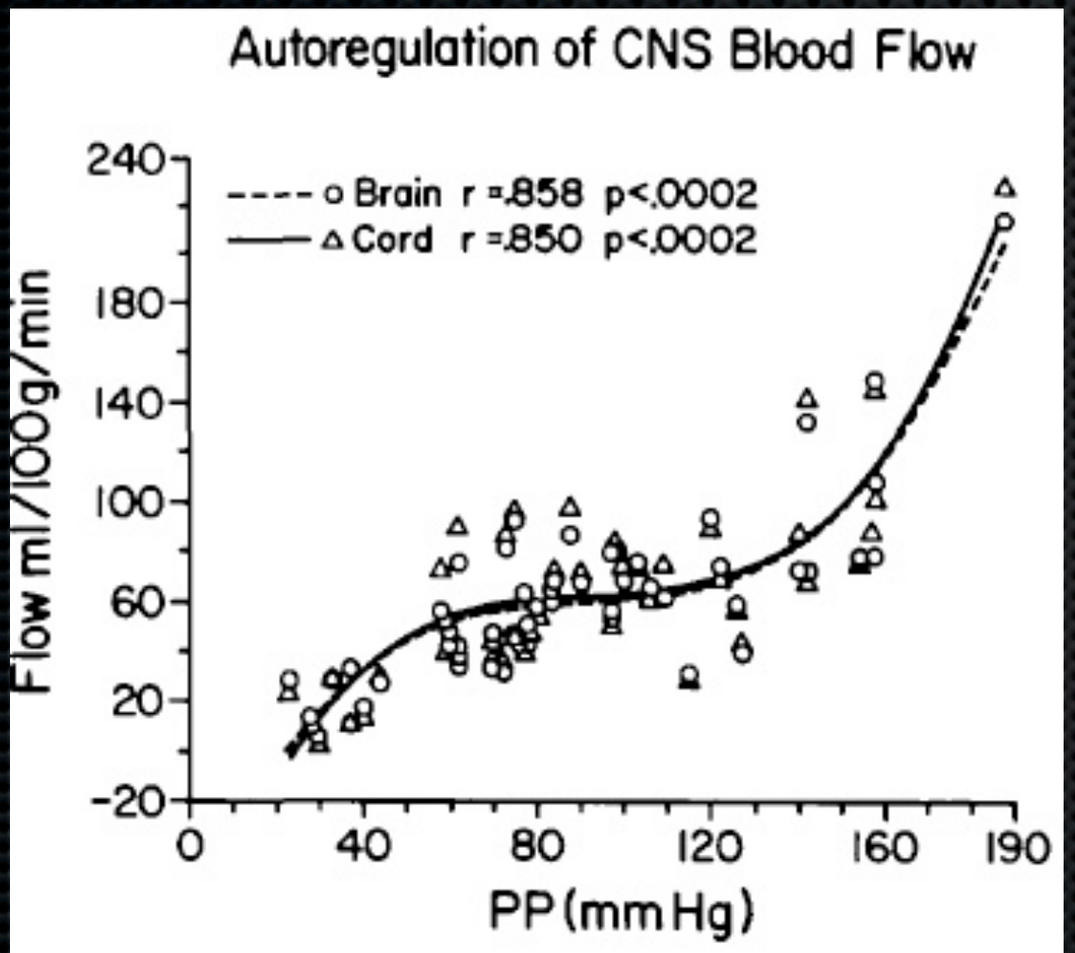
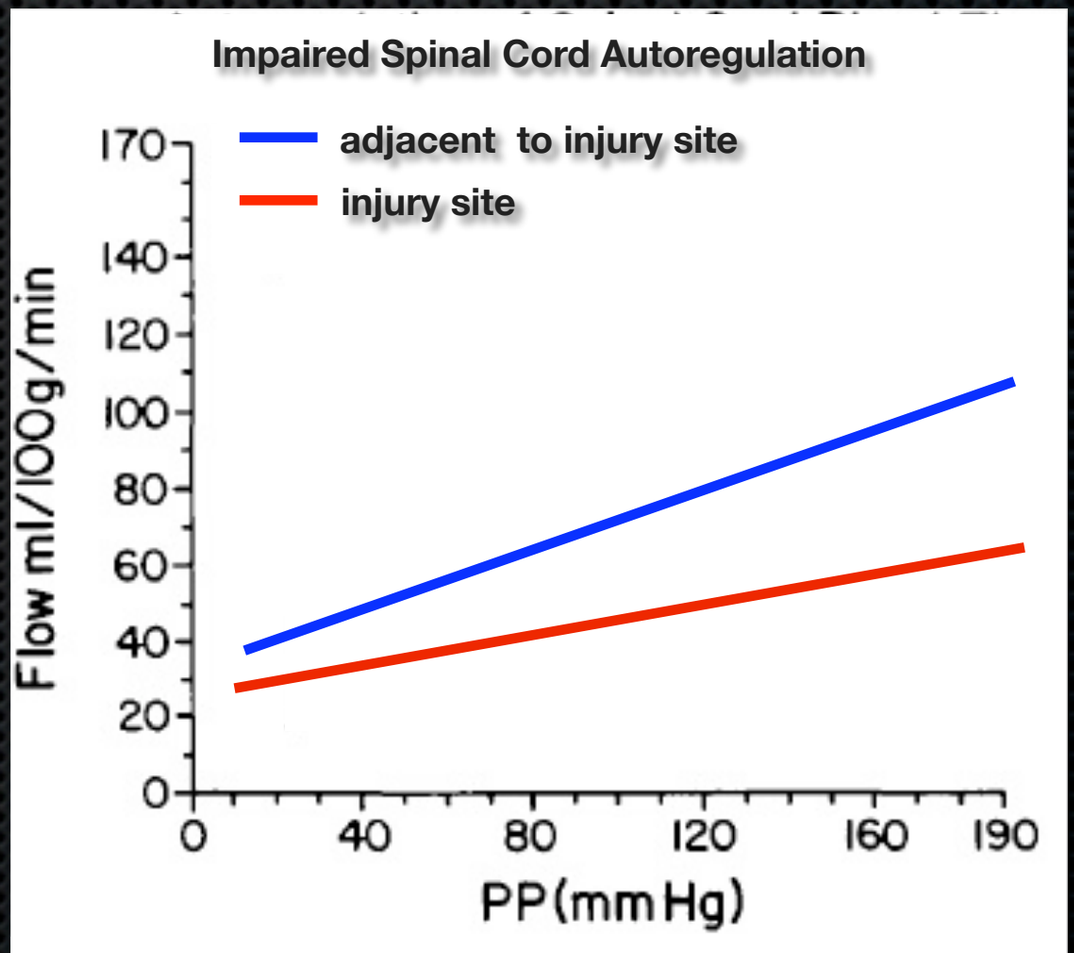


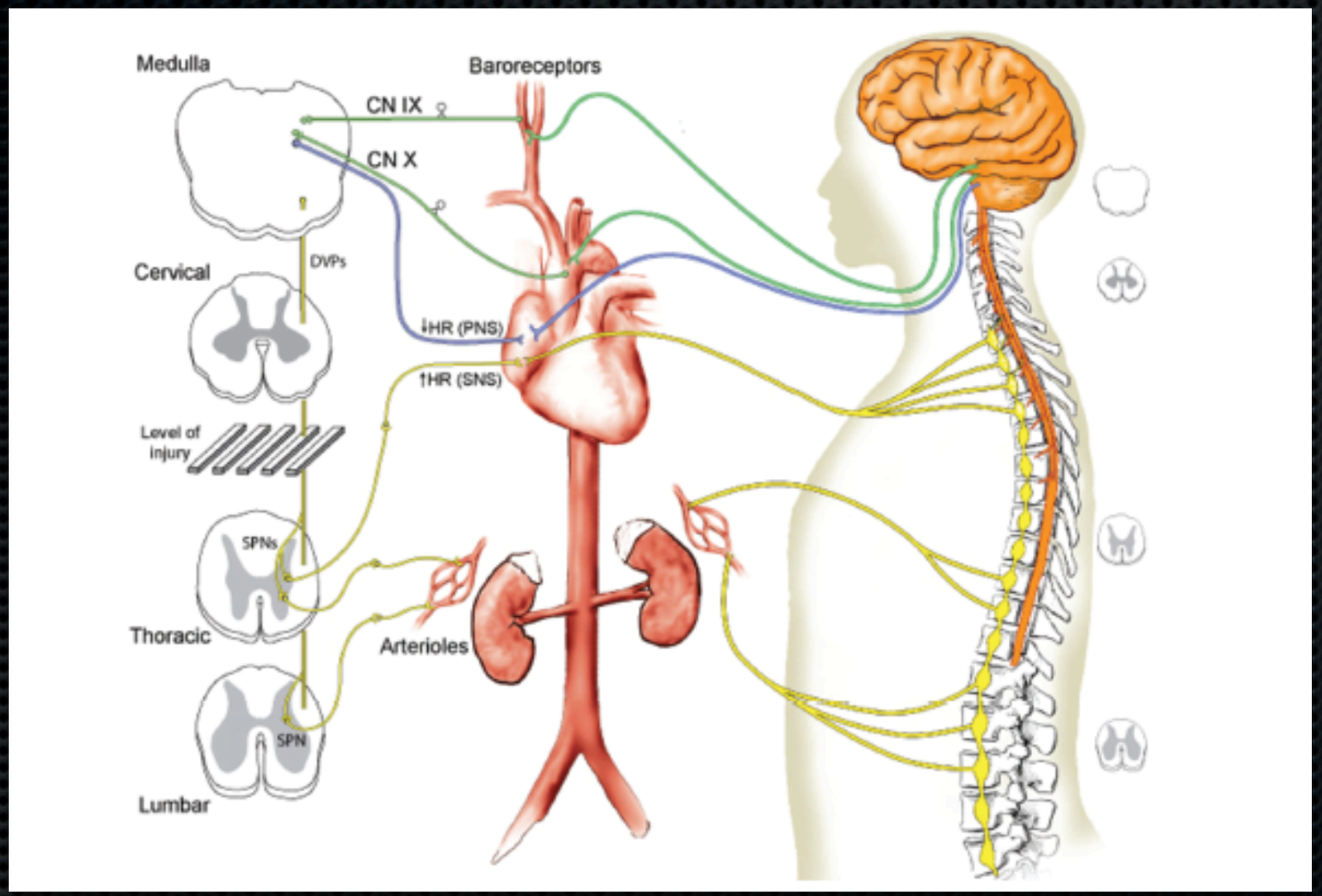
FIGURE 1. *Autoregulation of the spinal cord mimics the brain, with an autoregulatory range of 60–120 mm Hg perfusion pressure.*

Hickey et al. Stroke 17:1183, 1986



Spinal cord perfusion linearly dependent on MAP at both site and adjacent to site of injury

adapted from Guha et al. Stroke 20:372, 1989



Sympathetic Disruption in Acute SCI

Furlong and Fehlings. *Neurosurgery Focus.* 2008.

Shock in Acute SCI

Distributive-Neurogenic Shock

- sympathetic disruption resulting in bradycardia and vasodilation
- loss of muscle tone causing venous pooling

Hypovolemic

- Massive blood loss
- Multi-trauma; Chest, Abdo-pelvic,long bony

Obstructive

- flow of blood obstructed through cardio-pulmonary circuit
- cardiac tamponade/tension pneumothorax

Cardiogenic

- acute MI/arrhythmia 2º truama/stress/co-morbidities
- brainstem irritation/injury

Furlong and Fehlings. *Neurosurgery Focus* 25(5):E13 2008.

Mechanism of Vascular Injury in Acute SCI

- Mechanical disruption
- Systemic shock from Hemorrhage, Obstruction, Neurogenic
- Impairment of Spinal Cord perfusion and autoregulation

Progressive Necrosis and Apoptosis Central in Secondary SCI

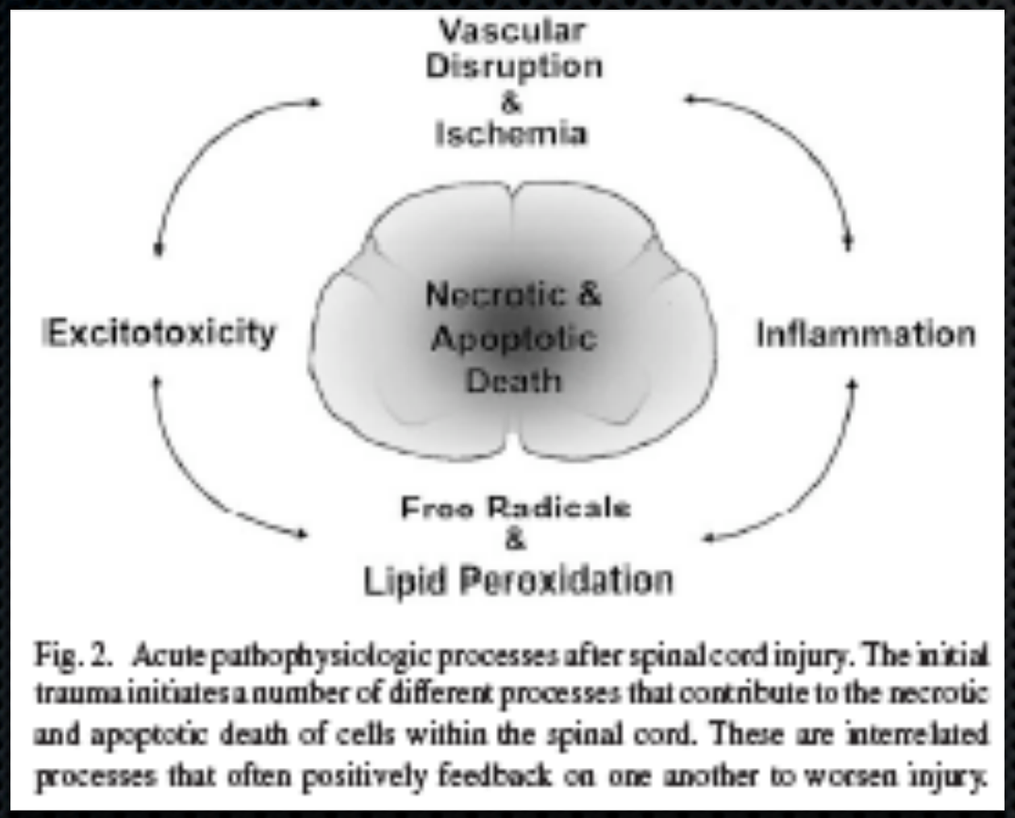
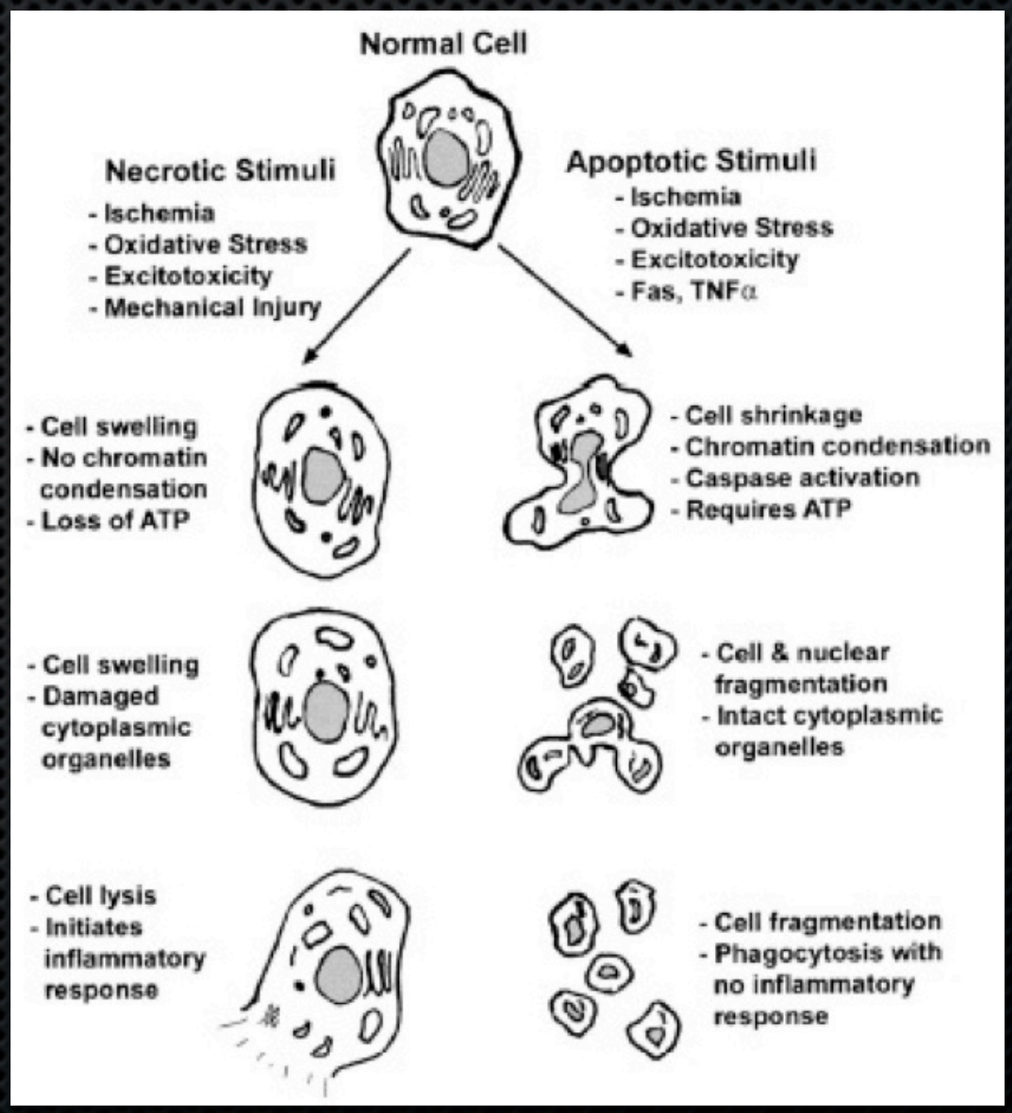
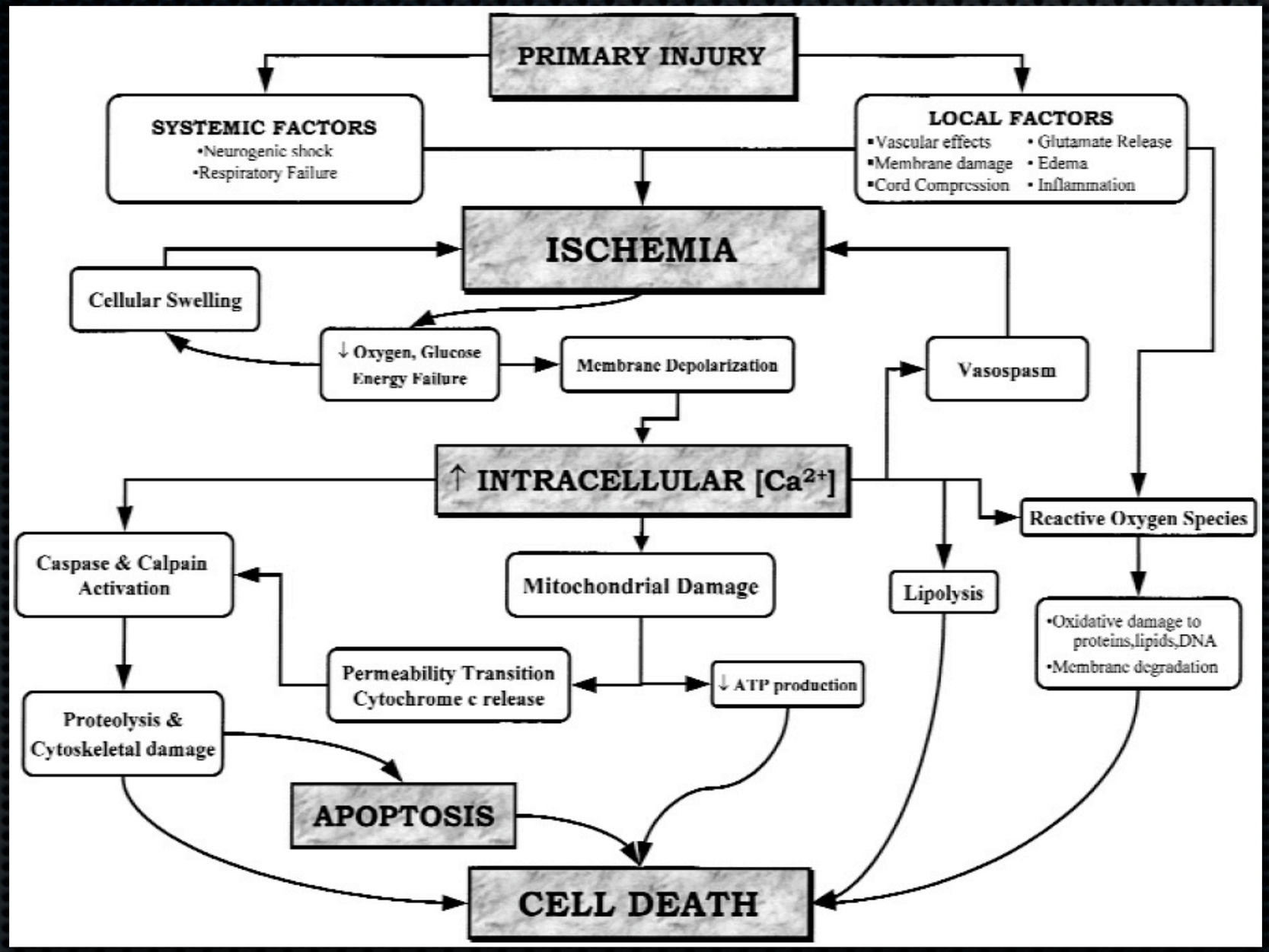


Fig. 2. Acute pathophysiologic processes after spinal cord injury. The initial trauma initiates a number of different processes that contribute to the necrotic and apoptotic death of cells within the spinal cord. These are interrelated processes that often positively feedback on one another to worsen injury.

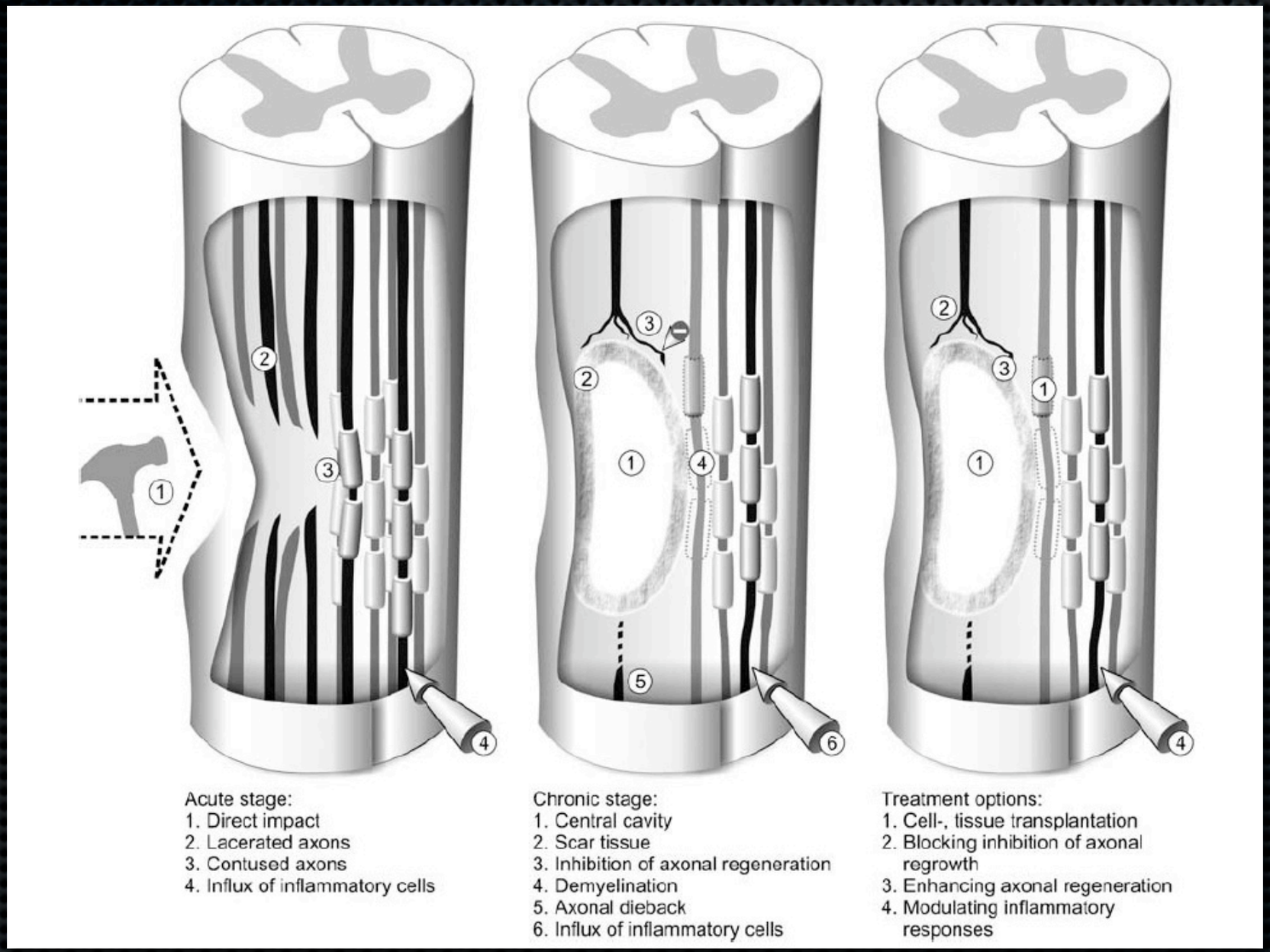


Kwon and Vaccarro et al. *The Spine Journal* 4:451-464 2004.



Mechanisms of Secondary SCI

Dumont & Hurlbert et al. *Clinical Neuropharmacology* 24(5):254-264 2001.



Targeting treatments for secondary SCI

Ronsyn et al. *Spinal Cord* 46:532-539 2008.