

Cervical Spine and Spinal Cord Injuries

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- The only Level 1 Adult and Level 1 Pediatric Trauma Center and Regional Spinal Cord Injury Center (University Hospital Rehabilitation Center) combined within the same institution in all Pennsylvania
- Current policy is for all E.D. to E. D. transfers to be automatically accepted by the on-duty E.D. faculty (subject only to ICU bed availability)
- Best number to call to arrange a transfer is 1-800-225-4837 (the Life Lion Communications Center located in the E.D.)
- Call the MD Referral network 1-800-233-4082 for discussions with other specialist attendings

Spinal Cord Injury: Epidemiology

- 12 to 53 per million population per year in the U.S.A.
- 12,000 new paraplegics & quadriplegics per year
- 4000 deaths per year in the field
- 1000 deaths per year in hospital
- Lifetime care costs now > \$1,000,000 per case

Spinal Cord Injury: Etiology

- **Motor vehicle crashes:** 46 %
- **Falls:** 26 %
- **Diving / Sports:** 11 %
- **GSW / stabbings:** 10 %
- **Miscellaneous:** 7 %

* > 50% of SCI in places like Detroit are due to

GSW's

Indications to Get C-spine Films for Trauma

- Appropriate mechanism of trauma
- Neck pain
- Neck tenderness (palpate under c-collar)
- Decreased pain perception
 - Head trauma
 - Alcohol or drugs
 - Children < 2 yrs.
 - Mentally retarded
- Penetrating trauma
- Neurologic symptoms or findings
- ? If another painful distracting injury

Cervical Spine Radiology

Film Choices

- 3 view: cross-table lateral + odontoid + AP
- 5 view: 3 view + right & left obliques
- 3 or 5 view + flexion / extension
- Swimmer's view to see lower C-spine
- Computed tomography (CT)
- Conventional tomography
- MRI

Incidență laterală
Aspect normal



Incidență laterală
Imagine incompletă



Incidență antero-posterioară
Aspect normal



Incidență occipitomentală (odontoidă)
Aspect normal



Incidență oblică
Aspect normal



Incidență oblică
Aspect normal



The Myth of the “Occult” Cervical Spine Fracture

- Reviewed by Holliman & Wuerz: Amer. Journal Emer. Med., Nov. 1992; 10(6): 611-612
- All previous reported “occult” cases (with 2 poorly documented exceptions) had intracranial injury, intoxication, neck pain or tenderness, and / or neurologic signs
- Two large prospective series showed no fractures in patients not having one of these features listed on the previous slide under “indications for C-spine films”

Cervical Trauma:

Indications for Computed Tomography

- Lower C-spine not seen well on lateral
- Vertebral body burst fractures
- Suspected posterior column fractures
- A suspected, but not clearly defined, fracture on plain films
- Marked DJD present

Cervical Trauma:

Indications for Conventional Tomography

- Suspected fracture at base of odontoid
- CAT scan marred by streak artifact from metal
- Suspected facet fractures
- Patient is too heavy (> 350 lbs.) for the CAT scanner

Cervical Trauma: Indications for Flexion / Extension Views

- Mild subluxation but no fracture seen
- Prevertebral soft tissue swelling but no fracture seen
- Spinal cord injury with normal plain films & CAT scan
- Persistent severe neck pain with normal screening films

Cervical Spine Injury: Clinical Assessment

- ABC's first (include "hard" immobilization)
- Maintain immobilization, but open the collar & palpate neck & observe anterior neck
- Clinical assessment features:
 - Pain / tenderness
 - Deformity / step-off
 - Edema / ecchymosis
 - Muscle spasm
 - Head position / abnormal tilt
 - Tracheal deviation / hematoma

Spine Injury: Neurologic Assessment

- Motor strength
- Sensory disturbances
- Reflex changes
- Autonomic dysfunction
- Rectal sphincter tone

Clinical Findings: Cervical Cord Injury

- Flaccid areflexia
- Diaphragmatic breathing
- Pain response above clavicle only
- Motor response limited to forearm flexion
- Priapism
- Neurogenic shock

Neurogenic Shock from Spinal Cord Injury

- Due to loss of sympathetic outflow
- Basically is peripheral vasodilatation & venous blood pooling
- Hypotension usually also with bradycardia
- Rx with IV fluids + / - alpha agonists (norepinephrine or dopamine drip, ephedrine) + / - atropine
- IV methylprednisolone

Cervical Spine Injury: “Spinal Shock”

- Is an “electrical” or depolarization injury
- NOT a circulatory phenomenon
- May represent electrical “stunning” of cord function
- Occurs immediately after time of injury
- Features:
 - Flaccidity
 - Loss of reflexes
- Can have full recovery in some patients

Treatment of Cervical Fractures and Suspected Spinal Cord Injury

- Maintain immobilization in hard collar
- Avoid traction / distraction
- Film rest of spine (T-spine & L-spine) if any sensory deficit present
- Support circulation with IV fluids + / - alpha vasopressors if neurogenic shock
- Antibiotics if open fracture
- Neuro surgery / ortho. Consult (consider transfer)
- High dose steroids

Effectiveness of High Dose Steroid Rx of Spinal Cord Injuries

- The Second National Acute Spinal Cord Injury Study (NASCIS II)
- Results reported I New Eng. J. Med. 1990; 322: 1405-1411
- Prospective, randomized, double-blind, placebo control
- Multicenter
- Compared high dose methylprednisolone vs. naloxone vs. placebo

NASCIS II

- Study design: Multicenter, randomized, double-blind, placebo-controlled
- Diagnosis: Acute spinal cord injury treated within 14 hours of injury
- Cohort: 487 patients (84 % male)
- Neurologic Assessments: At admission, at 6 weeks, and at 6 months
 - Sensation of pinprick
 - Sensation of light touch
 - Motor function

NASCIS II Treatments

- Methyprednisolone – 161 patients (30 mg / Kg / hr X 23 hrs)
- Naloxone – 153 patients (5.4 mg / Kg / hr X 23 hrs)
- Placebo (Vehicle) – 170 patients

Changes in Scores at 6 Months

Protocol-Compliant Patients Treated Within 8 Hours

Type	Motor	Pin	Touch
Placebo	+ 10.7	+ 5.9	+ 4.6
Methylpredni solone	+ 17.2	+ 12.9	+ 9.8
p Value	.011	.001	.020

NASCIS II: Complications at 6 Weeks After Injury (%)

	MP	NA	PL	p Value
Wound infections	7.1	3.3	3.6	.21
GI Bleeding	4.5	2.0	3.0	.44

- MP = Methylprednisolone; NA = Naloxone; PL = Placebo

NASCIS II: Results

- Methylprednisolone ≤ 8 hrs after injury
 - Significant improvement over placebo on all measures
 - Evident at 6 weeks and 6 months
 - Evident for both complete and incomplete injury
- Naloxone ≤ 8 hrs after injury
 - No significant improvement over placebo
- Either drug > 8 hrs after injury
 - No significant improvement over placebo

Conclusion of NASCIS II Study

- Methylprednisolone (Solu-Medrol) at a dose of 30 mg / kg bolus followed by IV drip at 5.4 mg / kg / hr for 23 hours:
 - Significantly enhances recovery (both motor & sensory) from complete & incomplete acute spinal cord injuries, IF started within 8 hours of injury

Indications for Emergent Surgery for Cervical Spine Injury

- Acute anterior cord Syndrome
- Ascending level of neuro deficit
- Compound (open) fracture
 - GWS's
 - Other penetrating trauma
 - Associated posterior pharyngeal trauma
- Pedicle fracture with nerve root symptoms
- Vertebral artery injury

C-Spine Trauma:

What to Look for on Lateral Films

- All 7 vertebrae and top of T1
- 3 lines:
 - Anterior edge of vertebral bodies
 - Posterior edge of vertebral bodies
 - Anterior edge of spinous processes
- Prevertebral space
 - C2 to C4: < 5 mm; below C4: < 22 mm
- Predental space
 - Adults: < 3 mm; Children: < 5 mm
- Bony structures
- Soft tissues
- Skull

Incidență laterală
Aspect normal



What to Look for on the A-P Radiograph

- Interspinous distance > 1.5 times the adjacent interspinous distance – anterior dislocation
- Double appearing spinous process – Clay Shoveler's fracture
- Deviation or rotation of spinous process – unilateral faced locking

Note: all these injuries have obvious signs on lateral view

Incidență antero-posterioară
Aspect normal



C-Spine Trauma: Injury Mechanism Classification

- Flexion
 - Anterior subluxation
 - Bilateral interfacetal dislocation
 - Wedge fracture vertebral body
 - Flexion teardrop fracture
 - Clay Shoveler's fracture
- Extension
 - Central Cord Syndrome – normal X-ray
 - Extension teardrop fracture
 - Hangman's fracture
 - Posterior atlantal arch fracture

C-Spine Trauma:

Injury Mechanism Classification (con't.)

- Rotation
 - Unilateral faced dislocation
 - Unilateral pillar fracture
- Vertical compression
 - Jefferson fracture of atlas
 - Burst fracture vertebral body
- Odontoid fracture
 - Type I – mythical (not ever seen clinically)
 - Type II – base of odontoid
 - Type III – extends into C2 body

C-Spine Injuries: Degree of Stability

A. Stable

- 1 – Anterior subluxation
- 2 – Unilateral faced dislocation
- 3 – Simple wedge fracture
- 4 – Burst fracture of lower cervical vertebrae
- 5 – Posterior neural arch fracture of atlas
- 6 – Pillar fracture
- 7 – Clay-Shoveler's fracture

B. Unstable

- 1 – Bilateral facet dislocation
- 2 – Flexion teardrop fracture
- 3 – Extension teardrop fracture (stable in flexion, unstable in extension)
- 4 – Hangman's fracture
- 5 – Jefferson's fracture of atlas
- 6 – Hyperextension fracture - dislocation

Definite Signs of Unstable Injury

- All anterior or posterior elements fractured
- > 3.5 mm horizontal vertebral body displacement
- > 11 degrees of kyphotic angulation

Incidence of Spinal Cord Injuries Occurring with Vertebral Injuries

Type of injury	% with Neurologic Deficit
Fracture of vertebral body only	3
Fracture of posterior elements only	19
Fracture of posterior elements and vertebral body	11
Dislocation only	17
Dislocation with fracture of posterior elements	27
Dislocation with fracture of vertebral body	56
Dislocation with fracture of posterior elements and vertebral body	61

Levels of Injury

(Data from Hershey C-Spine Study)

Site of Fx / Dislocation	Number of fractures	Number with SCI
C1	6	1
C2 body	11	3
C2 dens	4	0
C3	4	2
C4	6	5
C5	19	14
C6	12	7
C7	17	5
Total 79		

C-Spine Trauma

- Jefferson fractures
 - Burst fracture of atlas
 - fracture through anterior and posterior arches of C1
 - Transverse atlantal ligament disrupted
 - Unstable

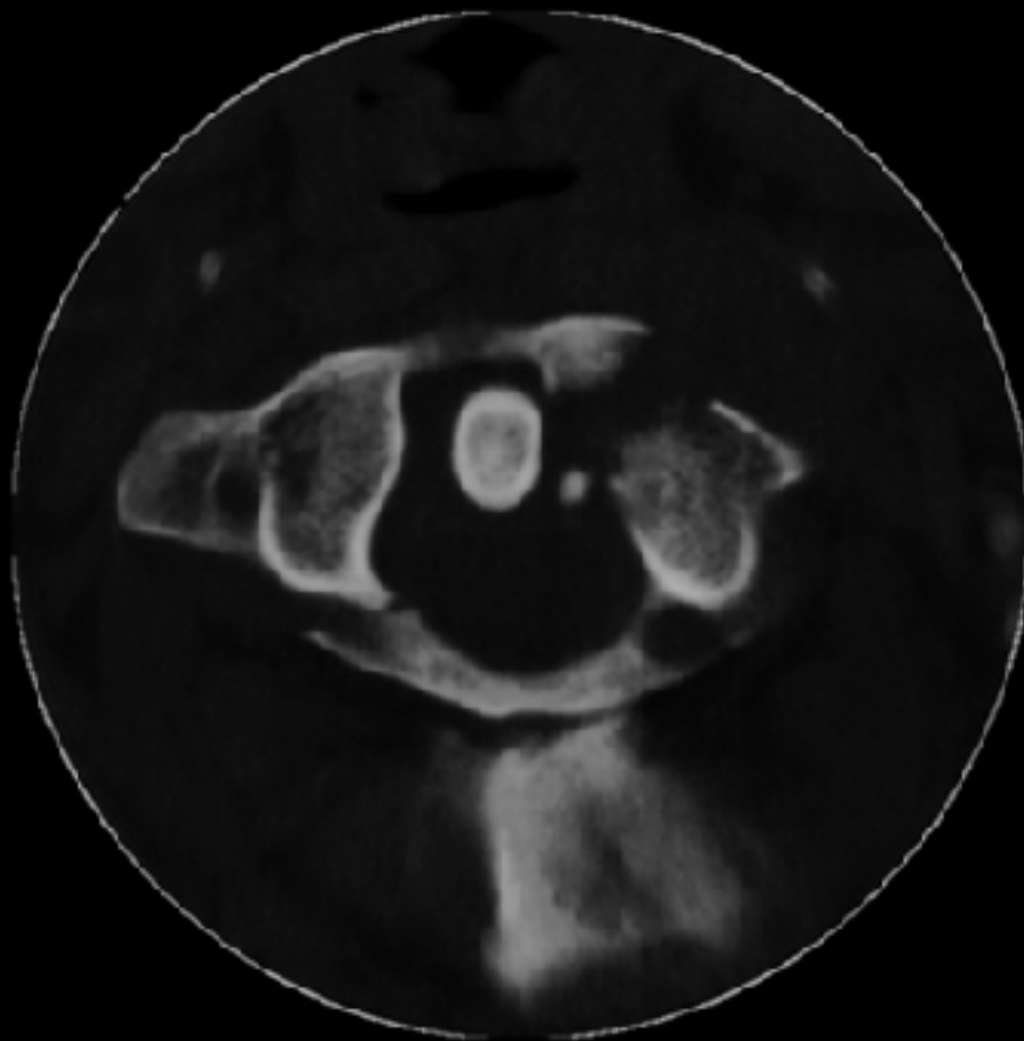
Fraktură Jefferson



Fractură Jefferson
Fragmente osoase la stânga apofizei odontoide



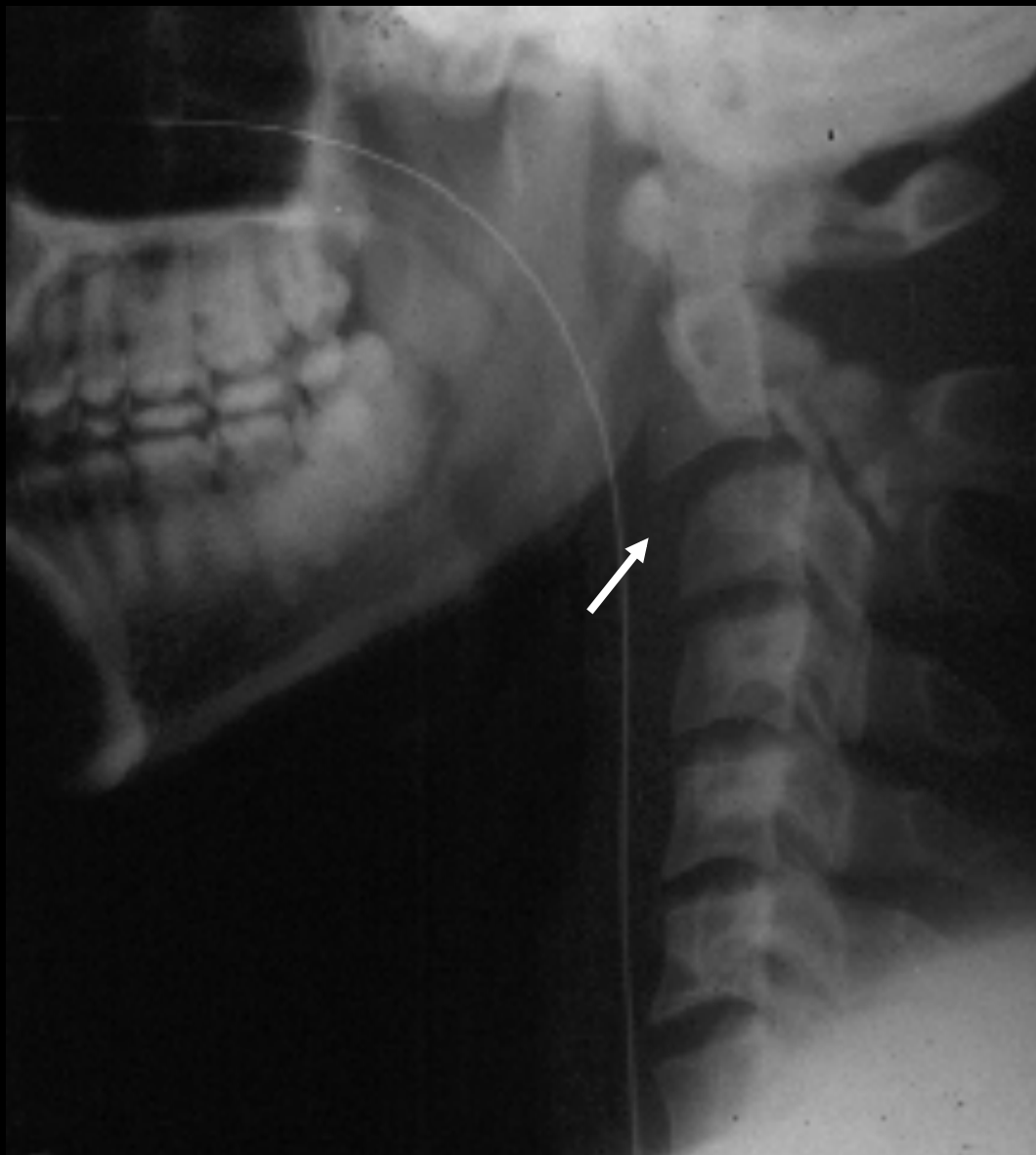
Fractură Jefferson
Aspect CT



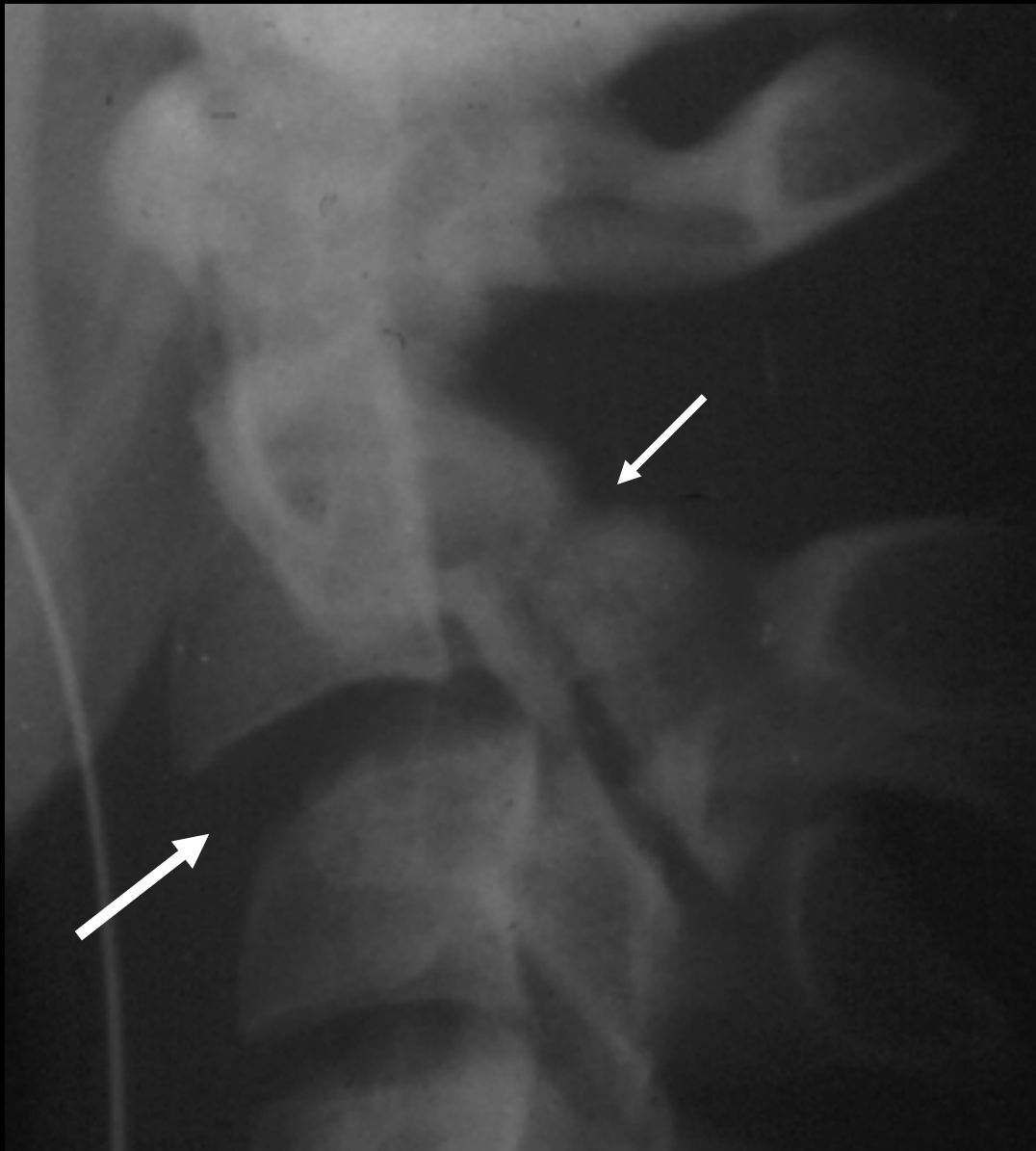
C-Spine Trauma

- Hangman's fracture
 - Traumatic spondylolysis of C2
 - Bilateral pedicle fracture C2
 - Usually no SCI (if from MVA)
 - Prevertebral swelling may compromise airway

Fractura spânzuratului



Fractura spânzuratului



C-Spine Trauma

- Anterior subluxation
 - Posterior ligament complex disrupted
 - > 3 mm vertebral body displacement abnormal
 - May be unstable (increased displacement with flexion)

C-Spine Trauma

- Wedge fracture
 - Ligament intact
 - Mechanically stable
 - + Soft tissue swelling
 - Loss of vertebral body height anteriorly
 - No vertical fracture line

C-Spine Trauma

- Vertebral body burst fracture
 - Usually mechanically stable
 - Posterior ligaments intact
 - Vertical and horizontal fracture lines
 - Often have SCI (bone fragments in canal)

C-Spine Trauma

- Flexion teardrop fracture
 - Unstable
 - Often have anterior cord syndrome
 - All ligaments disrupted (anterior longitudinal ligament is buckled)

Fraktură anterioară C4 “în lacrimă”



Fraktură C5 “în lacrimă” în flexie



C-Spine Trauma

- Extension teardrop fracture
 - Fracture upper anterior corner of vertebral body
 - Stable in flexion
 - Unstable in extension

Fraktură C5 “în lacrimă” în extensie



C-Spine Trauma

- Unilateral facet dislocation
 - Superior facet rests in vertebral foramen
 - Mechanically stable
 - Anterior displacement $< \frac{1}{2}$ vertebral body width
 - Above level of injury – interfacetal joints not superimposed (appear normal below injury)
 - AP view shows spinous process rotation

C-Spine Trauma

- Bilateral interfacetal dislocation
 - Unstable
 - High incidence of cord injury
 - Dislocated facets pass up and over the inferior facets
 - Complete – vertebral body displaced $> \frac{1}{2}$ width of vertebral body
 - Incomplete – dislocation $< \frac{1}{2}$ vertebral body width

Luxație fațetară bilaterală C5 – C6



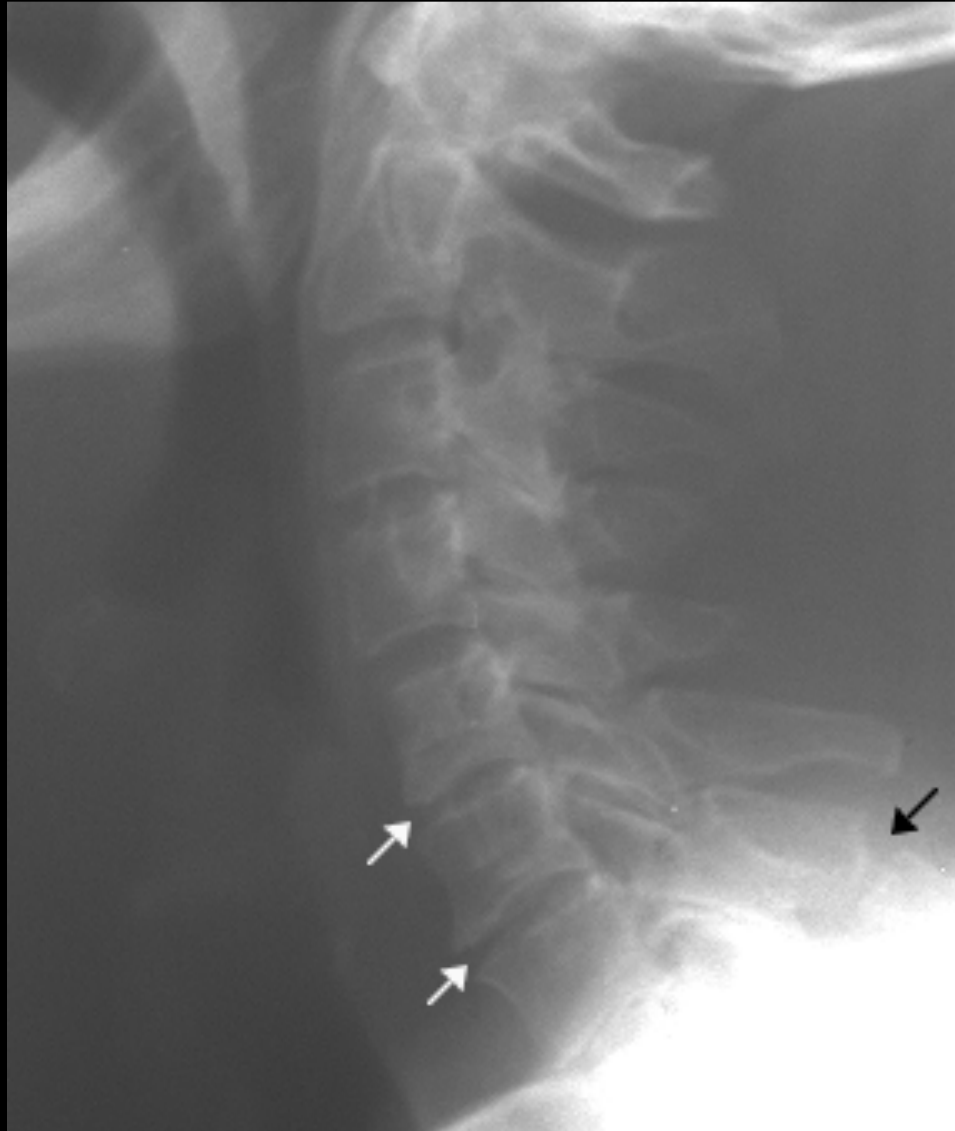
C-Spine Trauma

- Clay-Shoveler's fracture
 - Avulsion fracture of spinous process
 - Most common at C7, C6, T1
 - Stable
 - No treatment usually needed (except pain meds & maybe soft C-collar for comfort)
 - May be marker for another injury!

Incidență laterală



Fraktură Clay-Shoveler



Luxație atlanto-occipitală și atlanto-axială



Fractură de odontoidă



Fractură de odontoidă și luxație atlanto-axială



Luxație atlanto-axială



Fraktură de odontoidă și fractură-luxație atlanto-axială



Fractură-luxație C5 – C6



Fractură-luxație C5 – C6
Imagine CT



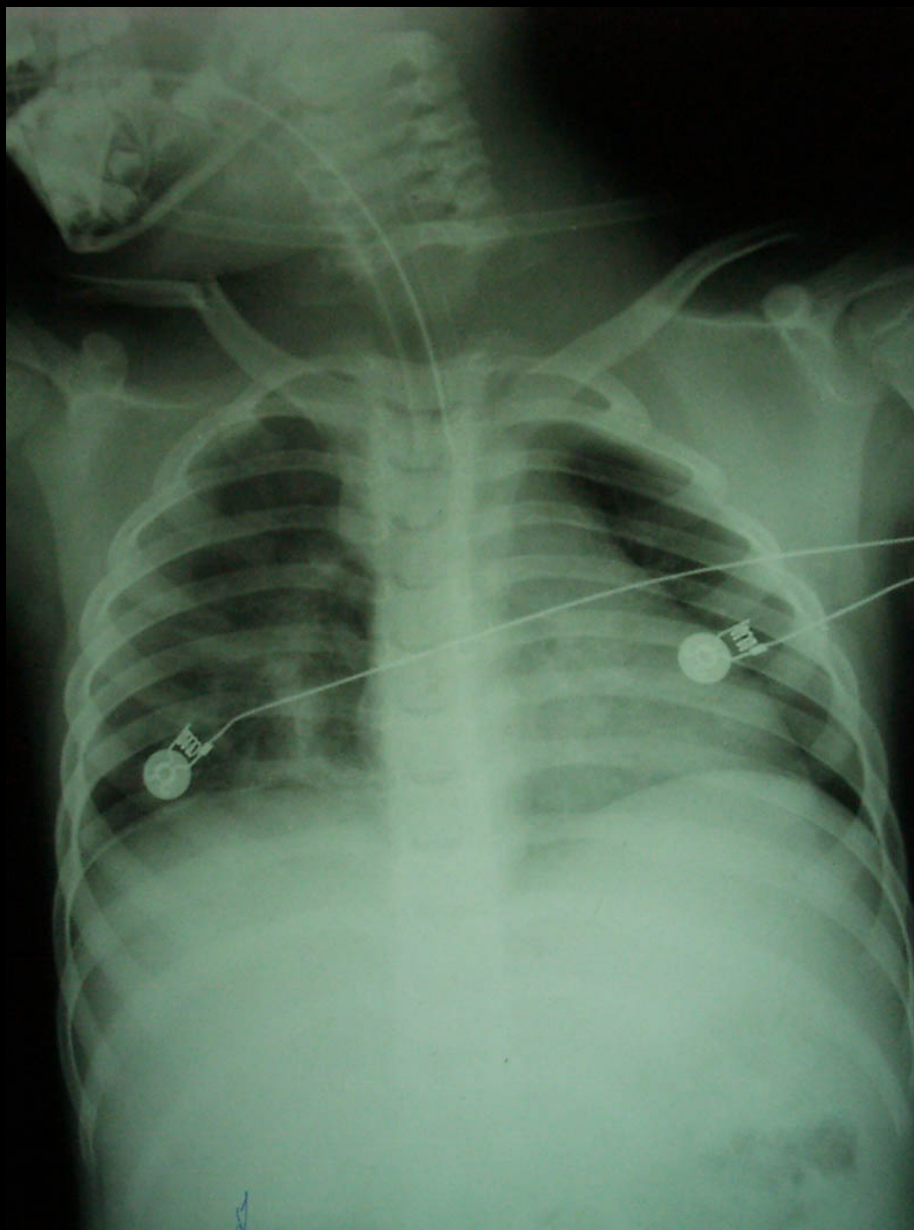
Fraktură cominutivă C4



Fraktură cominutivă C4 Imagine CT



Fraktură-luxație C7 – T1



Early Complications of Spinal Cord Injury

- Hypoventilation leading to pneumonia
- Vomiting with aspiration due to head immobilization
- Pressure sores
- UTI
- Autonomic dysreflexia

Adjunctive Agents Not Yet Proven to Help Spinal Cord Injuries

- Naloxone
- Mannitol / diuretics
- Hypothermia
- Antioxidants
- Calcium channel blockers
- Barbiturates

Hanging and Strangulation Injuries

- 3500 deaths per year in U.S.
- Third most common form of suicide
- Ligature or manual strangulation causes this pathologic sequence:
 - Venous obstruction: stagnant hypoxia: loss of consciousness: flaccidity: arterial occlusion: airway collapse: death
- Judicial hanging by contrast causes high spinal cord transection

Hanging and Strangulation Injuries

- Potential injuries to rule out:
 - Airway compromise from hematoma
 - Cervical spine fracture
 - Carotid thrombosis / intimal flap
 - Laryngeal fracture
 - Cerebral edema / increased ICP
 - Concurrent medication or drug overdose
 - Vocal cord paralysis

Treatment of Hanging and Strangulation Injuries

- Airway management / oxygen
- C-spine immobilization until films checked
- Hyperventilation
- Solu-Medrol IV if any possible cord injury
- + / - mannitol / diuretics / barbiturates for ICP
- ICU admission
- Observe at least 24 hrs for airway problems
- Check vocal cord function when extubated
- Psych consult when stable

Cervical Trauma - Summary

- Assess for possible cervical trauma & immobilize neck as part of primary survey
- Decide if radiographic studies needed as part of secondary survey
- Start IV steroids early if possible spinal cord injury
- Decide if subspecialist management or transfer of patient needed