Cervical Spine Injury

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Spinal Cord Injury

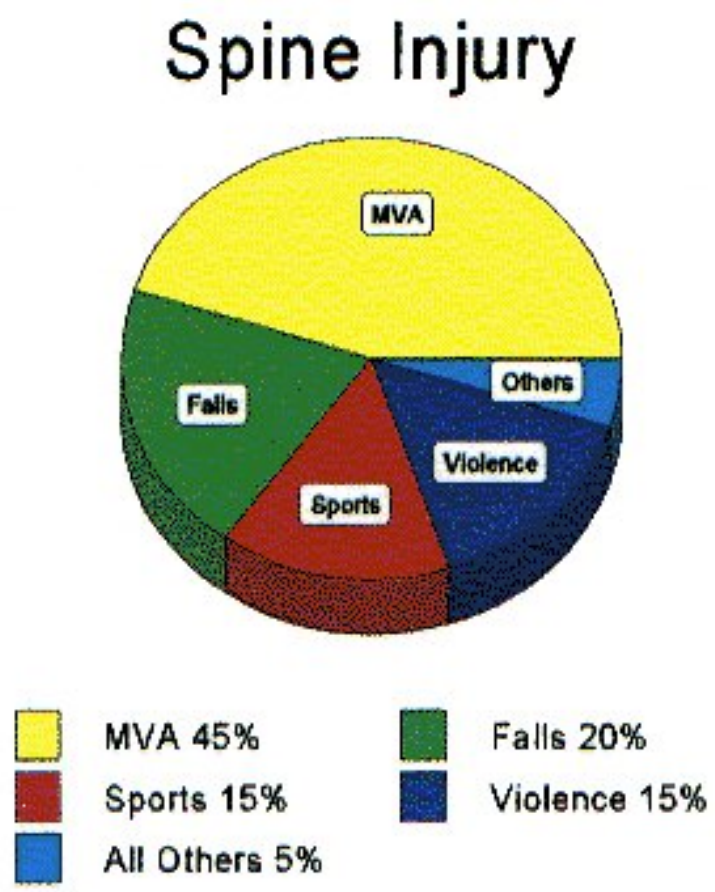
Importance:

- Big challenge in management
- Big emotional & financial effects to all.
  - Cost is in direct proportion to higher level (above C4) & older age.

Epidemiology

- Young > old
- Male > females (young)
- In elderly M=F
- 20% have another trauma.
- Etiology: RTA, falls, violence, work, sport.

Epidemiology



Epidemiology

- Cervical spine 55%
- Thoracic 15%
- Thoracolumbar 15%
- Lumbosacral 15%

- Acc. to ATLS course: C5 # is the most common.

Mechanisms of injury

- Flexion (compression #, ant. subluxations)
- Extension (Hangman's #)
- Vertical compression (Jefferson's #)
- Rotational (Rotational subluxations)

Clinical Evaluation

- Guided by the Advanced Trauma Life Support (ATLS) protocol mandated by the American College of Surgeons for trauma providers
- Evidence shows: ATLS ↓ M&M

Primary Survey: ABCDE

Secondary Survey: Head to Toe exam

Clinical Evaluation

In Secondary Survey:

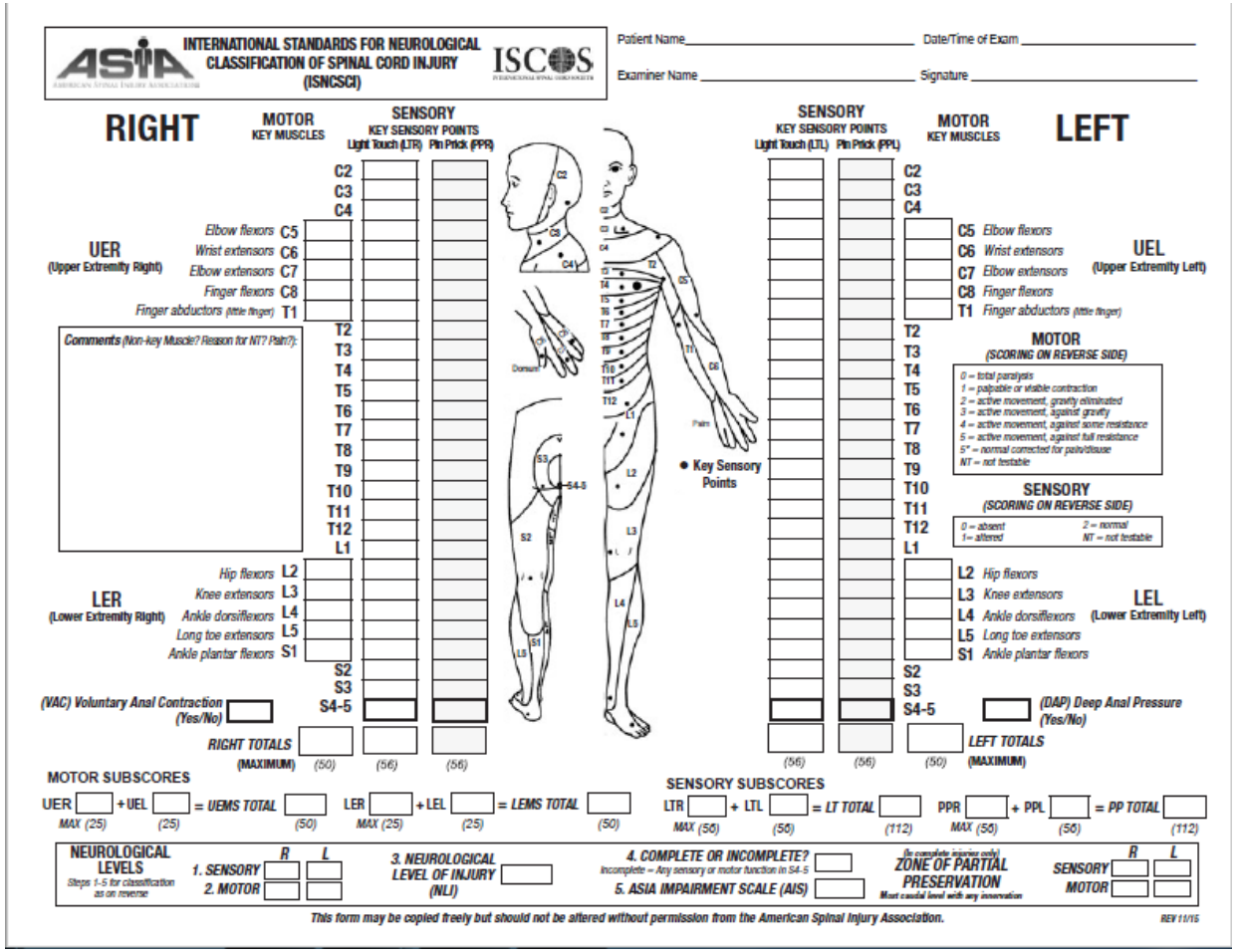
- Motor and sensory examination to localize the level of SCI (ASIA standardized methodology)

  Level, Score, Completeness

- Palpation of the spine during log roll.

- Rectal examination

Clinical Evaluation



INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY (ISNCSCI)

ASIA — ISCOS

Patient Name _____ Date/Time of Exam _____

Examiner Name _____ Signature _____

RIGHT

	MOTOR KEY MUSCLES	SENSORY KEY SENSORY POINTS Light Touch (LTR)	Pin Prick (PPR)
		C2	
		C3	
		C4	
Elbow flexors	C5		
Wrist extensors	C6		
Elbow extensors	C7		
Finger flexors	C8		
Finger abductors (little finger)	T1		
		T2	
		T3	
		T4	
		T5	
		T6	
		T7	
		T8	
		T9	
		T10	
		T11	
		T12	
		L1	
Hip flexors	L2		
Knee extensors	L3		
Ankle dorsiflexors	L4		
Long toe extensors	L5		
Ankle plantar flexors	S1		
		S2	
		S3	
		S4-5	
RIGHT TOTALS (MAXIMUM)		(50)	(56) (56)

UER (Upper Extremity Right)

LER (Lower Extremity Right)

Comments (Non-key Muscle? Reason for NT? Pain?):

(VAC) Voluntary Anal Contraction (Yes/No)

● Key Sensory Points

LEFT

SENSORY KEY SENSORY POINTS Light Touch (LTL)	Pin Prick (PPL)	MOTOR KEY MUSCLES	
		C2	
		C3	
		C4	
		C5	Elbow flexors
		C6	Wrist extensors
		C7	Elbow extensors
		C8	Finger flexors
		T1	Finger abductors (little finger)
		T2	
		T3	
		T4	
		T5	
		T6	
		T7	
		T8	
		T9	
		T10	
		T11	
		T12	
		L1	
		L2	Hip flexors
		L3	Knee extensors
		L4	Ankle dorsiflexors
		L5	Long toe extensors
		S1	Ankle plantar flexors
		S2	
		S3	
		S4-5	
LEFT TOTALS (MAXIMUM)		(56) (56)	(50)

UEL (Upper Extremity Left)

LEL (Lower Extremity Left)

MOTOR (SCORING ON REVERSE SIDE)

0 = total paralysis
1 = palpable or visible contraction
2 = active movement, gravity eliminated
3 = active movement, against gravity
4 = active movement, against some resistance
5 = active movement, against full resistance
5* = normal corrected for pain/tissue
NT = not testable

SENSORY (SCORING ON REVERSE SIDE)

0 = absent 2 = normal
1 = altered NT = not testable

(DAP) Deep Anal Pressure (Yes/No)

MOTOR SUBSCORES

UER [ ] + UEL [ ] = UEMS TOTAL [ ] (50) — MAX (25) (25)

LER [ ] + LEL [ ] = LEMS TOTAL [ ] (50) — MAX (25) (25)

SENSORY SUBSCORES

LTR [ ] + LTL [ ] = LT TOTAL [ ] (112) — MAX (56) (56)

PPR [ ] + PPL [ ] = PP TOTAL [ ] (112) — MAX (56) (56)

NEUROLOGICAL LEVELS (Steps 1-5 for classification as on reverse)	R	L			
1. SENSORY			3. NEUROLOGICAL LEVEL OF INJURY (NLI)		
2. MOTOR					

4. COMPLETE OR INCOMPLETE? (Incomplete = Any sensory or motor function in S4-5)

5. ASIA IMPAIRMENT SCALE (AIS)

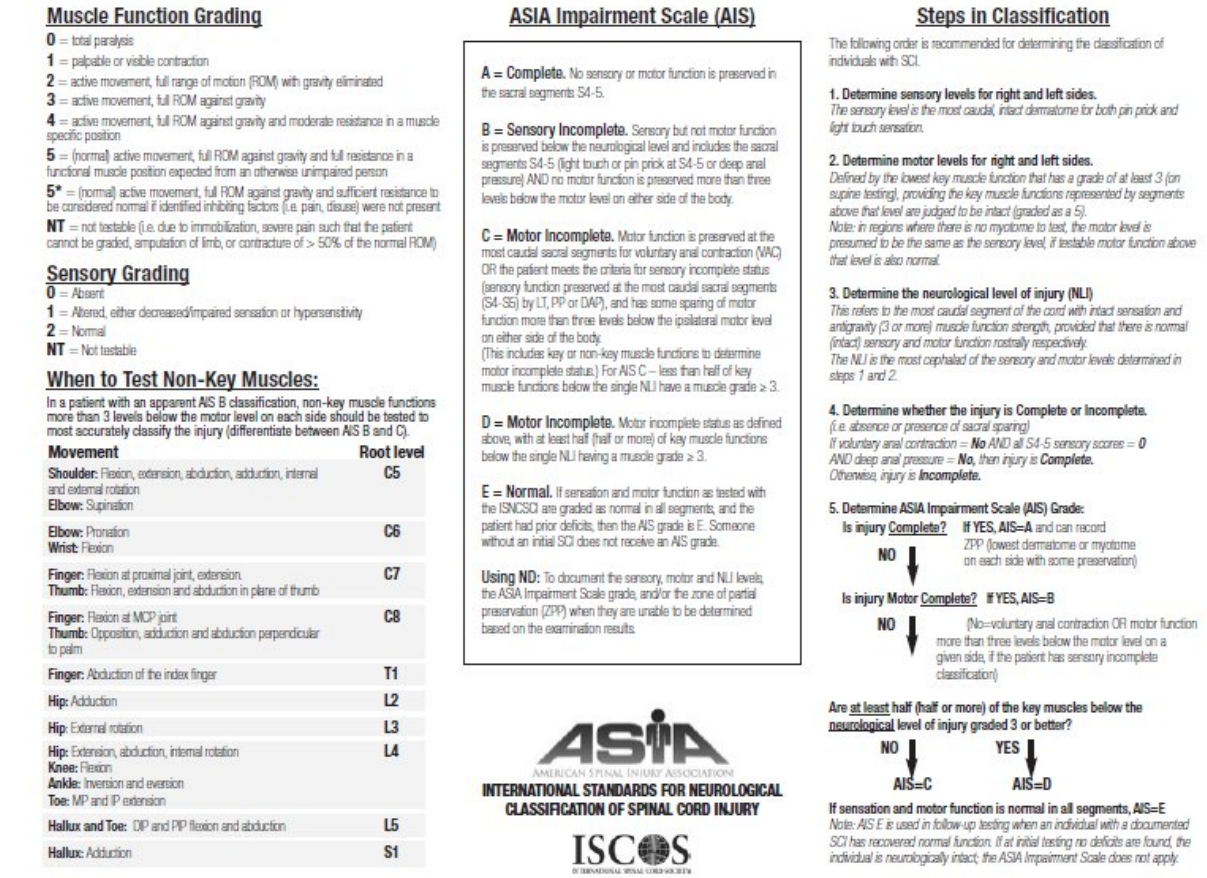
ZONE OF PARTIAL PRESERVATION (for complete injuries only) (Must caudal level with any innervation)

	R	L
SENSORY		
MOTOR		

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REV 11/15

Clinical Evaluation



Muscle Function Grading

0 = total paralysis

1 = palpable or visible contraction

2 = active movement, full range of motion (ROM) with gravity eliminated

3 = active movement, full ROM against gravity

4 = active movement, full ROM against gravity and moderate resistance in a muscle specific position

5 = (normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person

5* = (normal) active movement, full ROM against gravity and sufficient resistance to be considered normal if identified inhibiting factors (i.e. pain, disuse) were not present

NT = not testable (i.e. due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal ROM)

Sensory Grading

0 = Absent

1 = Altered, either decreased/impaired sensation or hypersensitivity

2 = Normal

NT = Not testable

When to Test Non-Key Muscles:

In a patient with an apparent AIS B classification, non-key muscle functions more than 3 levels below the motor level on each side should be tested to most accurately classify the injury (differentiate between AIS B and C).

Movement	Root level
Shoulder: Flexion, extension, abduction, adduction, internal and external rotation **Elbow:** Supination	C5
Elbow: Pronation **Wrist:** Flexion	C6
Finger: Flexion at proximal joint, extension. **Thumb:** Flexion, extension and abduction in plane of thumb	C7
Finger: Flexion at MCP joint **Thumb:** Opposition, adduction and abduction perpendicular to palm	C8
Finger: Abduction of the index finger	T1
Hip: Adduction	L2
Hip: External rotation	L3
Hip: Extension, abduction, internal rotation **Knee:** Flexion **Ankle:** Inversion and eversion **Toe:** MP and IP extension	L4
Hallux and Toe: DIP and PIP flexion and abduction	L5
Hallux: Adduction	S1

ASIA Impairment Scale (AIS)

A = Complete. No sensory or motor function is preserved in the sacral segments S4-5.

B = Sensory Incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.

C = Motor Incomplete. Motor function is preserved at the most caudal sacral segments for voluntary anal contraction (VAC) OR the patient meets the criteria for sensory incomplete status (sensory function preserved at the most caudal sacral segments (S4-S5) by LT, PP or DAP), and has some sparing of motor function more than three levels below the ipsilateral motor level on either side of the body.
(This includes key or non-key muscle functions to determine motor incomplete status.) For AIS C – less than half of key muscle functions below the single NLI have a muscle grade ≥ 3.

D = Motor Incomplete. Motor incomplete status as defined above, with at least half (half or more) of key muscle functions below the single NLI having a muscle grade ≥ 3.

E = Normal. If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade.

Using ND: To document the sensory, motor and NLI levels, the ASIA Impairment Scale grade, and/or the zone of partial preservation (ZPP) when they are unable to be determined based on the examination results.

ASIA
AMERICAN SPINAL INJURY ASSOCIATION
INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY
ISCOS
INTERNATIONAL SPINAL CORD SOCIETY

Steps in Classification

The following order is recommended for determining the classification of individuals with SCI.

1. Determine sensory levels for right and left sides.
The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.

2. Determine motor levels for right and left sides.
Defined by the lowest key muscle function that has a grade of at least 3 (on supine testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).
Note: in regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal.

3. Determine the neurological level of injury (NLI)
This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively.
The NLI is the most cephalad of the sensory and motor levels determined in steps 1 and 2.

4. Determine whether the injury is Complete or Incomplete.
(i.e. absence or presence of sacral sparing)
*If voluntary anal contraction = **No** AND all S4-5 sensory scores = **0** AND deep anal pressure = **No**, then injury is **Complete.***
*Otherwise, injury is **Incomplete.***

5. Determine ASIA Impairment Scale (AIS) Grade:

Is injury Complete? **If YES, AIS=A** and can record ZPP (lowest dermatome or myotome on each side with some preservation)

NO ↓

Is injury Motor Complete? **If YES, AIS=B**

NO ↓ (No=voluntary anal contraction OR motor function more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)

Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?

NO ↓ **AIS=C**

YES ↓ **AIS=D**

If sensation and motor function is normal in all segments, AIS=E
Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact; the ASIA Impairment Scale does not apply.

SCI assessment
Motor Level of injury

Upper Limb	Lower limb
C5- elbow flexion	L2- hip flexion
C6- wrist extension	L3- knee extension
C7- elbow extension	L4- ankle dorsiflexion
C8- finger flexion	L5- big toe extension
T1-finger abduction	S1- ankle plantarflexion

SCI assessment
Sensory Level of injury

Level	Area to test
C5	Deltoid
C6	Thumb
C7	Middle finger
C8	Little finger
T4	Nipple
T8	Xiphisternum
T10	Umbulicus
T12	Symphysis
L4	Medial leg
L5	Space between 1&2 toes
S1	Lateral foot
S3	Isch. tuberosity
S5	Perianal

SCI assessment
Scoring

Motor (MRC)	
0	No movement
1	Flicker
2	Without gravity
3	Against gravity
4	Subnormal
5	Normal Power

Sensory	
0	Absent
1	Impaired
2	Normal

Clinical Evaluation

Injury is Complete or Not ?

- Complete if all of the next is present:
  - No voluntary anal contraction
  - All S4, S5 sensory scores are zero
  - No deep anal pressure

  (Worse: Only 3% recover useful function)
- Otherwise: Incomplete (Sacral sparing)
  - better prognosis

SCI assessment
ASIA impairment scale

Class	Description
A	Complete (below the level of injury)
B	Incompl.: some sens. but no motor (below the level)
C	Incompl.: > ½ of key muscles have grade <3
D	Incompl.: > ½ of key muscles have grade ≥3
E	Normal

Cervical Spinal cord syndromes (incomplete injuries)

- Central cord syndrome
- Brown-Sequard syndrome
- Anterior spinal cord syndrome
- Posterior spinal cord syndrome

Neurogenic & Spinal Shock

Neurogenic shock	Spinal shock
• BP low, bradycardia, due to loss of sympath., • In injury above T6. • IVF, pressors	• Transient areflexia & hypotonia after severe SCI (hrs-wks) • Bulbocavernosus & anal reflexes recovers 1-st.

Field management

- Recognition of SCI: suspect in: (coma, multiple trauma, related symptoms & signs: sens, motor, abdominal breathing priapism).
- Immobilization.
- Airway & O2
- I.V. access (maintain BP)
- Brief motor examination.

Emergency room management

- Immobilization
- Airway & O2 (intubate if > C4)
- BP > 90 mmHg (careful hydration, pressors, Atropine in bradycardia)
- NGT, Foley catheter, t-regulation
- Neurological examination (detailed)
- Lab investigations: CBC, electrolytes
- Imaging

Emergency room management

Traction:

- Realign & stabilize the spine
- Gardner-Wells tongs
- C/I in: AOD, Hangman # IIA, III, <3 year.
- Weight added by 5-10 pounds (5 to each level, max. 1/3 body weight).
- In overdistraction, deterioration reduce wt.
- X-ray daily, & after every change in wt.

Emergency room management

Pharmacotherapy:

Steroids: (Class 3 evidence - optional!)

- √ Methylprednisolone 30 mg/kg in 15 min, next 45 min - nothing, then 5.4 mg/kg/hr for 23-47 hrs
- √ In incomplete nonpenetrating cord injury, with motor deficit, duration <8 hrs, in an adult.

Imaging

Clinical clearance

- No neck pain.
- No LOC. Normal mental status.
- Adult.
- No neck tenderness.
- No neurological signs or symptoms referable to the neck.
- No other distracting injury.

Imaging

Radiological clearance

- 3-view radiographs
- 5-view radiographs
- Flexion-extension views
- CT at the suspected level
- MRI if spinal injury present or suspected

Imaging – normal lat C-spine

- True lateral? (mandib rami, post clinoids)
- C7-T1 included
- 4 arcuate lines (AML,PML,SLL,PSL)
- Clivus-Dens: 5 mm(adults), 10 mm (peds) ↑ in AOD.
- ADI: 3mm (adults), 4 mm (peds), ↑ in AAD
- Canal diameter 17 +/- 5 mm
- PVST (at C2-C4: 7mm, C5-C7: 22mm)
- Interspinus distance (up to 1.5 of adjacent levels)



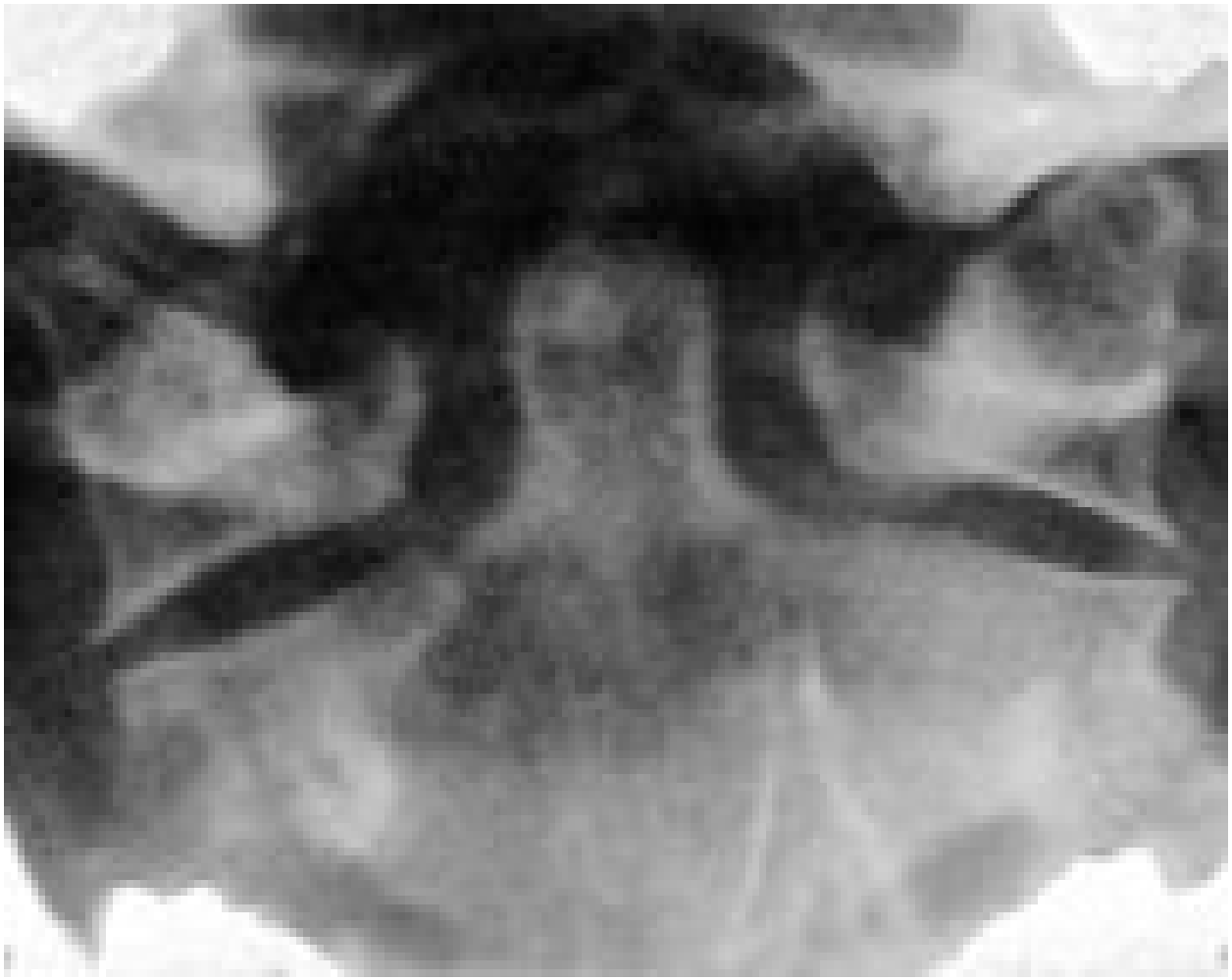

spinolaminar
posterior
anterior


Soft Tissue Shadow
Outline

AP normal



Normal open mouth view



Oblique views





Inadequate lateral view. Why?



Imaging – in pediatrics

- Pseudospread of Atlas (up to 4 years).
- Fusion between dens & body at 12 years.
- < 10 years flexion center at C2-C3.
- C3-C7 wedge shaped normally.

Imaging

While some missed cervical fractures, subluxations and dislocations are the result of film misinterpretation, the most frequent cause of overlooked injury is an inadequate film series.

ICU Management

Respiratory system:

✓ Possible complications (atelactasis, pneumonia, pulm embolus, p edema)

→ Prevention (suctioning, intubation, CPAP)

Consider tracheostomy in > 2/52 intubation

ICU Management

Cardiovascular:

√ Low BP + Bradycardia

→ IVF +/- Pressors +/- Atropine

GI SYSTEM:

√ Decreased peristalsis, ulcers, bleeding

→ NGT, H2-blocker

ICU Management

Urinary system:

✓ Atonic then spastic bladder, UTI, RF

➡ Foley, then intermittent catheter, C&S

Thromboembolic complications:

✓ DVT, PE

➡ Prevent with heparin 5000 IU sc bid

➡ Treat with full heparin-n, IVC filter

ICU Management

Pressure sores:

- Log-rolling / 2 hours
- Dressing in superficial lesions

Rotational flaps in deep ones

Surgery

Broad indications:

- ✓ Correction of deformity
- ✓ Stabilization
- ✓ Decompression of neurological element

Emergent Surgery - Indications

- Progression of signs
- Complete subarachnoid block
- Cord compression on imaging
- Compression of vital root
- Acute anterior spinal cord syndrome
- Nonreducible locked facets
- Penetrating trauma

Emergent Surgery - Contraindications

- Complete injury > 24 hours
- Unstable patient
- Central cord syndrome

Atlanto-occipital dislocation + Atlanto-axial dislocation



Atlanto-axial dislocation



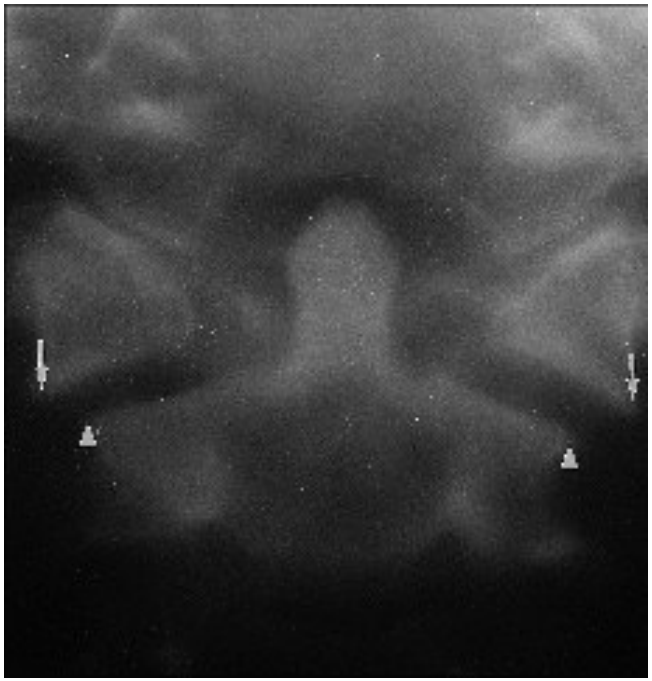


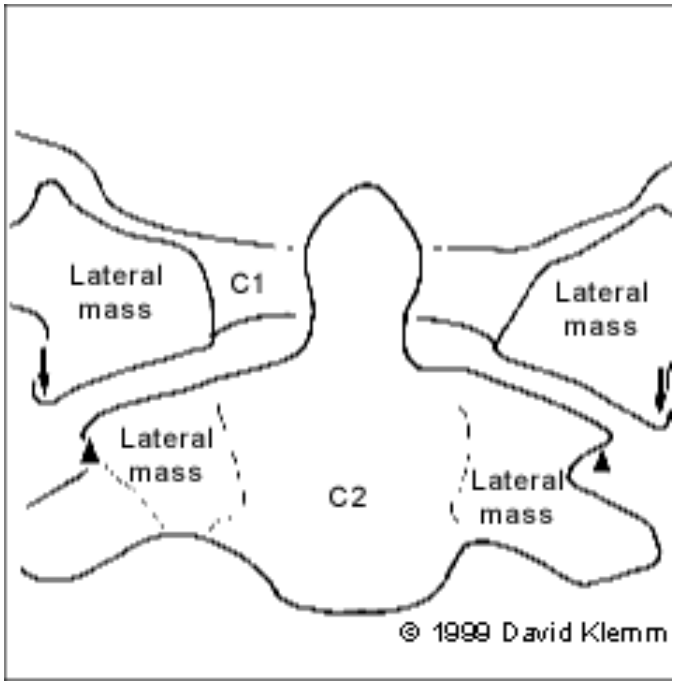
Atlas

- 5% of C-spine #
- 40% associated with C2 #
- The commonest # is Jefferson
- In patients who survive, neurodeficit is rare
- Dx: open mouth view, CT (measure lateral mass displ-t)
- If displacement 7 mm, rigid collar 12/52
- If displacement 7mm, Halo or ORIF
- If + C2#, treat acc. to C2 #

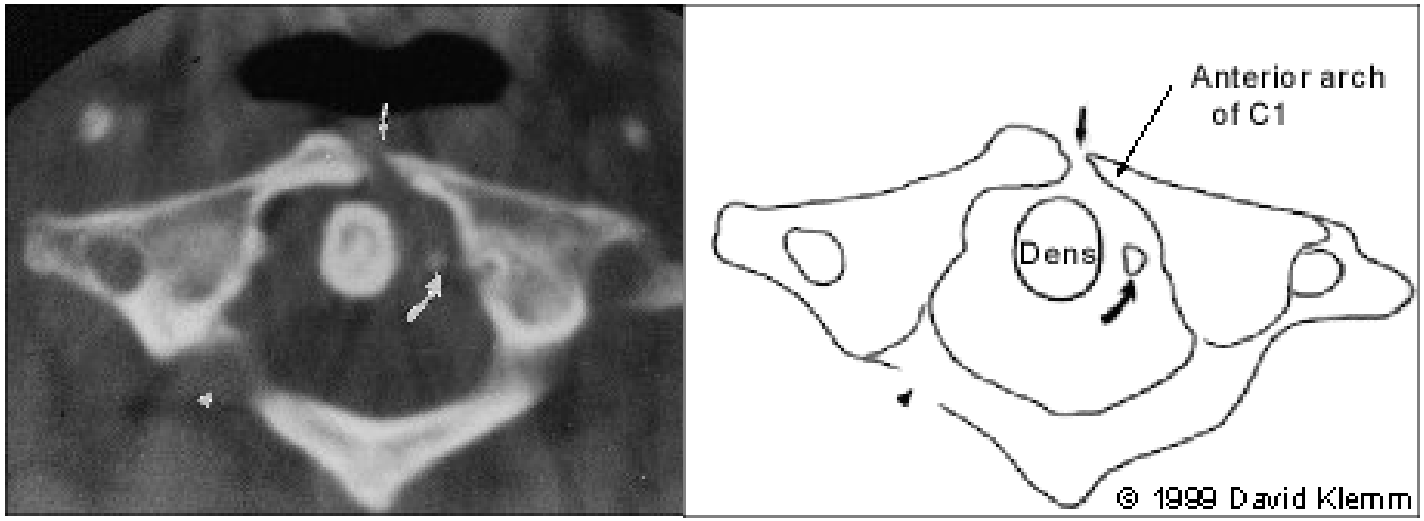
Jefferson

- Burst fracture of the ring of C1
- The process displaces the masses laterally and causes fractures of the anterior and posterior arches, along with possible disruption of the transverse ligament. Quadruple fracture of all 4 aspects of the C1 ring occurs
- If displacement of the lateral masses is more than 6.9 mm, complete disruption of the transverse ligament has occurred – Unstable.





Jefferson fracture



Jefferson fracture

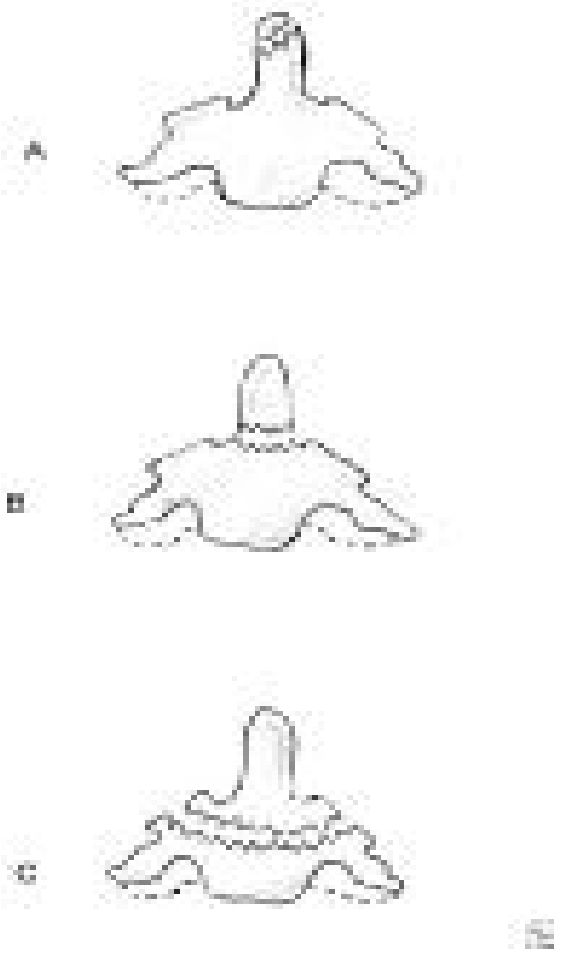
Axis

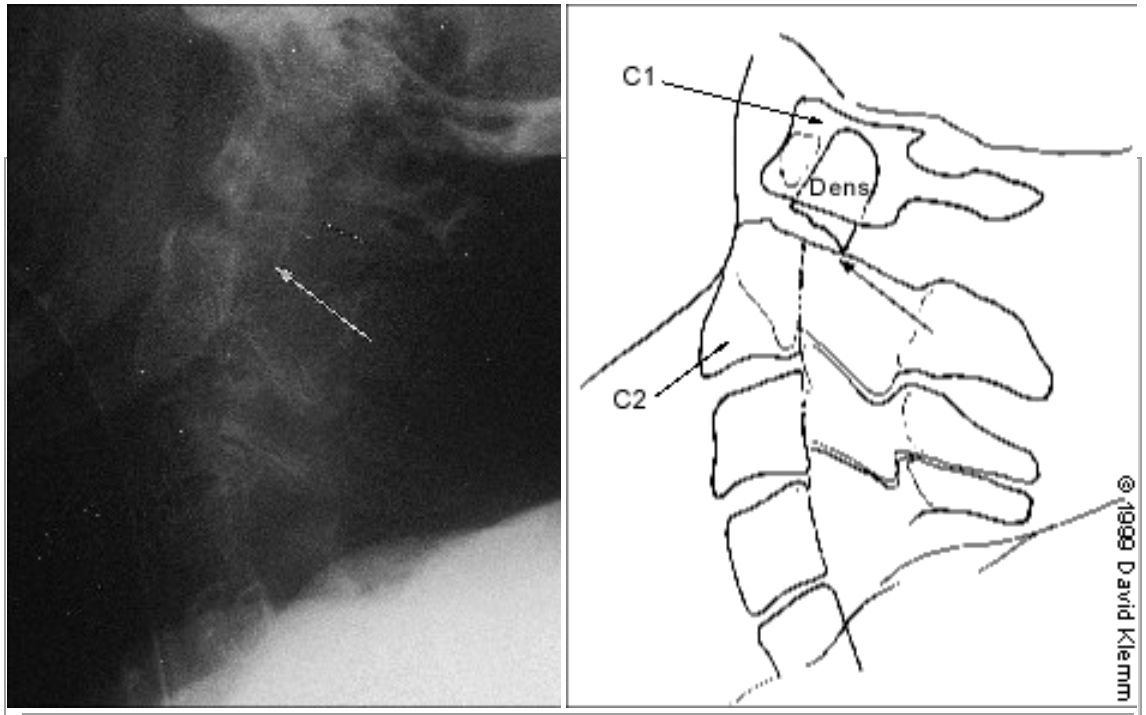
- 20% of C-spine #(largest, unusual shape)
- Neurodeficit only in 10%
- Most cases could be treated by rigid external immobilization (Halo Vest) for 3 months

Odontoid

- 60% of axis #
- Type 1: tip, uncommon, usually stable
- Type 2: base, the most common
  - consider surgery in 50 years or 5mm displacement
- Type 3: body, stable, only Halo in 90%

Types of Odontoid

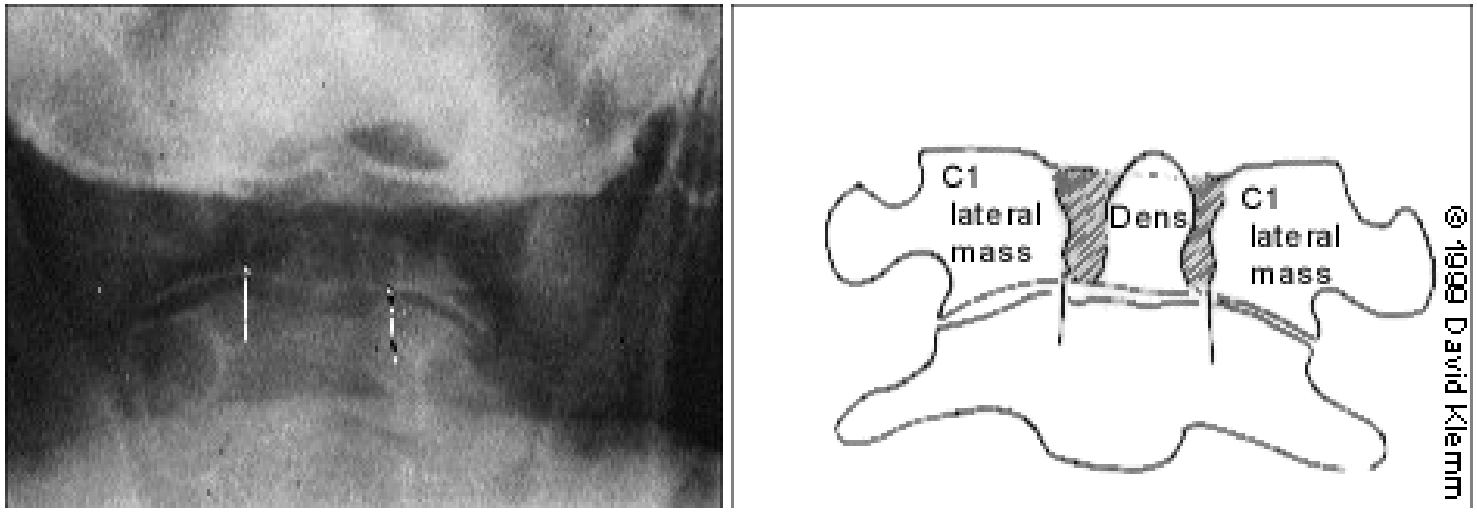




A type II dens fracture

Odontoid fracture

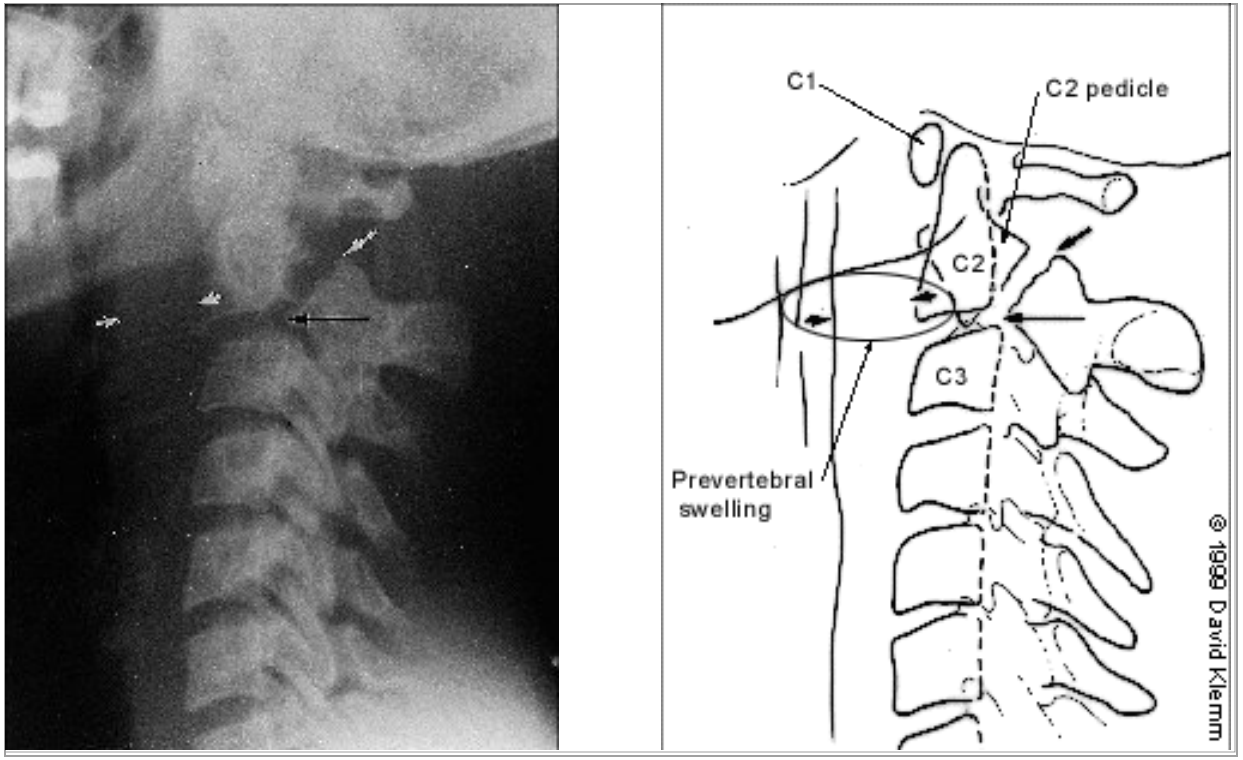




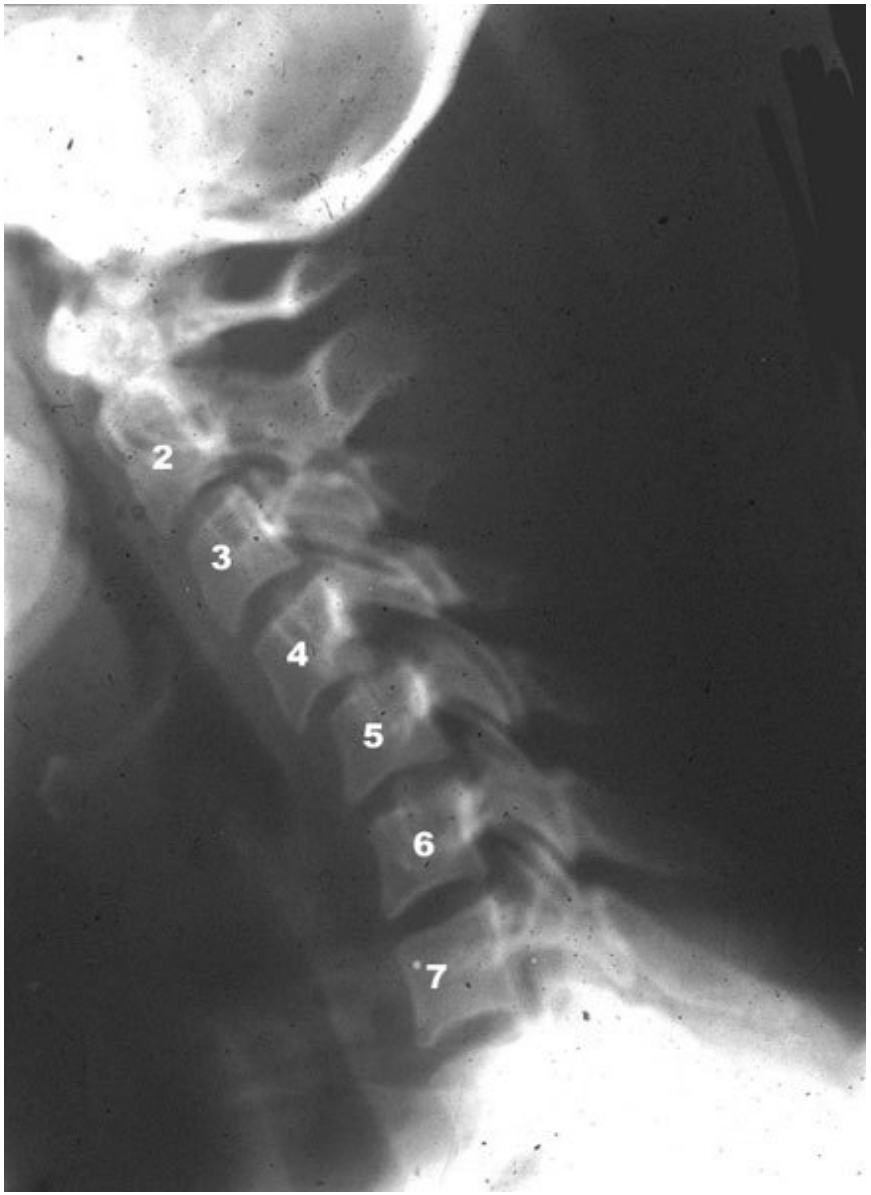
Fracture of dens type 2

Hangman

- Bilateral fractures through the pedicles of C2 due to hyperextension, + ant sublux C2/C3.
- 20% of axis #
- Disruption of the spinolaminar contour line
- Seldom is associated with spinal injury
- Type 1: 3mm sublux……Rigid collar
- Type 2: 4mm sublux, > 11 degree angulation (post lig disrupted)……Halo
- Type 3: ant lig disrupted……..ORIF



Hangman's fracture


2
3
4
5
6
7



Thanks



Any Questions?