Spinal Trauma

Epidemiology

C spine
Male:female 4:1
RF from MVAs are HI (most important), ejection, roll over, no SB, facial burns, extensive car damage, death of occupant
C2 most common # (25%); C5-6/6-7 most common dislocation

T/L spine
T/L junction most at risk
65% # between T12 and L2, 90% between T11 and L4
95% are vertical/oblique, 5% horizontal
20% with # have 2nd #; 50% have other injury

Paediatrics
Lower incidence
More upper C spine and atlanto-occipital (large head, lax ligs, horizontal plane of facet jts)
Dens fuses at 6-8yrs

Investigations

NEXUS
No XR if:
1. Absence of midline cervical tenderness
2. Normal alertness & consciousness
3. No intoxication
4. No focal neurological deficit
5. No painful distracting injury
Assess rotation 45deg - only XR if can’t do
Sens 99.6%, Spec 12.6%, NPV 99.9%. Reduces imaging by 13%

Canadian C spine rule
Incorporates MOI and examination findings
For alert, stable patients
Not applicable in: elderly, >2yrs
Sens 100%, spec 43% for clinically important injuries. Reduces imaging by 15%
Compares favourably with NEXUS
If low risk criteria fulfilled, assess rotation 45deg - only XR if can’t do
Absence of High-Risk factors - failure = XR
  Age >65
  Dangerous mechanism (fall >3 feet, axial load, highspeed/roll-over/ejection, MRV, bike,
  Presence of paraesthesia in extremities
Presence of Low-Risk factors - absence = XR
  Rear-end MVA
  Able to sit up
  Ambulatory at any time
  Delayed onset neck pain
  No midline tenderness

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C spine XR
Flexion/extension views not recommended, risk of neuro inj, false neg from spasm, no clinically validated criteria for interpretation, do MRI instead

C spine CT
Indications: any #/?# on XR (25% will have 2nd #, 35% will not have been visible on XR), head CT, high index suspicion despite normal XR
Sens >95% for #/dislocation; may miss ligamentous inj at C1-2; if altered LOC, no FND, normal CT - false neg rate 0.1%

C spine MRI
Better than CT for ligaments, discs, spinal cord
Sens 100% for cord inj, 55% for #, 80% for dislocations
In SC, hypoattenuation = haemorrhage, hyperattenuation = oedema/transection

L/T spine XR
Widened mediastinum; displacement L paraspinal line; pleural cap; interpedicular distances should gradually increase L1-5; lack of concavity post vertebral body cortex (?burst #)
Sens 75%

L/T spine CT
Sens 95%

C1 #
4%
15-20% assoc with C2 inj, 25% assoc with lower C inj

Jefferson #: vertical compression inj; blowout # ant and post arch; lateral masses C1 driven laterally; wide pre-dental space, but post spinal line may be OK; displacement of lateral masses >2mm or unilateral displacement
Unstable
50% survive without deficit
1/3 assoc with C2; ½ assoc with other C spine #

Atlanto-occipital dislocation: flexion inj; fatal; unstable
Ant atlanto-axial dislocation: flexion inj; rupture of transverse lig of dens; often fatal; unstable
Post atlanto-axial dislocation: extension inj; unstable

C2 #
Most commonly #ed vertebrae
Usually assoc with C1 inj

Hangman’s #: extension +/- distraction inj; bilateral # of pedicles of axis (through pars interarticularis) - ant movement of C2 on 3 of >2mm, avulsion of ant-inf corner of C2 assoc with rupture of ant long lig; prevertebral ST swelling; unstable; cord inj rare; causes Horner’s syndrome (ipsilateral constricted pupil due to damage of sympathetic trunk); trt with external immobilisation
# dens: flexion inj; 10-15%; complicated by ST swelling
I = 5-8% = tip, above transverse lig
II = 55-70% = junction of body and dens; unstable; needs OT if displaced >6mm
III = 30-35% = through body of dens; unstable but good prognosis

Extension teardrop #: usually involves axis; extension inj; unstable; causes central cord syndrome
Os odontotidum: failure of fusion of tip to body of dens (ossification centre should appear at 2yrs, fuse by 12yrs); unstable, requires post fusion
C2-3 pseudosubluxation: common in infants and children (40% <8yrs) – will disrupt post interspinous line but spinolaminar line conserved, will cause incr pre-dental space in children; less commonly occurs at C3-4, 4-5 levels

C7 #
Clay shoveller’s #: flexion inj; avulsion /direct blow to lower spinous processes; ghost sign on AP view (displaced fractured spinous process); stable; cervical collar 2-3/52

Other #s
Ant teardrop #
Flexion inj; Wedge-shaped ant-inf #; ligamentous (ant long lig) and NS involvement common due to retropulsion of fragments; unstable

Ant wedge/compression #
C spine: Flexion inj; Stable; cervical collar 6/52
T/L spine: major; flexion / axial load; most common at T12-L2; middle and post column intact; may be assoc with ant-sup marginal shearing #; neural injury rare (more common if lateral wedging and nerve root involvement; if post wedging present, suggests more violence, ?burst # and ?SC involvement); stable usually; unstable if ant margin reduced >50% and post lig injured; symptomatic trt

Chance # (posterior involvement)
Flexion/distraction inj, SB inj, distraction injury occurs as pivot pushed more anteriorly, around ant abdominal wall; major; failure of posterior column: complete disruption of spinous process, laminae, transverse process, pedicles, vertebral bodies; oblique / horizontal splitting of spinous process and neural arch, pushing post-sup aspect of vertebral body into IV disc; widened interpedicular distance seen; suggested by vacant appearance of vertebral body on AP film, discontinuity of cortex of pedicles / spinous processes on AP failure of post and middle columns; ligamentous involvement; unstable; 65% have intestinal / mesenteric inj

Horizontal fissure #
Similar to Chance #, but # line extends horizontally through vertebral body to anterior aspect

Smith #
# through superior articular processes, arch and sup-post vertebral body, but spares post spinous processes; post ligaments disrupted

Burst #
C spine: Vertical compression inj; comminuted but ligs intact; # fragments may still injure cord; stable unless severe (>15-20deg); traction 6/52
T/L spine: major; vertical compression inj; loss of vertebral height ant and posteriorly - pedicles widened on AP; # fragments may injure cord; failure of ant and middle columns; unstable

Transverse process #
Assoc with renal/ureteric/splenic/hepatic/pancreatic inj, adrenal haematoma, diaphragmatic hernia, pelvic # L3 most common (30%)

Translational inj
Shear forces; AP/PA trauma; affects neural canal

Subluxation
Flexion inj; loss of normal cervical lordosis, fanning of interspinous distance; only ant IV lig intact; unstable; requires reduction / fusion
Unilateral facet joint dislocation
Rotational injury; disruption (>2mm) of spinolaminar line and SP’s on AP / lat film; wide interspinous distances; widening of disc space; subluxation <1/2 vertebral body width of vertebra above over vertebra below; angulation of spine by >11deg on AP view; better view available on oblique films; unstable if assoc facet #; trt by reduction

Bilateral facet joint dislocation
Flexion inj; Disruption of ant lig and annulus of disc; bow tie/bat wing appearance of locked facets; subluxation >1/2 vertebral body width; unstable; require reduction/fusion

C spine immobilisation
Indication
Recommended if for XR; no evidence of efficacy in prevention of spinal cord injury in conscious patients (may worsen outcome by uncontrolled reduction); optimal position with 2cm occiput elevation

Method
Use C spine collar, sandbags + tape (better than collar), headblock and spinal board, strapping, Vac Pac

Complications
Incr ICP, decr access to neck, discomfort, prompts unnecessary investigation, patient anxiety, cutaneous pressure ulceration (esp if prolonged use), requirement for log rolling, aspiration, DVT, may worsen neurological injury (if displaced #, pre-existing cervical deformity), masks other injuries, decr pul function

Cord injury
Usually assoc with bony/ligamentous inj (SCIWORA rare, more in children, more in C spine); most common in C5-T1, mid-thoracic, L1-T12, close to bony fusion; “level” refers to last unaffected level; “complete” if ongoing Sx after reflexes return (implied incomplete if sacral sparing); paralysis flaccid and areflexia in SC inj

MOI: direct trauma, 2Y oedema, excitatory NT release, epidural haematoma, vascular inj, delayed apoptosis of oligodendrocytes

Central cord syndrome
Hyperextension inj, often in older patient (buckling and central haematoma of cord)
Good outcome (50% good recovery)
Bilateral prox and arm > distal and leg weakness
Bilateral prox and arm > distal and leg decr sensation
Reflexes variable

Anterior cord syndrome
Flexion/vertical compression inj
Poor outcome (10-15% full recovery)
Bilateral leg > arm weakness (UMN)
Bilateral loss of pain and T and coarse touch
May be vague preservation of sensation from dorsal column

Posterior column syndrome
Rare; usually penetrating inj from back/hyperextension
Motor OK
Bilateral loss vibration and proprioception and fine touch

Brown-Sequard lesion
More common with penetrating injury/unilateral facet joint injury
No sphincter involvement; moderate outcome
Ipsilateral weakness, loss of vibration and proprioception and light touch
Contralateral loss of pain and temp, Reflexes variable
Neurogenic shock of sympathetic innervation
Temporary cessation of SC neuro function - hypoactivity of SNS in patients with inj above T1-4)
Usually resolves in 48hrs
CV: decr HR, decr BP, vasoD; poikilothermia; dry (absent sweating) extremities with variable warmth; erection; do not get normal response to hypoV shock; may need to monitor CVP/UO to assess end organ perfusion; difficult to assess for haemorrhage (suspect if HR >80, persistent hypotension, patchy skin cyanosis)
GI: paralytic ileus (lasts 3-10/7); sphincter paralysis - aspiration from passive regurg
GU: flaccid paralysis bladder - urinary retention

Spinal shock/concussion
Loss of voluntary movement and sensation, loss of somatic and autonomic reflexes below level of lesion, changes in cord physiology
May last few hrs – several weeks
Recovery heralded by return of plantars and perineal reflexes - either recovery or spasticity (unless at conus medullaris or cauda equine where areflexia remains)

Autonomic dysreflexia
Not due to trauma, due to old lesion
Due to any lesion at/above T6
Impaired total body SNS, pelvic PNS
Precipitated by many factors (eg. bladder distension, pressure sore)
CV: decr HR, incr BP (risk of ICH), headache, sweating, chest tightness, erection; flushing above lesion; cold, piloerection below lesion
GI: bowel/bladder contraction
Other: mydriasis
Trt: elevate head; 10mg SL nifedipine, GTN, treat cause

Management
A:
NGT (high risk of aspiration)
Consider ETT
Have atropine available as exaggerated vagal response to instrumentation
C spine immobilisation
Pre-vertebral haematoma can cause obstruction
RSI best if urgent, fibreoptic if not
B:
Paradoxical breathing
Assess VC
O2 to prevent secondary injury (as in HI)
C:
Assess GCS, UO, CVP
Early insertion of IDC
Suspect hypoV until proven otherwise if decr BP - bolus IVF
May require inotrope/chronotrope
D:
Look for Horner’s if inj at/above T4
PR; anal and bulbocavernosus reflex
Analgesia
Temp control
IDC early to avoid bladder overdistension
E:
Care for pressure areas
**Steroids**
Indicated if <8hrs/recommended by spinal unit
30mg/kg IV methylpred over 15mins - 5.4mg/kg infusion over 23hrs
CI if heavily contaminated wounds, bowel perf, sepsis, DM

**Prognosis**
50% good recovery if preservation of S4-5 sensation at 3-7/7 (10-15% without)
Areas of sparing in dermatome gives 50% chance recovery in that myotome
Incr age, worse prognosis

**XR C Spine**

**Lateral**

**Adequacy:**
a. Count vertebrae: C7-T1 seen; dens: ossification centre appears 2yrs, fuses 12yrs
b. No jewellery

**Alignment:**
- Intervertebral lines
- C2-3 pseudosubluxation normal in infants and children
- Up to 1mm anterior subluxation acceptable in adults (3mm in children)
- Atlanto-occipital alignment:
  - ant margin of foramen magnum lines up with dens, posterior margin lines up with spinolaminar line
  - basion-dental Interval: base skull - tip peg ≤8.5mm on CT - marker of occipito-atlantal dissociation

**Bones**
- Predental space
- Abnormality = fracture of odontoid process/injury to transverse ligament
- <3mm adult, <5mm children
- Vertebral body height
- Anterior height no less than 3mm shorter than posterior height
- Intervertebral spaces
- Spinous processes

**Disc spaces**

**Soft tissue swelling**
Can be due to ETT, pooled pharyngeal secretions, children
Penning’s criteria: C1 <10mm/C2 <7mm/C6 <22mm (or <width vertebral body)
Sens 95% if adequate films

**Odontoid peg**
1. **Adequacy:** can see entire odontoid and lateral borders of C1-2
2. **Alignment:** symmetry of lateral mass around dens; occipital condyles line up with lateral masses
3. **Assess for rotation:** Line between top/bottom incisors passes through centre of dens
4. **Assess bones:** no break in margins

**Fractures**

**Flexion**
- Anterior subluxation, Unilateral facet dislocation, Bilateral facet dislocation
- Wedge compression fracture, Flexion teardrop fracture, Clay Shoveler’s fracture

**Extension**
- Hangman’s fracture

**Compression**
- Jefferson fracture, Burst fracture

**Complex**
- Odontoid
Unstable

Jefferson  Jeffersons #
Bit        Bilateral facet dislocation
Of         Odontoid type II, III
A          Any # with dislocation/subluxation
Hangmans   Hangmans #
Tit        Teardrop #

Unstable when:
2/3 columns affected
>3mm displacement of vertebral body
Angle >11 degrees between vertebrae
Anterior height <2/3 posterior height (>25% height of affected vertebral body)
Fanning of interspinous distance