

Overview

- Common causes: MVA (esp major or if head injury), sporting (esp rugby), diving, falls, assault, GSW. Rarely hanging.
- Incidence:
 - ~2% based on sig. spine or cord injuries found in trauma imaging of C-spines.
 - 10-20% HI injury also have a cervical spine injury.
 - ~15% have missed or delayed diagnosis of cervical spine injury, with a risk of permanent neurologic deficit of 29%.
- Site: 33% of injuries occur at the level of C2, and 50% occur at the level of C6 or C7.
- Paediatric: Most injuries are C1-C2 as relatively heavier head, lax ligaments.
- Gender: 4M:1F

Presentation

Cervical spine injury should be suspected if:

- Dangerous mechanism: MVA, fall, diving accident, axial load to head, sporting tackles
- Neck pain: Midline tenderness = vertebral vs lateral tenderness = muscle.
- Neurological signs: Paraesthesiae & weakness/paralysis. Spinal cord injury → various deficits, injury syndromes
- Other trauma: Multi-trauma, significant HI, distracting painful injury
- Elderly - increased fragility.
- ↓LOC - makes assessment difficult - assume an injury

C-Spine Immobilisation

For all patients suspected of having possible cervical spine injury before being cleared.

- Slight neck flexion (don't straighten neck to fit collar if deformity present)
- Options:
 - Hard polyethylene cervical collar (short-term use), sandbags + tape
 - Foam head blocks + spinal board (strapping for head, chest, pelvis & legs)
 - VacPac
 - Philadelphia collar - better immobiliser, for longer term use.
- Complications:
 - Uncomfortable, can lead to neck pain, pressure ulcers.
 - Reduced access & visualisation of jugular vessels, neck/occiput
 - Anxiety may due to restricted movement, claustrophobia, unable to see staff
 - ICP (Ave 2-5mmHg, max 15mmHg)
 - Aspiration risk.
 - Possible that may worsen some injuries.

Assessment

History: Details of trauma. When neck pain/neuro symptoms developed (usually delayed with whiplash). Prior spinal injuries. AMPLE history.

Examination: Palpate for tenderness, swelling, gap or step, muscle spasm. Neuro. (sensation, motor fn, reflexes, rectal tone, perianal sensation), other injuries.

Investigation: Decision to image based on NEXUS criteria or Canadian C-spine rule.

NEXUS criteria

Aim: Criteria for clearing a patient of any or significant C-spine injury without imaging.

Included: All who had trauma imaging of C-spine

Excluded: Penetrating trauma

Criteria:

- No midline posterior tenderness
- No focal neurological deficit
- Alert
- Not intoxicated
- No distracting painful condition - e.g. long bone #, large lac, degloving, crush injury, burns

Performance: Sensitivity 99% (any) or 99.6% (sig). Specificity 12.9% (any) or 12.9% (sig)

Validated: in elderly (have a higher prevalence of odontoid fx) & children >9 y

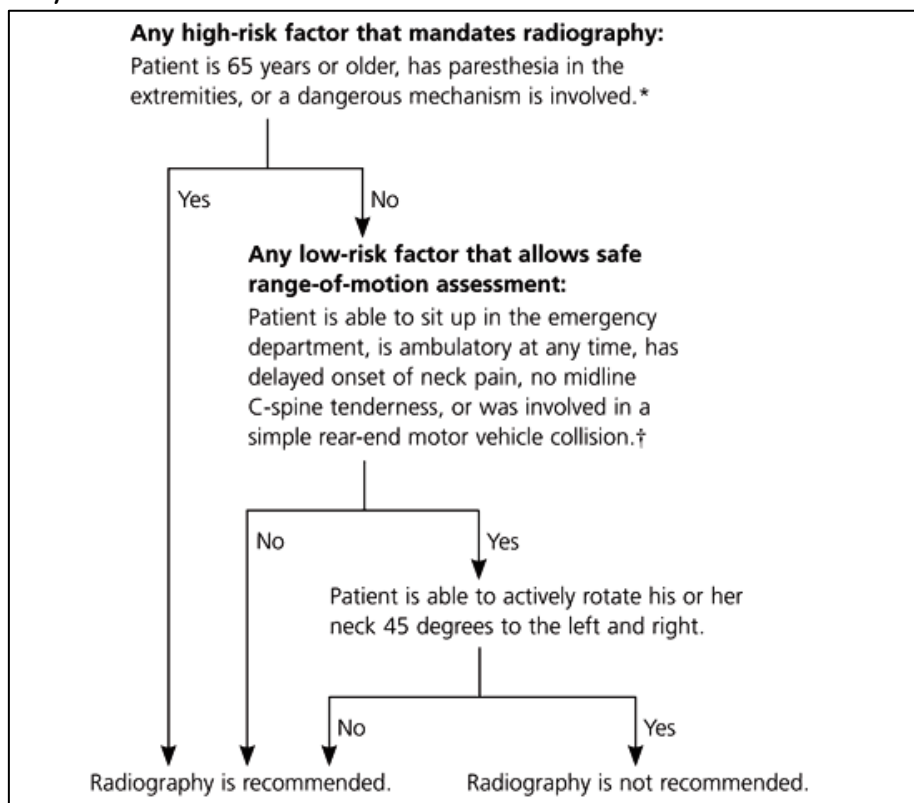
Canadian C-Spine Rules

Aim: Rules for detecting C-spine injuries in blunt trauma

Included: All who had blunt head or neck trauma, GCS15, stable (BPsys >90mmHg & RR 11-23)

Excluded: Penetrating trauma, age <16, pregnant, minor injuries only, GCS <15, >48h since injury, acute paralysis, known spinal disease, return for same injury.

Step-wise Rules:



*Dangerous mechanisms:

- Fall >1m/5 stairs
- Axial load e.g. diving
- MVA: >100kmh, rollover, ejection
- Motorised recreational vehicles
- Bicycle collision

† Simple rear-end MVC Exclusions

- Involving a pedestrian
- Being hit by bus or large truck
- Rollover
- High speed collision

Performance: Sensitivity 100%. Specificity 42.5%

Comparison of Nexus & CCR

N: Definitions of intoxication & distracting injuries imprecise.

N: Easier to use as simple 5 elements.

N: Valid to identify low risk in elderly too

C: Blanket rule to image all aged ≥65

C: Mechanisms list is limited

C: More exclusions, incl pregnancy & age <16.

C: Had higher specificity, thus fewer false positives

Clearing the C-Spine

Institutions vary on implementing these validated criteria/rules and often use a hybrid, e.g. "If alert, sober, neurologically intact patient <65y with low risk mechanism, no midline pain or tenderness to palpation, and no distracting injuries, can remove collar & rotate head 45° to left & right. If asymptomatic then cervical spine is cleared, otherwise, imaging required."

Imaging

Plain X-rays: Lat, AP & peg. Shows skeletal #s, alignment, but 5-15% injuries missed. 57% sens.

CT: shows skeletal #s, sublux/disloc injuries, disc spaces, alignment, 98% sens but ~5x Radⁿ

MRI: shows ligamentous, disc & cord injuries well, less good view of #s. Controversy over use.

One algorithm used is:

If intubated, focal neurological signs, or ↓LOC/sev HI/torso injury indicated-CT → CT

- If CT NAD & asymptomatic then clear C-spine otherwise → MRI

Otherwise if cannot be cleared by NEXUS/CCR then C-spine XRs

- If XR NAD & asymptomatic then clear C-spine otherwise → CT
 - If CT NAD & asymptomatic then clear C-spine otherwise → MRI

C-Spine XR Interpretation

Lateral view (gives most info)

Adequate if can see alignment of C7 on T1. If not → Swimmer's view. Note any FBs.

Trace 3 anatomical lines: anterior & posterior vertebral lines and spinolaminar junction line.

- Trace the vertebral lines all the way to the odontoid peg tip
- Look for steps, tear drop #, osteophytes
- Beware of "pseudosubluxation" at C2/C3 (25% children) - a posterior step <2mm

Check cervical spinal canal is approximately 10-20mm (equal to vert body width)

Measure retropharyngeal prevertebral soft tissues

- Max widths - C1-4: 7mm (~30% vert body width), C5-7: 22mm (~vert body width)
- ↑ by haemorrhage/oedema from #/disloc. (or infection)

Check odontoid peg

- Separation of between C1 arch & ant aspect of peg ≤3mm in adults & ≤5mm in children otherwise ?transverse ligament disruption.
- Sclerotic Harris' ring at the base of C2, overlying the vertebral body. This should remain unbroken anteriorly, posteriorly and superiorly.

Trace each vertebral body & intervertebral disc space

- Each body & space should be of uniform height. If anterior height of a body is ≥3mm less than posterior height → suggests a wedge-compression fracture.

Check spinous processes for # and uniform interspinous gaps.

AP View

Check spinous processes

- Should lie in a straight line (malalignment may suggest an unilateral facet jt dislocation)
- Equally spaced. If space >50% wider than adjacent one then ?anterior cervical dislocation
- Note if bifid.

Check vertebral body heights equal & uniform.

Open Mouth /Peg View

Check lateral masses of C1 don't overhang the lateral masses of C2 else ?burst fracture

Check space between peg and lateral masses of C1 is symmetric

Beware Mach effect: artefacts (teeth/occiput/soft tissues) overlying peg and mimicking #.

Extra views:

Oblique Views (45°): Show intervertebral foramina & osteophyte encroachment in spondylosis (OA). Facet joints. Alignment of C7 with T1 if Swimmer's view unobtainable (30% obliques OK). Right posterior oblique demonstrates the left foramina and vice versa.

Flexion and Extension Views: Not recommended as may → neurological injury. CT/MRI better.

Spinal Cord Injury

See separate article.

SCIWORA

- Spinal cord injury without radiological abnormality
- Rare- 1:1000 of cervical injuries , ~2:100,000 imagings of C-spine for injuries.

Injury Mechanisms

- Hyperflexion (most common, 80%)
 - Fractures: Ant wedge #, flexion teardrop #, clay shoveller's #, peg #
 - Dislocations: ant subluxation, bilateral interfacet dislocation, atlanto-occipital dislocation, ant atlanto-axial dislocation
- Hyperextension:
 - Fractures: Hangman's #, C1 post arch #, extension teardrop #, peg #
 - Dislocation: ant atlanto-axial dislocation
- Axial compression: Jefferson #, vertebral burst #
- Distraction
- Lateral rotation: Unilat interfacet dislocation, rotatory atlanto-axial dislocation

Stable vs Unstable Injuries

- The spine may be split into three "columns" for the purpose of assessment of stability:
 - Anterior column - ant 2/3 of vertebral body/intervertebral disc & ant long lig.
 - Middle column - posterior 1/3 of vertebral body/intervertebral disc & post long lig.
 - Posterior column - vertebral arch (pedicles, lamina, facets, spinous processes) & associated ligaments.
- An injury is unstable if 2 of 3 columns disrupted.
- Middle col is fulcrum for flexion & ext. If intact, simple flex/ext injuries are likely stable. Axial compression, distraction & rotational injuries, usually disrupt the middle col.
- Also unstable if: >3mm overriding or >11° angle between adjacent vertebra, if anterior height < 2/3 posterior vertebra height.

General Management

Maintain spinal precautions until C-spine cleared of if unstable #/lig injury found.

- Lying supine on flat surface , Collar/splinting, Log rolling

Analgesia ± Antiemetics

Neurosurgery/Orthopaedic involvement: Cervical traction or Open repair/fixation

Treatment of spinal cord injury if present

Whiplash Management & Prognosis

- Provision of adequate analgesia. Avoid soft collars. Remain as active as possible.
- Lignocaine IM if chronic & methylprednisolone IV for acute whiplash are effective
- Other Rx (NSAIDs, BDZ, Botox) have contradictory/limited evidence of benefit.
- Neck injuries may also lead to financial as well as psychological difficulties.
- Prognosis: 50% return to usual activity by 1mo, 12-25% off up to 6mo, 2% off 1yr.
- Poor prognostic factors include: elderly, female, pre-injury depression/anxiety.

Cervical Spine Injury Patterns

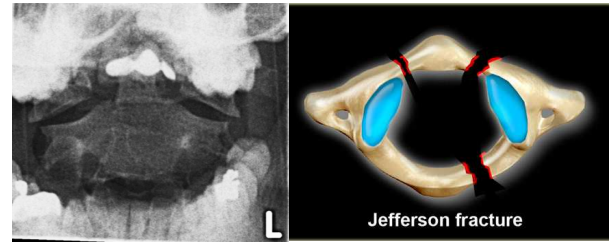
Atlas (C1)

Neural arch fracture

Longitudinal # through post. neural arch, usually bilateral caused by hyperextension. Stable.

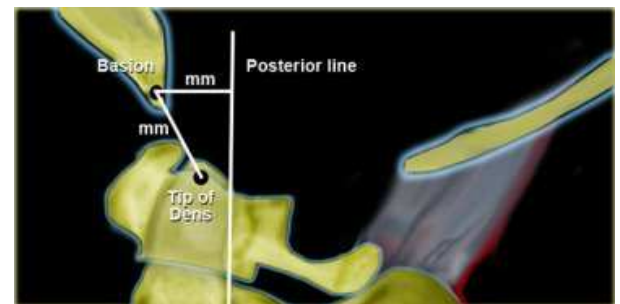
Burst (Jefferson) fracture

Comminuted fracture, with bilateral disruption of both anterior and posterior arches, and lateral displacement of both lateral masses. Caused by axial compression. Peg view shows unilateral C1/C2 peg joint space widening & lateral masses of C1 overhang those of C2. Stable if sum of bilateral overhangs <7mm.



Atlanto-occipital dislocation

Uncommon. Disruption of all ligaments between occiput and atlas with subluxation or complete dislocation of the occipito-atlantal facets. Anterior translation of the skull can stretch brainstem → respiratory arrest & death. More common in children due to the larger head. Up to 50% of atlanto-occipital dislocations are initially missed. Harris' measurements (mm in diagram) <12mm easier to calc than Powers ratio.



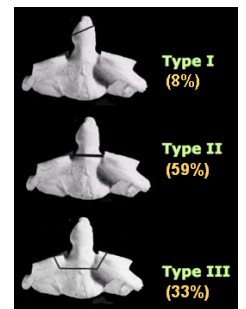
Transverse ligament disruption (ant. atlantoaxial dislocation)

Predental space >3mm (child >5mm) as dens moves back compressing spinal cord.

Axis (C2)

Odontoid peg fracture

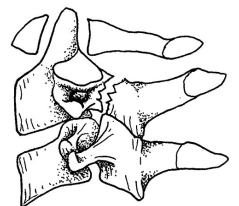
Most common # of C2. May be caused by flexion or extension and usually results in ligamentous instability. Type I stable. Type II unstable & poor healing. Type III: Can be unstable, but heals better than Type II. Seen on peg or lateral view.



Assess soft tissue swelling anteriorly & look carefully at Harris' ring on the lateral projection.

Hangman's fracture (traumatic spondylolisthesis)

Hyperextension → pressure & bilat oblique # C2 pedicles + traction disruption of ant longitudinal lig → unstable injury. C2 usually slips forward on C3 on lat XR



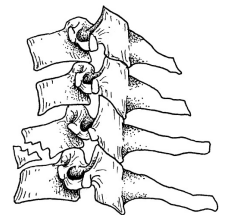
C2-C7

Anterior wedge compression fracture

Hyperflexion # with reduced ht (≥3mm) of vertebral body only anteriorly. Usually stable injury.

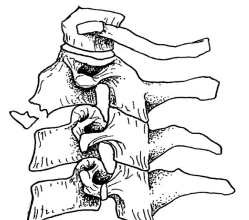
Teardrop flexion fracture

Hyperflexion & compression causes a wedge-shaped # of vertebral body. The larger posterior part of the vertebral body is displaced backward into spinal canal. On lat XR facet joints and interspinous distances are usually widened and the disk space may be narrowed. Often neurological deficits (ant cord syndrome) and is unstable with complete disruption of ligaments.



Teardrop extension fracture

Hyperextension causes a triangular fragment to be avulsed off the antero-inferior corner of the vertebral body. C2 is most commonly involved. Only rarely assoc with neurological deficit.



Burst fracture

Axial compression → comminuted fracture ± fragment surface driven back into spinal canal. Unstable injury that often → spinal cord injury.

Unilateral (locked) facet joint dislocation

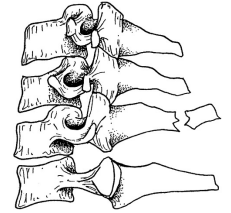
Flexion, rotation and distraction may cause the facet joints on one side to be locked. This results in the vertebra being displaced anteriorly by up to 25% on the lateral film.

Bilateral (locked) facet joint dislocation

If distraction increases, the facets may become disarticulated & body is displaced ant by 50% on lateral view.

Spinous process fracture

Hyperflexion causes avulsion of the spinous process by the supraspinatous ligament, usually C6 or C7 (Clay shoveller's). This is caused by flexion as the body rotates relative to the head and neck. Usually undisplaced, stable and seen on lateral film.



Whiplash (Cervical Strain)

Sudden deceleration of the body, with flexion and extension movements of the cervical spine usually results in sprain or intervertebral disc injury without fracture or dislocation. The commonest radiographic appearance is straightening of the cervical spine due to severe muscle spasm, with the normal curvature reduced or reversed. Usually MVA. May be increased with seat belts. Reduced by proper head rests.

Hyperflexion Strain

Anterior subluxation occurs with disruption of posterior longitudinal ligament, interspinous ligament and intervertebral disc. Lat film shows localised kyphotic angulation with increase in height of intervertebral disc posteriorly and associated fanning of the spinous processes.

Hyperextension Strain

The converse of hyperflexion strain; the anterior longitudinal ligament is disrupted as evidenced by widening of the intervertebral disc space anteriorly. The facet joints are disrupted and the interspinous distance is narrowed.

Other Pathology

Spondylosis

Refers to OA of the spine. Disc space narrowing and osteophyte formation. The associated osteophytes may impinge on the nerve root foramina. May obscure underlying injury. A common injury mechanism in these patients (often elderly) is a fall directly onto forehead → C2 #.

Metastatic disease

Primary tumours can metastasise to vertebral bodies demonstrating a lucent, moth-eaten, permeative appearance. There is often subsequent collapse.

Congenital fusion

It is not unusual to see a congenital fusion within the cervical spine, usually at C2/C3 with fusion of the vertebral bodies and posterior elements. This is associated with a hypoplastic odontoid peg.

Hanging

3rd most popular method of suicide. More common in young adult males & indigenous pop.

Cervical spine injury in only 1% (Hangman's fracture) only if drop > patient height. Death less likely from tracheal obstruction as from venous obstruction → suffusion, venous cerebral infarction, carotid sinus reflex bradycardia & ↓CNS → asphyxia. May have petechial/sub conj haemorrhages, hyoid #, laryngeal # or thyroid/cricoid cartilages. 75% intact if survive to ED.