Whiplash Associated Disorders: The pathway from acute to chronic pain

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Learning Objectives

• Determine patient’s prognosis and potential to experience chronic pain syndrome following a whiplash injury, prior to providing chiropractic services.
Whiplash Neck Injury

• First described by Crowe in 1928.
• Most common type of injury following motor vehicle crashes
• Usually 2-3 weeks for recovery
• Yet, up to 42% transition from acute to chronic pain status. (1)
“Diagnosis is the key to successful treatment!”
Quebec Task Force Definition

- Whiplash injury is “an acceleration-deceleration mechanism of energy transferred to the neck,” usually resulting from rear-end or side-impact motor vehicle collision. (2)
Hyperextension

Sprain or strain of cervical tissues

Hyperflexion
<table>
<thead>
<tr>
<th>Time (milliseconds)</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>Before impact</td>
</tr>
<tr>
<td>75</td>
<td>Ligament injury occurs</td>
</tr>
<tr>
<td>150</td>
<td>Maximum head extension</td>
</tr>
<tr>
<td>300</td>
<td>Maximum head flexion</td>
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How whiplash occurs

Motorists involved in rear-end crashes commonly experience whiplash. Injuries to the neck occur as the torso accelerates forward and the neck lags, then the head whips forward.

1. During normal driving, the head and torso move relative to the vehicle.

2. As the vehicle is struck from behind, the head tilts backward.

3. After the initial impact, the head snaps forward.

The torso rebounds.

The torso rises up.

Vehicle traveling forward
Whiplash Injury Costs

• Queensland, Australia = $500 million Australian dollars (1994-2001)
  

• United Kingdom = £3 billion per annum
  

• United States = USD $29 billion per annum
  
Pathomechanics of Whiplash Injury

Just Prior to Impact:
Neck has normal curvature

1/20th Second (50ms) Later:
Neck has an “S” shaped curve.
Lower neck with possible facet injury.

1/10th Second (100ms) Later:
All levels extend, but none excessively.
Likely after the moment of injury.
Whiplash Injury Symptoms

- Pain,
- dizziness,
- visual and auditory disturbances,
- temporomandibular joint dysfunction,
- photophobia,
- dysphonia,
- dysphonia,
- fatigue,
- cognitive difficulties such as concentration and memory loss, anxiety, insomnia, and depression (3)

-
Case One = WAD I

• Patient presents with neck complaints including stiffness or tenderness in the neck regions and no physical signs of injury.

• Most likely diagnosis is acute, mild cervical strain

• Prognosis is good

• Spontaneous recovery within 2-3 weeks is common.

Case Two: WAD II

• Patient presents with neck complaints including stiffness or tenderness, and some physical signs of injury, such as point tenderness or trouble turning the head.

• Acute, moderate cervical sprain/strain is most likely DX

• Prognosis is difficult to predict

• Current management does not appear to lessen transition from acute to chronic pain status

• Physical and psychological impairment poorly addressed by treatments predictive of poor recovery
Case Three: WAD III

• Patient presents with neck complaints including stiffness or tenderness and neurological signs of injury such as deep tendon reflex or motor deficits.

• Acute, moderate sprain/strain with resultant cervical radiculopathy

• Current management does not appear to lessen transition from acute to chronic pain status

• Physical and psychological impairment poorly addressed by treatments predictive of poor recovery
Case Four: WAD IV

- Patient presents with neck complaints and a fracture and/or dislocation of the cervical spine.
Grade 3 Facet Sprains and Transverse Processes Fractures

- Multiple facet joint ruptures and fractures of the transverse processes from C4 to C6.
- At autopsy a hematoma in the longus colli musculature extended along the brachial plexus into the axilla.
- These serial fractures were detected at second look on the specimen radiograms.
- The fractures run posteriorly through the intertransverse bar into the joints that display torn capsules and meniscoids and hemarthrosis.
Occipital Condyle Fracture

- The fragment was avulsed by the (intact) alar ligament.
- On the plain radiograms this fracture was barely visible and was only detected at second-look evaluation.
- The avulsed fragment is displaced posteriorly and medially, embedding medium fills the wide fracture gap.
- In the atlanto–axial joint the posterior meniscoid and the joint capsule are torn, pulling the C2 nerve into the joint space.
“Diagnosis is the key to successful treatment!”
Quebec Task Force (QTF) Classifications

• Sponsored by a public insurer in Canada.
• QTF submitted recommendations regarding classification and treatment of WAD, which was used to develop a guide for managing whiplash in 1995.
• An updated report was published in 2001.
• Each of the grades corresponds to a specific treatment recommendation.
Quebec Task Force (1995) Criticisms

1. Largely consensus based rather than evidence-based
2. Selection bias for the literature review
Swedish Study and Quebec Task Force

• Neither the WAD classification nor the QTF follow-up regimen could be linked to a better outcome.

• Jouko Kivioja, Irene Jensen, and Urban Lindgren. Neither the WAD-classification nor the Quebec Task Force follow-up regimen seems to be important for the outcome after a whiplash injury. A prospective study on 186 consecutive patients. Eur Spine J. 2008 Jul; 17(7): 930–935.
Swedish Study and Quebec Task Force

- The multiple-follow-up regimen is both time consuming and costly and appears not be justified in a routine clinical setting.
Swedish Study and Quebec Task Force

- The WAD-classification could not predict persistent neck pain after a whiplash injury in this hospital emergency department based population.
Swedish Study and Quebec Task Force

• Nor was there a statistically significant difference in the rate of chronic neck pain between the no-follow-up regimen and the multiple-follow-up regimen proposed by the QTF.
Swedish Study and Quebec Task Force

- At the first visit we recommend a careful history, physical examination and information about the nature of the condition.
Swedish Study Findings

• In this study cases with neck pain before the accident and a high degree of emotional distress from the accident had a tenfold increased risk of developing chronic neck pain. (4)
Transition from Acute to Chronic Pain Status

- Patients that do not resolve within weeks often exhibit a myriad of symptoms soon after the injury event.
“Diagnosis is the key to successful treatment!”
Pathoanatomical Lesions in the Whiplash Injury

1. Cervical Facet joints (Zygapophyseal Joints)
2. Dorsal Root Ganglion (DRG) and Nerve Roots
3. Cervical Ligaments
4. Intervertebral Disc Injuries
5. Muscle Injuries
Facet Joint Injury Model

• Studies employing the cervical facet joint injury model have identified the occurrence of hemarthrosis, capsular damage, joint fractures, and capsular rupture.

Cervical Facet Injury Model

• Clinical support for a facetogenic model of persistent pain generation in whiplash can be found in the literature.

Cervical Facet Injury Model

- As a result of facet joint injury, whiplash patients frequently encounter, headaches, back and shoulder pain in addition to neck pain.

Cervical Facet Joint Injury and Referred Pain

• The most common facets to be injured and highest prevalence of joint pain are at C2/C3 and C5/C6, which frequently results in referred pain.

Dorsal Root Ganglion and Nerve Roots

- Vulnerable to excessive stretching and injury during rapid acceleration/deceleration (“S-shaped” curve) or lateral bending of the neck as demonstrated in rear-end or side-vector impact whiplash.
Dorsal Root Ganglion (DRG) Compression and Soft Tissue Changes

- Largely undetected
- May contribute to adaptation in the overall functioning of the cervical DRG
- May predispose an individual to abnormal, centrally mediated pain processing. (5, 6)
Cervical Ligamentous Sprain Injuries

• Possible injury to mechanoreceptive and nociceptive nerve endings leading to pain, inflammation and chronic pain syndrome

Persistent Pain: A Chronic Illness

• Acute pain usually goes away after an injury or illness resolves. But when pain persists for months or even years, long after whatever started the pain has gone or because the injury continues, it becomes a chronic condition and illness in its own right.

National Pain Strategy

• **Chronic pain** - Pain that occurs on at least half the days for six months or more.
Upper Cervical Ligament Sprain Injuries and the Presence of Rust’s Sign

• History of roll-over MVA or blow to head
• Suspect upper cervical spine instability
• Order immediate CT Scan to check for non-displaced cervical spine fracture
“Diagnosis is the key to successful treatment!”
Upper Cervical Ligament Sprain Injuries Leading Chronic Pain

• Severity of alar ligament injury, head position at time of impact, Neck Disability Index (NDI) scores and reproduction of pain and excessive mobility with manual examination. (7, 8)

• Sharp Purser Maneuver test for upper cervical spine instability.
Cervical Disc Injuries

Present in 25% of subjects post whiplash injury and correlated with radicular symptoms (9, 10)
Cervical Disc Injuries

- C 5-6 segmental level was found to be the most common level of disc injury...
- greater risk of low-grade spinal cord injury with pre-existing spinal canal narrowing at C5-6 level

Cervical Spondylotic Myelopathy

Common symptoms
- Clumsy or weak hands
- Leg weakness or stiffness
- Neck stiffness
- Pain in shoulders or arms
- Unsteady gait

Common signs
- Atrophy of the hand musculature
- Hyperreflexia
- Lhermitte's sign (electric shock-like sensation down the center of the back following flexion of the neck)
- Sensory loss
Muscles

- Whiplash has been demonstrated to strain SCM, semispinalis, splenius capitis and upper trapezius with rear-end impacts.

Physical and Psychological Features Leading to Chronic Pain Syndrome

- Poor outcomes at 2-3 years post injury
  - High pain and disability levels with physical and psychological factors
  - Early presence of cervical movement loss, cold temperature hyperalgesia, and posttraumatic stress symptoms

“Diagnosis is the key to successful treatment!”
Characteristics of the Whiplash Presentation

• Motor Dysfunction
  • Active cervical ROM restrictions
  • Short and long-term deficits
  • Altered patterns of muscle recruitment in cervical spine and shoulder girdle (11, 12)
Characteristics of the Whiplash Presentation

- Sensorimotor Dysfunction
  - Acute and chronic WAD
  - Greater joint repositioning errors with chronic WAD and acute with more severe pain and disability
  - Loss of balance and disturbed neck-influenced eye movements with chronic WAD

Characteristics of the Whiplash Presentation

Sensory Function Disturbances

• Hypersensitivity (decreased pain threshold) to pressure, thermal, electrocutaneous

• Spinal cord hypersensitivity (central sensitization)

Psychological Factors and Chronic WAD or Chronic Pain Syndrome-Post-Traumatic

- Affective disorders
- Anxiety
- Depression
- Behavioral abnormalities (fear of movement)
- Posttraumatic stress
Post Whiplash Injury Muscle Fatty Infiltrates

- Muscle fatty infiltrates on MRI develop soon after the whiplash event (between 4-weeks and 3-months) but only in those with higher initial pain levels and a subsequent post-traumatic stress response (PTSD).

Degeneration of the Cervical Extensor Musculature in Chronic WAD

Content not quantity is a better measure of muscle degeneration in whiplash.

Whiplash Presentation

• “Whiplash is a markedly heterogeneous and complex condition with varied disturbances in motor, sensorimotor and sensory function as well as psychological distress.”
Sensorimotor dysfunction

- Disturbance in eye movement control
- Disturbance in proprioceptive acuity
- Disturbance in cervicobrachial muscle activation
- Disturbance in balance
Clinical Implications and Prognosis of Chronic Pain

- Kinesthetic deficits (joint position error)
- Cervical muscle recruitment patterns
- Altered activity in upper trapezius muscle
- Poor control of balance
- Impaired eye movement (13-17)
Testing for Joint Positioning Error and Kinesthetic deficits

Target distance is 90 CM
Beyond the yellow area is a significant error. (18)

Cervical muscle recruitment patterns

• Cranio-cervical flexion test attempts to determine the strength/weakness of the deep flexor muscles of the cervical spine (Longus capitis and colli)
• Eliminating the influence of the superficial neck flexors (Sternocleidomastoideus and anterior scalene)
Oculomotor Control

The assessment of smooth pursuit and gaze stability is an important part of the assessment of sensorimotor impairment following whiplash injury.
Sensorimotor Ocular Testing

• Smooth pursuit involves the subject keeping their head still and following a slow moving object with just their eyes from about 30° one side of the midline to 30° on the opposite side.
Sensorimotor Ocular Testing

• The clinician closely observes the subject’s eye movements, looking for jerky or fast movements.
Sensorimotor Ocular Testing

• Reproduction of dizziness or pain, increased effort or difficulty performing the test, all suggest sensorimotor impairment.
Sensorimotor Impairment: Smooth Pursuit Neck Torsion Test (SPNT)

- This test involves comparison of smooth pursuit performance in a neutral head position with performance in a neck torsioned position 45° degrees left and 45° right.
- It is termed ‘neck torsion’ because the trunk is rotated on the neck to avoid stimulation of the vestibular system.
Sensorimotor Impairment: Smooth Pursuit Neck Torsion Test (SPNT)

- The clinician closely observes the subject’s eye movements, looking for jerky or fast movements.
- Reproduction of symptoms or difficulty performing the test suggests sensorimotor impairment.
Gaze Stability Testing

• Ask patient to look at an object roughly arm’s-length from their face and to slowly flex and extend their head and neck or gently rotate their head and neck whilst keeping their eyes still.

• Reproduction of symptoms or difficulty performing the test suggests sensorimotor impairment.
Early Sensory Findings

- Brachial plexus provocation test
- Pressure pain thresholds
- Thermal pain thresholds
- Sympathetic vasoconstrictor reflex
- Neck disability index (19)
Late Sensory Findings

- Muscular hyperalgesia
- Large referred pain areas
- Possible neurogenic pain
- Findings suggest a generalised central hyperexcitability in patients suffering from chronic whiplash syndrome

- Koelbaeck JM. Generalised muscular hyperalgesia in chronic whiplash syndrome. Pain. 1999 Nov;83(2):229-34
Algometry with Clothes Peg
Mechanism of Closed Head Injury

Deceleration ➔ Acceleration

1. Head thrown backward while brain hits front of skull
2. Head thrown forward while brain hits back of skull

Diagram illustrates the mechanical forces involved in closed head injury, showing the sequence of events during deceleration and acceleration phases.
Mild Traumatic Brain Injury and Concussion

- The acceleration-deceleration shearing forces generated by motor vehicle accidents and the rotational shearing forces generated with boxing, most especially the uppercut, causes diffuse axonal injury. (20)
Conclusions: The evaluation and management of whiplash injuries must attempt to:

• Discover mechanism of injury
• Reveal pain severity
• Determine the injured tissues and pain generators
• Understand biopsychosocial factors
• Perform a differential diagnosis
• Provide a reasonable prognosis (acute and chronic)
• Offer appropriate treatment
• Integrate a health care team of providers
First Evaluate Patient and Make a Diagnosis/Prognosis Before Treating Patient
Evidence-based, patient-centered and ethical report of findings with whiplash injuries

• Report the diagnoses, suggest appropriate treatment, gain permission to treat (informed consent), and discuss the prognosis
• Attempt to reduce disability and chronic pain with use of placebo effect
• Report impairment with medical legal cases but avoid nocebo effect
“Diagnosis is the key to successful treatment!”
Case

- 56 y/o male professor presents with the following HPI

- Acute, exacerbations of neck pain and unilateral upper extremity paresthesia in the C6 dermatome.

- Past history of side impact motor vehicle collision (MVC) with whiplash injury some 20 years earlier. Resulted in fractured teeth, spinal and hand strain/sprain injuries, confusion and short-term memory loss.

- MRI demonstrated cervical discopathy at C5-6-7 two years following the motor vehicle collision

- Discontinued racquetball due to pain and weakness in RUE

- He has experienced daily neck pain and stiffness since the MVC with episodic neck/arm pain with paresthesias.
Engaged Learning Task (30 minutes)

- Form groups of 6 doctors each
- Complete discussion in 10 minutes
- Select a spokesperson who will provide a brief presentation
Active learning tasks

Please state the following for this 56 year-old patient:

- Differential diagnosis
- Working diagnosis
- Prognosis
“Diagnosis is the key to successful treatment!”
References


References


Thank You!
Cranio-cervical Flexion Test

• Performed with the patient in supine crook lying with the neck in a neutral position (no pillow) such that the line of the face is horizontal and a line bisecting the neck longitudinally is horizontal to the testing surface. Layers of towel may be placed under the head if necessary to achieve a neutral position. The uninflated pressure sensor is placed behind the neck so that it abuts the occiput and is inflated to a stable baseline pressure of 20 mm Hg, a standard pressure sufficient to fill the space between the testing surface and the neck but not push the neck into a lordosis. The device provides the feedback and direction to the patient to perform the required five stages of the test. The patient is instructed that the test is not one of strength but rather one of precision. The movement is performed gently and slowly as a head nodding action (as if saying “yes”). The CCFT tests the activation and endurance of the deep cervical flexors in progressive inner range positions as the patient attempts to sequentially target five, 2-mm Hg progressive pressure increases from the baseline of 20 mm Hg to a maximum of 30 mm Hg as well as to maintain a isometric contraction at the progressive pressures as an endurance task.