

“WHIPLASH” and the Search for Effective Early Intervention:

An Assessment of Current Best Evidence

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SPT, UNC DPT 2019



Whiplash Defined:

“an acceleration/deceleration mechanism of injury transfer to the neck, which...may result in bony or soft tissue injuries (whiplash injury), which in turn may lead to a variety of clinical manifestations (whiplash-associated disorders)”¹⁰ (WAD)

Signs and Symptoms:⁴

- | | |
|--|--|
| <ul style="list-style-type: none">- Neck pain- Neck stiffness- Headaches- Shoulder pain- Arm pain/numbness- Paresthesias- Weakness- Dysphagia | <ul style="list-style-type: none">- Visual disturbances- Auditory symptoms- Cognitive disturbances- Jaw pain- Psychological problems |
|--|--|

Symptoms may include neck pain, neck stiffness, headaches, shoulder pain, arm pain/numbness, paresthesias, weakness, dysphagia, visual disturbances, auditory symptoms, dizziness, cognitive disturbances, and jaw pain⁵

The Stats:¹³

- Most common injury resulting from MVC treated in US hospital EDs
- Demographically...females age 20-24 show the highest incidence
- 40-60% of patients develop chronicity comprised of residual neck pain, with approximately 30% reporting moderate/severe neck pain and disability

Wiangkham

2015

- Chronicity typically refers to 6 months post injury, but several follow-ups have shown similar stats for up to 3 years!

Importance of Acute Intervention:

- Prevalence of chronicity
- Annual economic burden (\$3.9 billion, £10 billion)¹³
- Health care costs
- Work capacity and productivity
- Pathoanatomic correlations are often variable and poorly understood⁹
- Personal burden

Unfortunately, attempts to establish effective interventions for WAD in the acute stages have also been largely inconclusive.

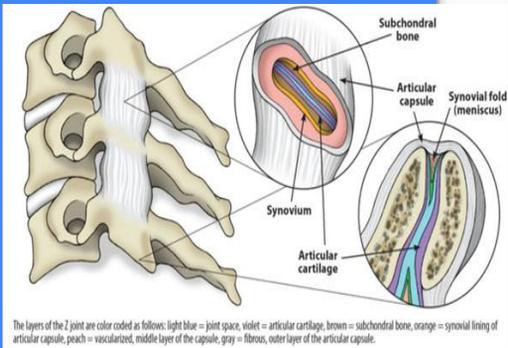
Ineffective treatment leads to frustration in patients and providers alike.
Under or over-utilization of healthcare resources...sometimes both are at play.

Anatomy review first...

Anatomy Review...

...proposed anatomy and biomechanics and sites of injury in WAD

Facet Joint & Capsular Ligament⁹



- Most common source of neck pain
- Two proposed MOIs:
 - Pinching of the synovial folds (compression/shear)
 - Excessive capsular strain (tension)
- Cadaveric studies in the early 2000s:
 - 29-40% strain, normal bending = 6±5% doubled in head-turned position
- Animal studies:
 - Sub-failure strain and collagen disorganization
- Innervation:
 - Mechanoreceptors
 - Unmyelinated nociceptors
 - A-delta and C-fibers
 - Substance P and other NTs and neuromodulators

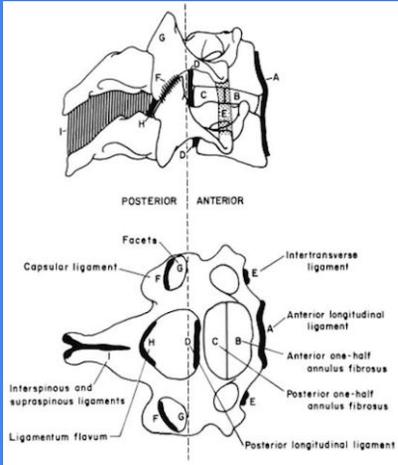
mechanoreceptors

unmyelinated nociceptors

A-delta and C-fibers (nociceptive)

Nociceptors reactive for substance P and calcitonin gene-related peptide (neurotransmitters and neuromodulators involved in pain integration)

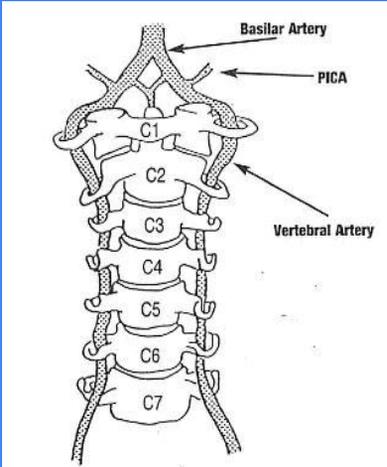
Ligaments & Disc⁹



- Confirmed with MRI and autopsy studies
- Ligament injuries can lead to pain and chronic instability
- Embedded mechanoreceptors and nociceptors
- C5-C6 shown to be most at risk during frontal and rear impacts

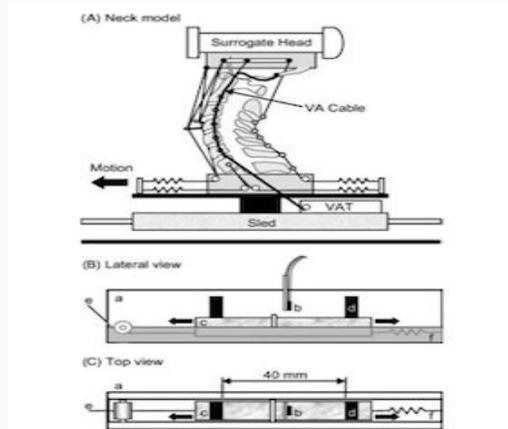
Damage to these structures could certainly correlate to sx's of whiplash (pain, mm dysfunction)

Vertebral Artery⁹

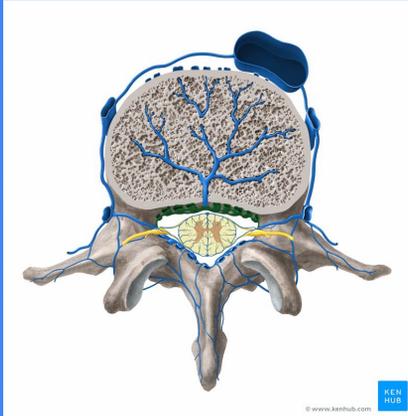


<http://chiro-trust.org/wp-content/uploads/2014/02/img-4.jpg>

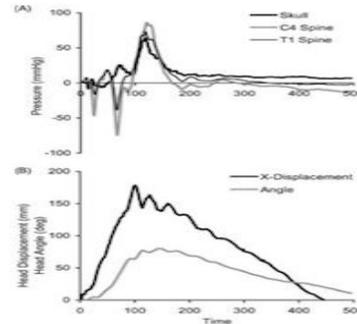
- Altered blood flow due to spasms and narrowing of vertebral artery
- Could correlate to sx's (headache, blurred vision, vertigo, tinnitus, dizziness)
- 30.5 mm elongation observed in head turned rear impacts!



Dorsal Root Ganglia (DRG)⁹



- Contains the cell bodies of most peripheral sensory nerves
- MOIs:
 - Sudden transient pressure gradient (fluid dynamics)
 - Interstitial hemorrhage
 - Direct injury - foraminal narrowing
- Could correlate to sx's (neck pain, headache, vision disturbances, vertigo, symptoms in the arms)



generalized pressure hypersensitivity and decreased thermal thresholds → impaired local sensory processing
 Increased electrical activity in spinal cord and widespread reductions in electrical and pressure thresholds after whiplash suggest altered central pain processing (hyperalgesia and larger areas of referred pain)

MOI -

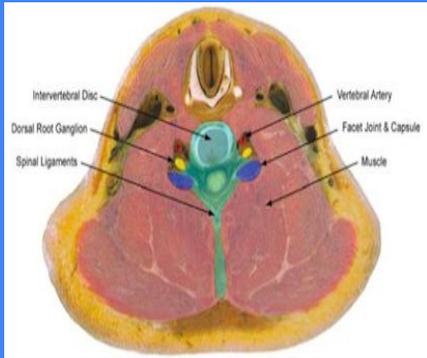
normal cervical motion causes changes in the spinal canal volume, but internal and external venous pleural volumes can easily move to compensate

with rapid motion as seen in whiplash, a pressure gradient can occur which load the spinal ganglion nerve roots

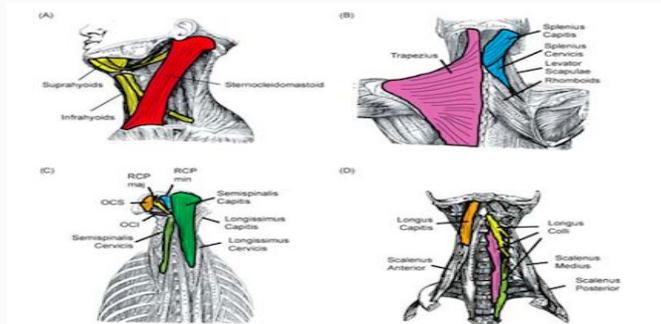
supported with porcine subjects, cadaveric, and autopsy studies (**interstitial hemorrhage in DRG despite absence of injury to other surrounding structures.**)

could compress the nerve roots in the foramen as well causing damage

Muscles⁹



- Often a complaint despite inconclusive evidence
- MOI:
 - Eccentric loading
 - Interaction with surrounding anatomy
 - Multifidi
 - Altered neuromuscular control (deficit or pain avoidance behavior?)
 - Fatty infiltrates
 - Muscle recruitment - deep vs superficial flexors
- High density of muscle spindles
- Serum creatine kinase levels



- Multifidi attach directly to facet capsule
- Muscle spindles (gain or tension → TrP)
- Serum creatine kinase - seen 24 hrs but not 48 hrs after injury - Despite having neck pain >3 months

Need more RESEARCH!

(and maybe technology)

But does it really matter?

We know from many studies on LBP, that pain and disability are not always represented patho-anatomically.

As PTs, imaging can help guide directions for treatments, but this is really determined from clinical presentations found in the initial eval and physical exam

Quebec Task Force (1995)

Grade	Clinical presentation
0	No neck complaint No physical sign(s)
I	Neck complaint involving pain, stiffness or tenderness only No physical sign(s)
II	Neck complaint AND Musculoskeletal sign(s)
III	Neck complaint AND Neurological sign(s)
IV	Neck complaint AND Fracture or dislocation

https://clinicalgate.com/wp-content/uploads/2015/03/B9780702031458000107_00101.png

QTF Time Axis: Evaluation Guidelines Consensus Statement

Time axis	Duration of Symptoms In Days
	<4 Grade I-reassure, prescribe activity, manage pain/Grade II-III X-ray/ Grade IV surgical eval.
2 decision points	4-21 After day 7 reassess; Specialist after 21 days
The 6 week mark	22-45 Specialist advice/Multi-disciplinary evaluation
The 12 week mark	46-180 Multi-disciplinary evaluation
	>180 Chronic refractory

Spitzer et.al., Scientific Monograph of the Quebec Task Force on Whiplash –Associated Disorders: Redefining “Whiplash” And Its Management. Spine Volume 20, Number 8S, 1995

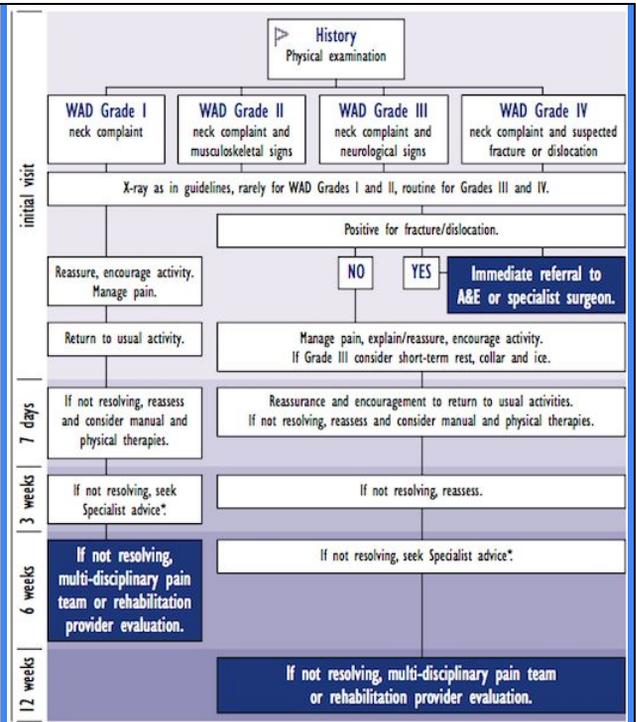
**Important to note that these classifications and guidelines are based on clinical and physical findings, and an assessment of research current to that time (which was noted to be minimal at best) - Therefore this was primarily developed on the basis of professional consensus, not scientific validation¹⁰

They did address this as a limitation and called for the need to research whiplash in terms of assessment, prognosis, and effectiveness of treatments.

**approx. 93% of pts classified as WAD II. Conservative management is commonly utilized for these pts and consists of active exercise, manual techniques and physical therapy.¹³

QTF Follow-up Regimen:

- Kivioja et al. 2008:⁶
 - 186 consecutive WAD pts
 - 82% WAD Grade II
 - Neither the Grade or the Follow-up regimen predicted outcomes in 1 yr follow-up
 - Highlights the heterogeneity of pts with WAD and the need to screen for high risk for chronicity
 - Previous neck pain and emotional distress from accident 10 fold increased risk
 - Need to identify cost-effective treatments for acute WAD



186 consecutive cases seen in ED during acute whiplash studied for 1 yr.

One group: QTF follow-up regimen. 1,3,6,12 wks and 1 yr after accident.

outcome variable used was neck pain at 1yr

The WAD-classification could not predict persistent neck pain after whiplash injury. Nor was there a significant difference in pain levels between follow-up protocols

Highlights the heterogeneity of patients with WAD and the importance of screening for high risk for chronicity.

Showed that previous neck pain and high degree of emotional distress from accident each had a tenfold increased risk of developing chronic neck pain.

Despite the research into both the anatomy and the treatments of WAD, there still lacks a clear clinical picture.

Evaluation of the QTF Classification:

Strengths:

- Provides a common language
- Clear clinical observations and physical findings required within each class
- Provides some guidelines on the treatment of WAD based on the grade of injury and time since injury

Limitations:

- Based on professional consensus
- Not scientifically validated
- Based solely on physical and clinical presentations
- Does not incorporate psychosocial aspects of injury
- Vague and outdated
- Heterogeneity of grades (especially WADII)

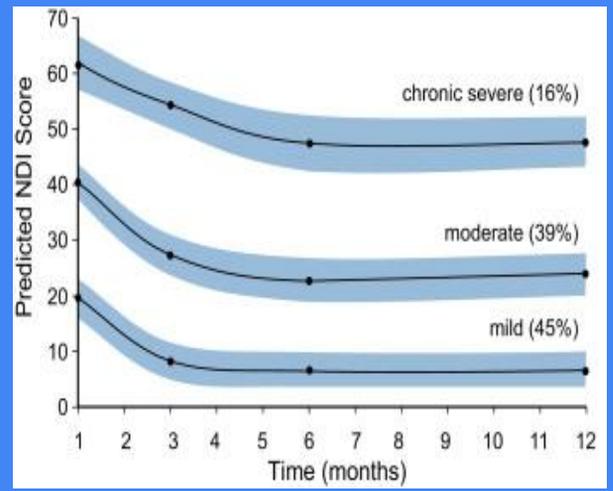
Ultimately the effectiveness of early interventions for WAD, particularly the ability to prevent chronic pain and disability, is not clear. Leaves a lot to be desired by the clinician and therefore the patient looking for treatment.

Previous studies that boast the effectiveness of “natural resolution” or “act as usual” approaches often include both WAD 1 and 2 patients, which may skew the results in favor of these recommendations.³

WAD 2 is the most common, but also potentially the most heterogeneous group making it difficult to treat with a “one size fits all” treatment. These are the patients typically seen in PT.³

Early Management:

- Most recovery occurs in 2-3 months after injury
- Identifying poor prognostic factors
- Act as usual
- Encourage Activity
- Mobilization
- Exercise, BUT which ones?



Why early management is important...

Graph:³

So What's New?

Clinical Implications Derived From Evidence.



Active Intervention in Patients with Whiplash-Associated Disorders Improves Long-Term Prognosis

A Randomized Controlled Clinical Trial

Mark Rosenfeld, RPT*†, Aris Seferiadis, RPT*, Jane Carlsson, RPT, PhD*, and Ronny Gunnarsson, MD, PhD†‡

Design:

- 3 yr Follow-up of a RCT (Grade 0,I and II)
- Active vs. Standard Intervention
- Early (96hrs) vs. Delayed (14 days)
-

Measures:

- Pain intensity
- Cervical ROM
- Sick leave
- 6 mos and 3 yrs

Results:

- Greater pain reduction and less sick leave for Active group
- CROM - early active intervention pts were close to unexposed individuals at 3 yrs
- CROM - better if active early OR standard later
- Average of 4 active treatment sessions

Clinical Implications:

- Active movement rather than caution
- Assigning early exercise within comfort limits may alleviate fear of serious injury
- Rotational (acute) and McKenzie (subacute)

Standard Intervention = initial rest, soft collar, and gradual self-mobilization

Active Intervention = frequent active cervical rotation complemented by assessment and treatment according to McKenzie principles

- Initial Phase: information, postural control, and cervical rotation exercises (10 times each way in max comfortable range, every waking hour) Supine if too painful in sitting.
- Second phase (if sx's unresolved 20 days): McKenzie (63% of pts)
- Terminated at 6 weeks or earlier
- The only WAD 0 pt that DID NOT experience delayed sx's was in the early active intervention
- WHY ROTATION?⁸
 - Functional
 - Minimizes stress while mobilizing nerve tissue on contralateral side while avoiding longitudinal stress in other motions

ARTICLES

Efficacy of Postural and Neck-Stabilization Exercises for Persons with Acute Whiplash-Associated Disorders: A Systematic Review

Kara Drescher, Sandra Hardy, Jill MacLean, Martine Schindler, Katrin Scott, Susan R. Harris

Design:

- Systematic Review (2008)
- "Neck stabilization"= any exercise that strengthens the muscles around the neck
- "Postural Exercises"= any correction, exercise, or advice with aim to improve posture

Measures:

- Pain
- ROM
- Time off work

Results:

- Support of active over soft collars
- Limited or conflicting evidence for acute WAD
- Author cites the narrow focus of the review as a limitation

Clinical Implications:

- Postural exercises can be implemented early for reduction of pain and time off work, but not ROM
- Conflicting evidence for stabilization exercises

Rationale: Dysfunction in neck muscles and posture seen after whiplash injury.⁴

Examples of exercises used in included studies:

- Previous study (Rosenfeld)
 - Dynamic neck and shoulder exercises (pulls and rows)
 - Deep neck flexors (CCF)
 - Shoulder mobility (rolling, elevation, retraction)
 - Postural correction throughout day
- Mentions that the initial costs of exercise intervention were higher, but overall cost was lower (sick leave, other intervention eventually used by persons in control groups)

Patient Safety in Surgery



Research

Open Access

Grade II whiplash injuries to the neck: what is the benefit for patients treated by different physical therapy modalities?

Christoph Dehner^{*†1}, Martin Elbel^{†1}, Philipp Strobel¹, Matthias Scheich¹, Florian Schneider², Gert Krischak¹ and Michael Kramer¹

Design:

- RCT, n=70 (WAD II only)
- APT and PPT compared with each other and to AAU group from previous study

Measures:

- Pain
- ROM
- Period of Disability, POD (3-6 months)

Results:

- APT: greater pain reduction
- APT and PPT recovered ROM
- POD: APT and PPT = 14 days, AAU = 49 days
- Non-compliance on AAU group, the members that sought PT showed greater pain reduction.

Clinical Implications:

- "Active" PT seems preferred from a therapeutic and economic perspective.

Study aims to address the claim that PT is not medically necessary or cost-effective compared to AAU intervention.³

- Pts in both groups in this study still wore soft collar for 7 days??

**Protocol for Dehner 2009 study:³

"Passive" therapy

The treatment consisted of the application of moist heat [22,23], classic massage [22] and electrotherapy [22,24].

"Active" therapy

Week 2

Soft-tissue treatment [25], trigger point treatment [22-24], joint mobilisation without involvement of the cervical spine, posture training and electrotherapy.

Week 3

As above, with addition of coordination training [26], training of the trunk and extremities and stabilization techniques with short, segmental leverage [23].

Week 6

As above, with addition of three-dimensional training with the head's own weight as the limit of resistance.

Week 8

As above, with addition of specific joint mobilization of the cervical spine, if necessary

"Act as usual"

In a detailed consultation session, the benign nature of the injury was explained to the patients. Patients were given the recommendation to resume their usual activities without modification. No therapeutic measures were recommended.

The Effect of Balance Training on Cervical Sensorimotor Function and Neck Pain

Konstantin Beinert^{1,2}, Wolfgang Taube¹

¹University of Fribourg, Department of Medicine, Movement and Sports Science, Switzerland. ²Institute for Applied Science of the Human Movement System, Neustadt a.d. Weinstraße, Germany.

Design:

- RCT, n=34 with impaired joint position sense and subclinical neck pain
- Intervention: 5 weeks balance training
- Control: "stay active"

Measures:

- Joint Position Sense (JPS)
- Neck Pain

Results:

- JPS and neck pain improved significantly in intervention group only

Clinical Implications:

- Balance training may augment interventions that aim to decrease neck pain and improve kinesthetic awareness
- This does what other studies have done, BUT in reverse
- Points to correlation between mm dysfunction, balance, and neck pain

Laser pointer on head method

Balance training:

- Tandem stance
- SLS
- Standing on rocker board

Done for 20 seconds and progressed when mastered

"Sensorimotor function and pain perception:

cortical areas active in balance control are also known to be involved in chronic pain processing.

Does balance training affect supraspinal structures (i.e. muscle spindles) responsible for both sensorimotor control and pain perception??

Both cortical (central) and supra spinal (peripheral) effects that may be involved in both balance and pain??"¹

"Utilizes unconscious sensorimotor control of neck stabilization rather than asking a patient to "think" about their neck. Using a different neuromuscular control mechanism"¹ (speculation)

Invited Topical Review

Physiotherapy management of whiplash-associated disorders (WAD)

Michele Sterling

Centre of National Research on Disability and Rehabilitation Medicine (CONROD), The University of Queensland and Griffith University, Australia

Design:

- Topical Review of Current Evidence

Measures:

- Effectiveness of Interventions for Acute WAD:
- Pain
- ROM
- Disability
- Psychological Measures**

Results:

- Exercise may only slightly improve outcomes (low/moderate support, often conflicting)
- Small effect sizes seen in many studies (heterogeneity of WAD pts)
- Psychological aspects seem to be important factors for prognosis.

Clinical Implications:

- Difficulty in choosing specific interventions - which type is best?
- PT as "gatekeeper" for WAD patients¹¹

Which type is best? - WAD presents in such a varied way...the type that is showing continued improvement.

Initial Pain and NDI score are still high prognostic factors, But this review points to the importance of psychological effects:¹¹

- Found that WAD pts tend to comply with PT better than meds or treatment by a clinical psychologist (stigma or pain/injury perception?)
- With direct access, PTs are in a unique position as they initially assess, identify risk factors, develop a treatment plan, follow the pt's progress through the POC, and modify as appropriate. This article suggest that PTs may be the best positioned to give psychological-like interventions in the case that these are moderately present factors.

Central Sensitization in WAD neck pain:

The Theories and Evidence:

- Sensorimotor function and pain perception - correlation between cortical changes in areas that are involved in balance and pain perception¹
- Active TrPs in Acute WAD, lower PPT, and lower CROM⁵
- Analgesic injections to facet joints - reduction of cold hyperalgesia and increase in PPT locally and peripherally.¹²
- Psychological factors: pain catastrophizing, PTSD

Clinical Implications:

- PTs role in screening for poor prognostic factors early
- Providing education on pain neurophysiology for chronic pain conditions
- Functional vs Organic injury⁸
- Whiplash as a “systemic illness”⁴

Functional (chronic illness behavior) vs organic (persistent tissue injury) - Rosenfeld

“It has been proposed that whiplash is a “systemic illness” with symptoms arising from pathology, psychological response, and social context; it is a complex injury with considerable variation in presentation and progression.” (Drescher)

Do patients tend to identify with their “whiplash” injury, altering their perception of pain and disability??

Results of the Search...

Recommendations:

- Collars are BAD
- Encourage usual activity
- Mobilization (rotation) - with or without exercises⁸
- McKenzie course⁸
- Evidence fails to identify a specific type of exercise:
 - Postural⁴
 - Balance¹
- Too much, too early can be bad²
- Ultimately clinical reasoning is key!

Areas for Future Research - The Gaps:

- Exploring the psychological aspects of WAD
- Studying specific exercises with better study design
- Paying more attention to identifying prognostic factors and utilizing resources accordingly
- Active Behavioral Physiotherapy Intervention (ABPI)¹⁴

Potential for a treatment-based classification system for clinical presentations after whiplash MOI?

Talk about Cote study and “too much too early” idea = inverse relationship between # of healthcare visits within 30 days of injury and recovery time.²

- This may indicate a POC founded in enforcing active coping behaviors and self-management (strong HEP and McKenzie and “act as usual”)

Future Directions

Protocol study:

Design:

- RCT
- Standard Physical Therapy vs Active Behavioral Physiotherapy
- ABPI consisting of 4 phases:
 - Understanding
 - Maturity
 - Stamina
 - Coping

Measures:

- NDI
- Pain
- CROM
- PPT
- Impact of Events Scale
- Fear-Avoidance Beliefs Questionnaire

Potential Clinical Implications:

- Therapeutic and cost-effectiveness of a more comprehensive approach
- Preventing chronicity

Poor Prognostic Factors:

Factors showing prognostic capacity for ongoing pain and disability	Factors showing consistent evidence of not being predictive of poor outcome	Factors with inconsistent evidence
<ul style="list-style-type: none"> ● Initial pain intensity: >5.5/10 ● Initial disability: NDI>29% ● Post-traumatic stress symptoms ● Negative expectations of recovery from the injury ● Pain catastrophising ● Cold hyperalgesia 	<ul style="list-style-type: none"> ● Accident related features, e.g. collision awareness, position in vehicle, speed of accident, type of vehicle ● Findings on imaging, e.g. X-ray, MRI ● Muscle and motor control dysfunction, e.g. cranio-cervical flexion test, joint positioning errors, eye movement control 	<ul style="list-style-type: none"> ● Older age ● Female gender ● Neck range of movement ● Compensation related factors, e.g. compensation system, lawyer involvement

Table 1: Prognostic indicators of poor functional recovery following whiplash injury based on findings of systematic reviews (Carroll et al 2008; Daenen et al 2013; Goldsmith et al 2012; Walton et al 2013a, b; Walton et al 2009)

<https://alanteighphysio.files.wordpress.com/2015/03/prognostic-risks-whiplash.jpg>

In summary, The evidence available highlights the variability and complexity of WAD patients.

Despite an increase in research dedicated to this patient population, the recommendations have changed little.

- Stop performing Studies with the use of soft collars

Recognize the importance of these factors and implement regular screening for them

- Possible need to incorporate psychometric outcome measure
- Assessment for signs of hypersensitivity
- BIO-PSYCHO-SOCIAL Model

CHRISTMAS 2008: MUSIC

Head and neck injury risks in heavy metal: head bangers stuck between rock and a hard bass

Declan Patton, research assistant, Andrew McIntosh, associate professor

Headbanging = Violent and rhythmic movement of the head synchronous with music

- Most common among heavy metal music fans
- Up and down style is most popular
- Used equations of Head Injury Criteria and Neck Injury Criteria
- Results: Higher tempo songs carry higher risk of injury
- Recommendations:
 - Decrease ROM during headbanging
 - Only headbang to every other beat
 - Wear protective equipment
 - Substitute softer listening for metal



[110204-beavis-butthead.png](#)

Focus group of 10 local musicians nominated 10 best “headbanging songs”
Compared to randomly selected “I Will Always Love You” Whitney Houston, “Hello”
Lionel Ritchie, and “Babe” by Styx

An average head banging song has a tempo of about 146 beats per minute, which is predicted to cause mild head injury when the range of motion is greater than 75° . At higher tempos and greater ranges of motion there is a risk of neck injury.⁷

Thank you ORC
Team!

-Spencer E.



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