Using Research to Predict Recovery in Whiplash Associated Disorders

Dr. Joe Betz, Boise, ID

Disclosures

- Private Practice, Modern Chiropractic Center (mc^2),
  - Boise, ID since 2001, Nampa, ID since 2019
- Certified Instructor, Chiropractic BioPhysics (CBP®)
- CBP® researcher, co-authored Chapters in CBP® Lumbar Rehab book
- Vice President, CBP® NonProfit, Inc
- Immediate Past-President, Idaho Association Chiropractic Physicians
- President, Mountain West Independent Practice Association
- Board of Directors, International Chiropractors Association
  - Co-Chair, Technique and Posture Committee
  - Chair, Chiropractic Guidelines Committee
  - Instructor, Advances in the Management of Traumatic Injuries (AMTI)
- Principle Investigator, PCCRP X-ray Guidelines
- Principle Investigator and Co-Editor, ICA BPPG
- Co-Author of ICA of CA Management of WAD Guidelines
- Consultant for ScoliCare (Sydney AU)
- Certified Independent Medical Examiner (CIME): ABIME
- Co-Founder, Advanced Clinical Consultants (Expert Witness, Plaintiff IME)

ADVANCES IN THE MANAGEMENT
AMTI
OF TRAUMATIC INJURIES

- Module 2: March 23-24 (Denver, CO)
- Module 3: June 1-2 (Denver, CO)
- Module 4: September 7-8 (Denver, CO)
- Module 5: November 2-3 (Denver, CO)
- Module 6: Home Study/Certification Exam

Spectrum of Whiplash-Induced Injuries in Typical Chiropractic Office

MILD ⟷ SEVERE

- Subluxation
- Strains
- Minor sprains
- Bumps
- Bruises

- Subluxation
- Major sprains
- Mild radicular Sx
- Resolved ligamentous instability
- Cervical hypolordosis

- Subluxation
- Disc derangement
- Severe radicular Sx
- Permanent ligamentous instability
- Cervical kyphosis
- Permanent Impairment
- Severe TBI

Definitions of Subluxation:

International Chiropractors Association:

- “The subluxation complex includes any alteration of the biomechanics and physiological dynamics of contiguous spinal structures which can cause neuronal disturbances.”

Association of Chiropractic Colleges:

- “A subluxation is a complex of functional and/or structural and/or pathological articular changes that compromise neural integrity and may influence organ system function and general health..”

Stephenson’s 1927 chiropractic text:

- “A subluxation is the condition of a vertebrae that has lost its proper juxtaposition with the one above or the one below, or both; to an extent less than a luxation; which impinges nerves and interferes with the transmission of mental impulses.”

RCW 18.25.005

"Chiropractic" defined.

(1) Chiropractic is the practice of health care that deals with the diagnosis or analysis and care or treatment of the vertebral subluxation complex and its effects, articular dysfunction, and musculoskeletal disorders, all for the restoration and maintenance of health and recognizing the recuperative powers of the body.

ASSOCIATION
and the patients they serve.
About
Member Services
Patients
Government Relations
Plexus
Marketplace
Contact Us
WSCA
Annual Meeting
2019
SATURDAY, MARCH 16, 2019 • 9:00AM-2:00PM
RADISSON HOTEL SEATTLE AIRPORT

Factors Worsening Injury, Complicate Care and Predict Recovery

- Risk Factors:
  - Pre-existing factors that predispose a patient to injury in a crash
- Complicating Factors (Factors Inhibiting Recovery):
  - Pre-existing AND post-injury factors that inhibit recovery
- Prognostic Factors:
  - Factors that can predict recovery vs chronicity

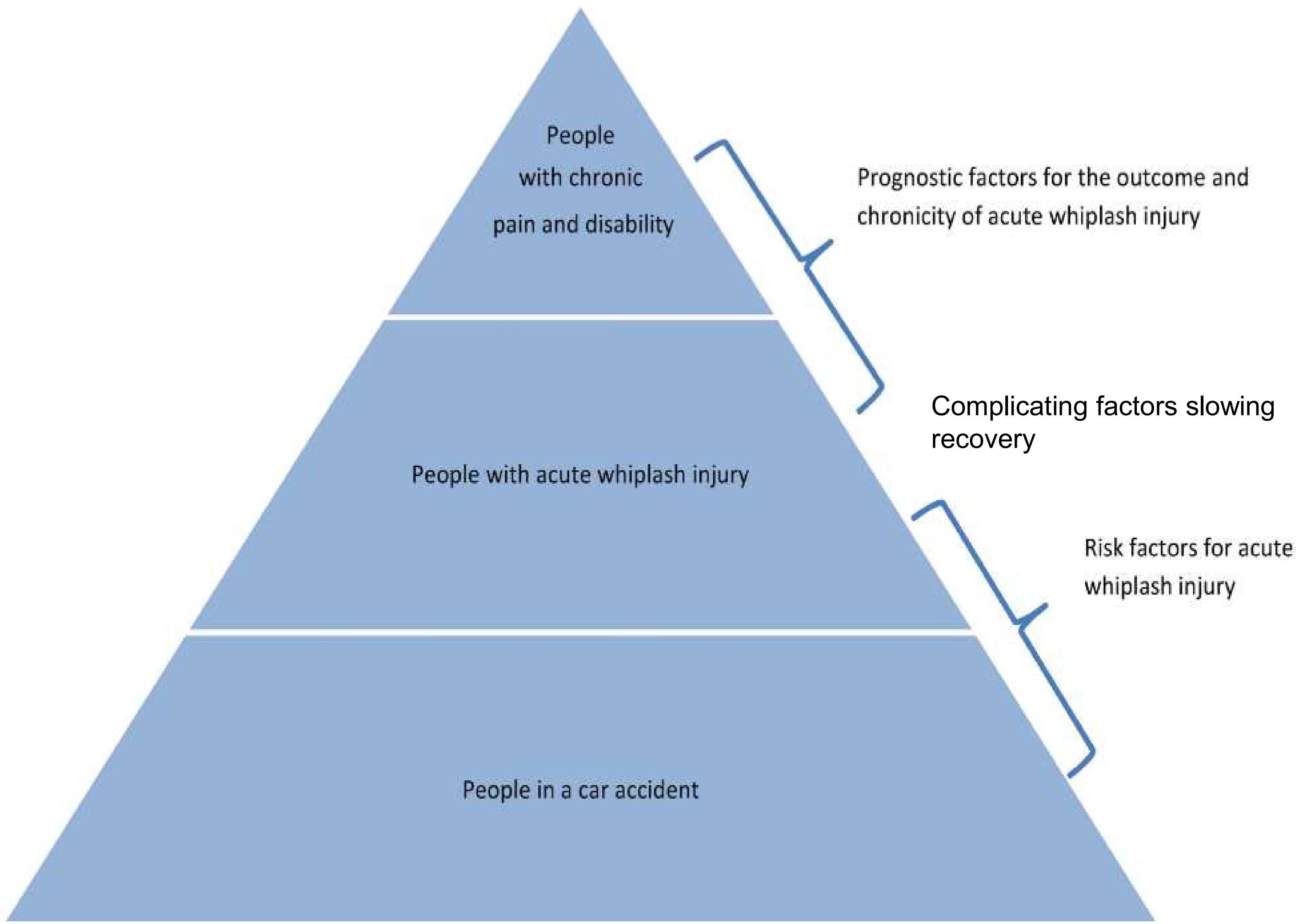

People
with chronic
pain and disability
Prognostic factors for the outcome and
chronicity of acute whiplash injury
Complicating factors slowing
recovery
People with acute whiplash injury
Risk factors for acute
whiplash injury
People in a car accident

Table 17
Croft's List of Complicating Factors

1. Advance Age
2. Disc protrusion/herniation
3. Prior vertebral facture
4. Metabolic disorders
5. Spondylosis and/or facet arthrosis
6. Osteoporosis or bone disease
7. Congenital anomalies of the spine
8. Arthritis of the spine Spinal or foraminal stenosis
9. Development anomalies of the spine
10. AS or other spondylarthropathy
11. Paraplegia/tetraplegia
12. Degenerative disc disease
13. Prior cervical or lumbar spine surgery
14. Prior spinal injury; scoliosis

Complicating Factors for WAD Tx: ICA BPPG Chapter 11, Table 7

1. <5 yrs at same employer
2. Abnormal joint motion
3. Abnormal Posture
4. Absolute cervical spinal canal stenosis (10-12 mm)
5. Advanced age
6. Asymmetry of muscle tone
7. Cervical Kyphosis
8. Compression fracture
9. Condition chronicity
10. Congenital fused cervical segments
11. Dens fracture
12. Emotional stress
13. Employment satisfaction
14. Ergonomic factors
15. Expectations of recovery
16. Facet fracture
17. Falling as a mechanism of prior injury
18. Family/relationship stress
19. Fixated segment on flexion/extension films
20. Increased spine flexibility
21. Laterolisthesis
22. Leg length inequality
23. Leg pain greater than back pain
24. Level of fitness
25. Likely mechanical tissue damage
26. Loss of cervical lordosis
27. Loss of consciousness after trauma
28. Lower wage employment
29. Lumbar Kyphosis
30. Managing Named Diseases (eg., MS, Chrones Disease, Asthma, etc)
31. NRS ≥ 7.0
32. Obesity
33. One-sided sports/exercise activity
34. Osteoarthritis
35. Pain with radicular signs/symptoms
36. Physical limitations (can't exercise, can't walk, wheelchair, etc)
37. poor body mechanics
38. Poor spinal motor control
39. Pre-existing degenerative joint disease
40. Prior recent injury (<6 mos.)
41. Prior surgery in area of complaint
42. Prolonged static postures
43. Reduced muscle endurance
44. Relative cervical spinal canal stenosis (13-15 mm)
45. Retrolisthesis
46. Rheumatoid arthritis
47. Scoliosis (define: 10° or more?)
48. Smoking
49. Spinal Anomaly
50. Spondylolisthesis/spondylolysis
51. Surgically fused cervical segments
52. Sustained (frequent/continuous) trunk load > 20 lbs.
53. Traumatic causation
54. Wearing high heel shoes
55. Work-related duties

8 Prognostic Factors for WAD Recovery

1. Initial Pain Intensity (NRS, VAS, etc)
2. Initial Neck Disability Index (NDI)
3. Initial WAD Grade of Injury
4. Initial Cervical Range of Motion
5. Hyeralgesia (cold, algometry, etc)
6. Initial Expectations of Recovery
7. Post-Crash Emotional Factors (e.g. catastrophizing)
8. Muscle Fatty Infiltration (on MRI)

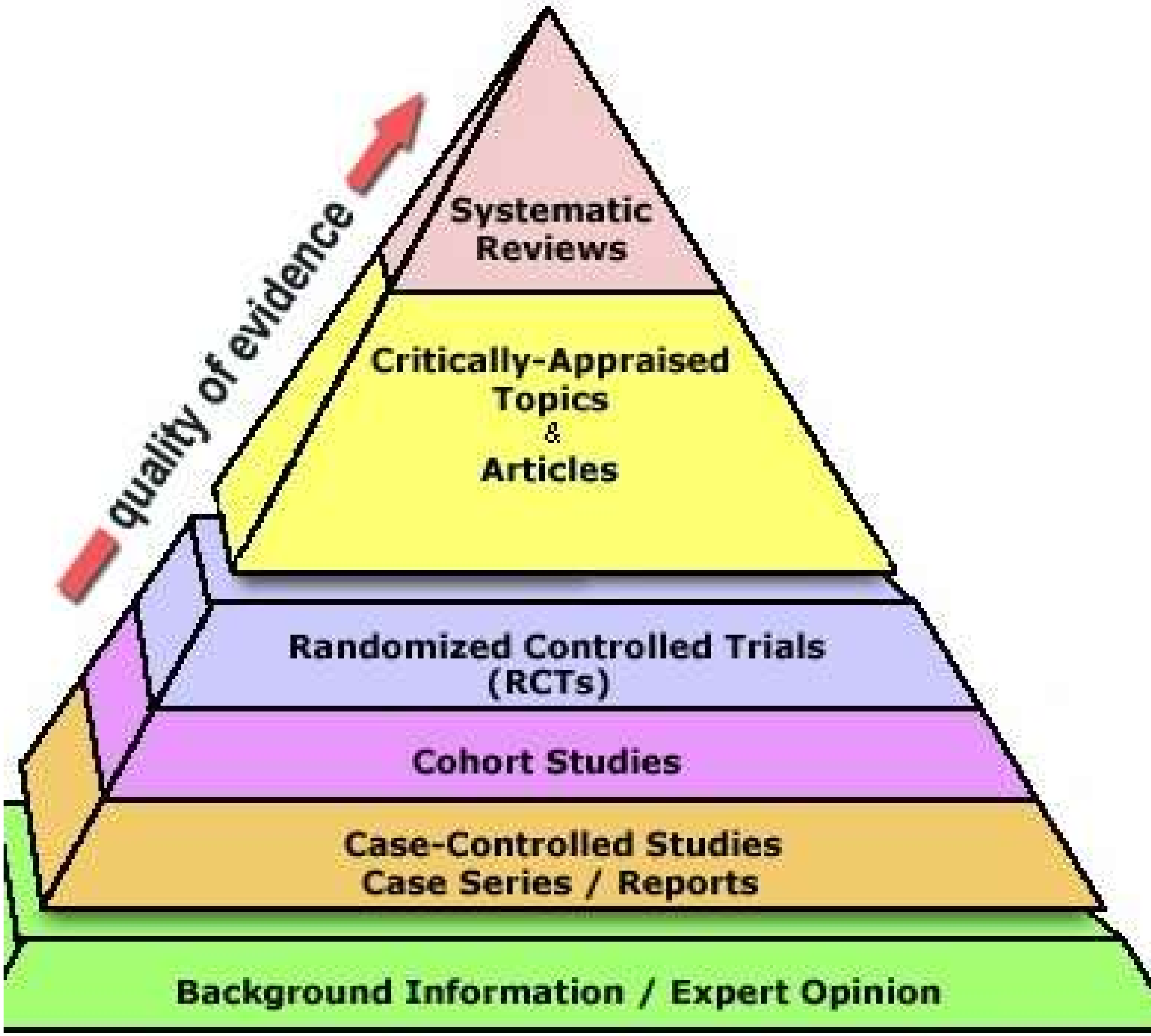
8 Prognostic Factors for WAD Recovery

Why is this Important??

1. 50% of people injured in a crash never fully recover
   - 25% of these people have permanent impairment/disability
2. Give the patient a real "prognosis"
3. Determine how aggressive (diverse) to be with Tx plan and co-management plan
   - Do everything you can early in management
4. Medicolegal implications of likely becoming permanently impaired

1. Initial Pain Intensity

Hierarchy of Evidence



Predictors of Poor Prognosis after Acute WAD

#1 predictor that a patient will not fully recover to pre-injury status:

Self-Reported Pain Intensity

1. Kamper S, Rebbeck T, Maher C, et al. Course and prognostic factors of whiplash: a systematic review and meta-analysis. Pain 2008; 138:617-19.
2. Cote P, Cassidy D, Carroll L, etal. A systematic review of the prognosis of acute whiplash and a new conceptual framework to synthesize the literature. Spine 2001; 26:E445-58 .
3. Scholten-Peeters G, Verhagen A, Bekkering G, etal. Prognostic factors of whiplash associated disorders: a systematic review of prospective cohort studies. Pain 2003; 104:303-22 .
4. Walton D, Pretty J, MacDermid J, etal. Risk factors for persistent problems following whiplash injury: results of a systematic review and meta-analysis. J Orthop Sports Phys Ther 2009; 39:334-50 .
5. Williamson E, Williams M, Gates S, et al. A systematic review of psychological factors and the development of late whiplash syndrome. Pain 2008; 135:20-30.
6. Walton DM, et al. Risk factors for persistent problems following acute whiplash injury: update of a systematic review and meta-analysis. J Orthop Sports Phys Ther. 2013 Feb;43(2):31-43.
7. Sarrami P, Armstrong E, Naylor JM, Harris IA. Factors predicting outcome in whiplash injury: a systematic meta-review of prognostic factors. J Orthopaed Traumatol. 2017;18;9-16

Predictors of Poor Prognosis after Acute WAD

#1 predictor that a patient will not fully recover to pre-injury status:

Self-Reported Pain Intensity

Walton, etal (2009):

- Synthesized the data (meta analysis) from eight cohorts and established a cutoff point of **5.5 of 10** on a VAS, with pain greater than this demonstrating a nearly **sixfold** (OR: 5.77; 95% CI: 2.89–11.52) increase in the risk of persistent pain or disability at long-term follow-up.

JOSPT Journal of Orthopaedic & Sports Physical Therapy

Risk factors for persistent problems following acute whiplash injury: update of a systematic review and meta-analysis.

Walton DM, et al. J Orthop Sports Phys Ther. 2013 Feb;43(2):31-43.

The significant variables included:

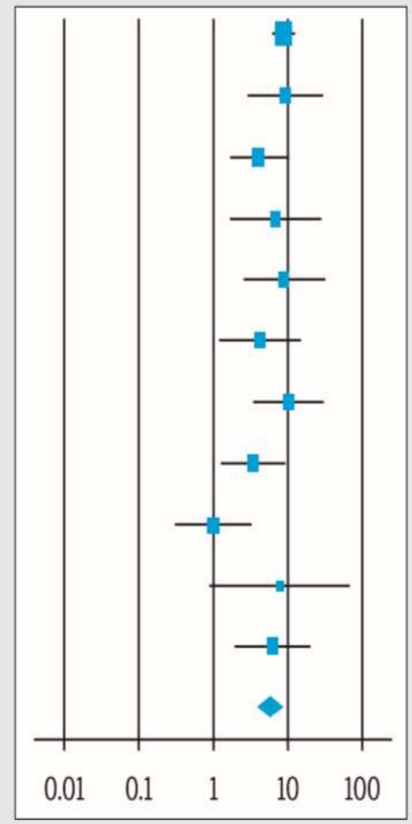
- high baseline pain intensity (greater than 5.5/10)
- report of headache at inception
- less than postsecondary education
- no seatbelt in use during the accident
- report of low back pain at inception,
- high Neck Disability Index score (greater than 14.5/50)
- preinjury neck pain
- report of neck pain at inception (regardless of intensity)
- high catastrophizing
- female sex
- WAD grade 2 or 3, and
- WAD grade 3 alone.

Walton DM, et al. J Orthop Sports Phys Ther. 2013 Feb;43(2):31-43.

High Pain Intensity

Study	Outcome	Follow-up, mo	Odds Ratio	Lower Limit	Upper Limit	*z* Value	*P* Value
Berglund et al[2]	Pain	12	8.85	6.32	12.38	12.72	.00
Hartling et al[10]	Pain	6	9.14	2.92	28.61	3.80	.00
Hendriks et al[12]	Pain	12	4.06	1.69	9.74	3.13	.00
Kasch et al[17]	Disability	12	6.86	1.71	27.46	2.72	.01
Kivioja et al[21]	Pain	12	8.84	2.54	30.72	3.43	.00
Kivioja et al[22]	Pain	12	4.22	1.23	14.47	2.29	.02
Nederhand et al[28]	Disability	6	9.99	3.38	29.49	4.17	.00
Radanov et al[29]	Pain	24	3.41	1.29	9.01	2.47	.01
Söderlund et al[32]	Pain	6	1.00	0.31	3.18	0.00	1.00
Sterling[34]	Disability	6	7.71	0.91	65.35	1.87	.06
Vetti et al[41]	Pain	12	6.17	1.95	19.58	3.09	.00
...	...	...	5.61	3.74	8.43	8.31	.00

Odds Ratio and 95% CI*



J Orthopaed Traumatol (2017) 18:9–16
DOI 10.1007/s10195-016-0431-x

REVIEW ARTICLE

Factors predicting outcome in whiplash injury: a systematic meta-review of prognostic factors

Pooria Sarrami[1,2] · Elizabeth Armstrong[3] · Justine M. Naylor[2,4] · Ian A. Harris[2,4]

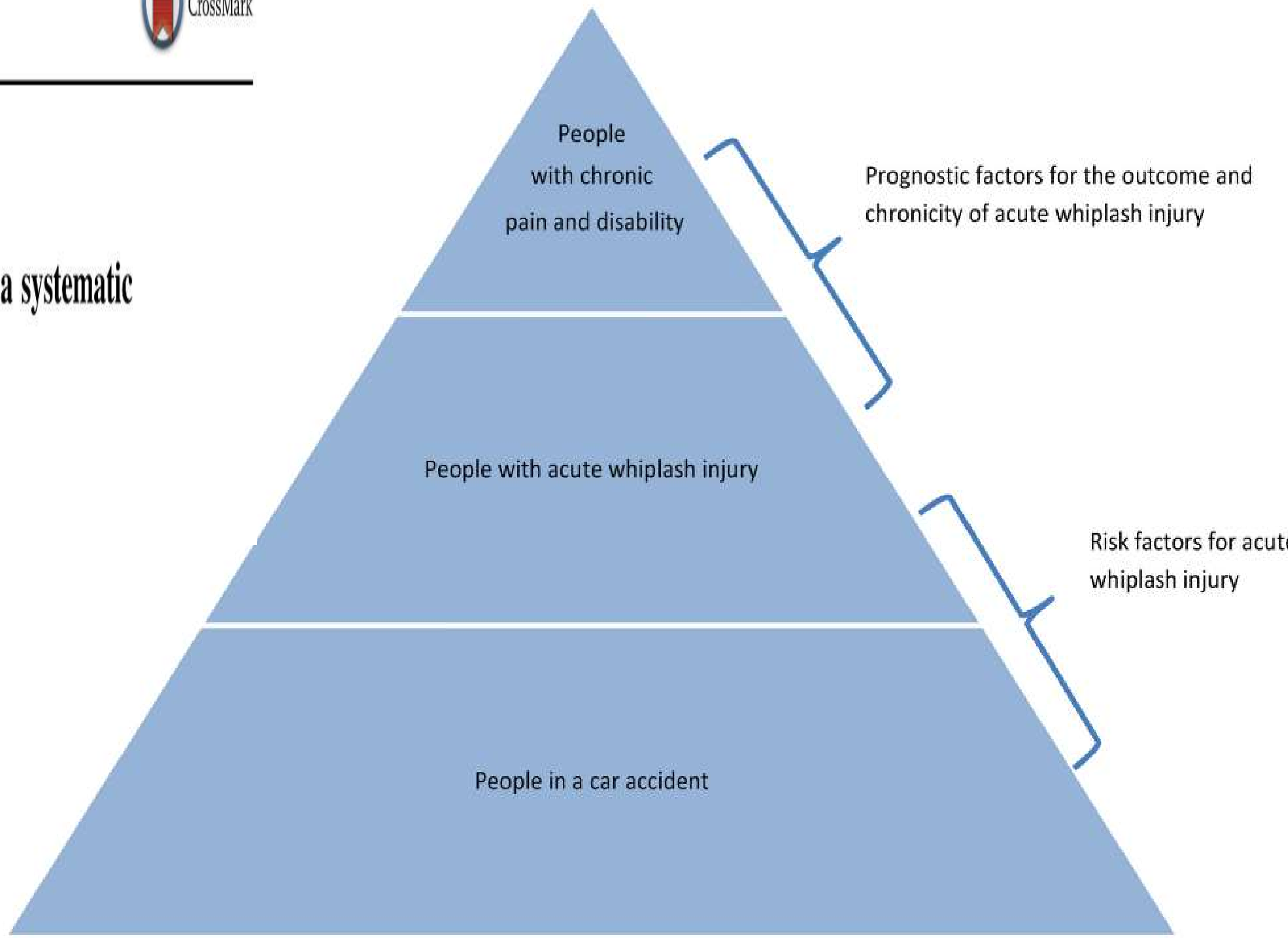


Fig. 1 Illustration of risk factors and prognostic factors of acute whiplash injury

J Orthopaed Traumatol (2017) 18:9–16
DOI 10.1007/s10195-016-0431-x

CrossMark

REVIEW ARTICLE

Factors predicting outcome in whiplash injury: a systematic meta-review of prognostic factors

Pooria Sarrami[1,2] · **Elizabeth Armstrong**[3] · **Justine M. Naylor**[2,4] · **Ian A. Harris**[2,4]

Table 2 Associated factors

Factors	The conclusion of evaluated systematic reviews [and citations]	Overall
Post-injury pain and disability, whiplash grades, cold hyperalgesia	A [15], A [17], A [18], A [19], A [21], A [22], A [23]	Associated
Post-injury anxiety	A [18], A [20]	Associated (based on outdated reviews)[a]
Catastrophizing	A [18], A [14], C [20]	Associated (based on outdated reviews)
Compensation and legal factors	A [16], A [18], L [23]	Associated
Early healthcare use	A [18], L [23]	Associated (based on outdated reviews)[a]

A associated, *L* lack of evidence

[a] Systematic reviews that were published 5 years ago or earlier are considered 'outdated'

J Orthopaed Traumatol (2017) 18:9–16
DOI 10.1007/s10195-016-0431-x

CrossMark

REVIEW ARTICLE

Factors predicting outcome in whiplash injury: a systematic meta-review of prognostic factors

Pooria Sarrami[1,2] · Elizabeth Armstrong[3] · Justine M. Naylor[2,4] ·
Ian A. Harris[2,4]

Table 3 Non-associated factors

Factors	The conclusion of evaluated systematic reviews [and citations]	Overall
Post-injury MRI or radiological findings	N [12], N [18]	Not associated
Motor dysfunctions	N [13]	Not associated
Collision factors	N [15], N [19], N [18], N [22], C [23]	Not associated

N non-associated, *C* controversial

J Orthopaed Traumatol (2017) 18:9–16
DOI 10.1007/s10195-016-0431-x

CrossMark

REVIEW ARTICLE

Factors predicting outcome in whiplash injury: a systematic meta-review of prognostic factors

Pooria Sarrami[1,2] · Elizabeth Armstrong[3] · Justine M. Naylor[2,4] · Ian A. Harris[2,4]

Table 4 Factors that were controversial or lacked evidence

Factors	The conclusion of evaluated systematic reviews [and citations]	Overall
Gender	A [15], C [18], N [19], N [22], A [23]	Controversial
Age	N [15], N [19], C [18], N [22], A [23]	Controversial
Education	A [15], C (18], C [23)	Controversial
Pain prior to accident	A [15], C [18], C [23]	Controversial
Genetic factors	L [18]	Lack of evidence
Coping behaviour	C [18], C [20]	Controversial (based on outdated reviews)[a]
General psychological distress	A [19], N [20]	Controversial (based on outdated reviews)[a]
Depressive mood	N [14], A [18], C [20]	Controversial (based on outdated reviews)[a]

A associated, *N* non-associated, *C* controversial, *L* lack of evidence

[a] Systematic reviews that were published 5 years ago or earlier are considered 'outdated'

J Orthopaed Traumatol (2017) 18:9–16
DOI 10.1007/s10195-016-0431-x

REVIEW ARTICLE

Factors predicting outcome in whiplash injury: a systematic meta-review of prognostic factors

Pooria Sarrami[1,2] · Elizabeth Armstrong[3] · Justine M. Naylor[2,4] · Ian A. Harris[2,4]

12. Li Q, Shen H, Li M (2013) Magnetic resonance imaging signal changes of alar and transverse ligaments not correlated with whiplash-associated disorders: a meta-analysis of case-control studies. Eur Spine J 22(1):14–20
13. Daenen L, Nijs J, Raadsen B, Roussel N, Cras P, Dankaerts W (2013) Cervical motor dysfunction and its predictive value for long-term recovery in patients with acute whiplash-associated disorders: a systematic review. J Rehabil Med 45(2):113–122
14. Walton DM, Pretty J, Macdermid JC, Teasell RW (2009) Risk factors for persistent problems following whiplash injury: results of a systematic review and meta-analysis. J Orthop Sports Phys Ther 39(5):334–350
15. Walton DM, Macdermid JC, Giorgianni AA, Mascarenhas JC, West SC, Zammit CA (2013) Risk factors for persistent problems following acute whiplash injury: update of a systematic review and meta-analysis. J Orthop Sports Phys Ther 43(2):31–43
16. Spearing NM, Connelly LB, Gargett S, Sterling M (2012) Does injury compensation lead to worse health after whiplash? A systematic review. Pain 153(6):1274–1282
17. Goldsmith R, Wright C, Bell SF, Rushton A (2012) Cold hyperalgesia as a prognostic factor in whiplash associated disorders: a systematic review. Man Ther 17(5):402–410
18. Carroll LJ, Holm LW, Hogg-Johnson S, Côté P, Cassidy JD, Haldeman S et al (2008) Course and prognostic factors for neck pain in whiplash-associated disorders (WAD): results of the Bone and Joint Decade 2000–2010 Task Force on Neck Pain and Its Associated Disorders. Spine 33(4S):S83–S92
19. Kamper SJ, Rebbeck TJ, Maher CG, McAuley JH, Sterling M (2008) Course and prognostic factors of whiplash: a systematic review and meta-analysis. Pain 138(3):617–629
20. Williamson E, Williams M, Gates S, Lamb SE (2008) A systematic literature review of psychological factors and the development of late whiplash syndrome. Pain 135(1–2):20–30
21. Williams M, Williamson E, Gates S, Lamb S, Cooke M (2007) A systematic literature review of physical prognostic factors for the development of Late Whiplash Syndrome. Spine 32(25):E764–E780
22. Scholten-Peeters GG, Verhagen AP, Bekkering GE, van der Windt DA, Barnsley L, Oostendorp RA et al (2003) Prognostic factors of whiplash-associated disorders: a systematic review of prospective cohort studies. Pain 104(1–2):303–322
23. Cote P, Cassidy JD, Carroll L, Frank JW, Bombardier C (2001) A systematic review of the prognosis of acute whiplash and a new conceptual framework to synthesize the literature. Spine 26(19):E445–E458

J Orthopaed Traumatol (2017) 18:9–16
DOI 10.1007/s10195-016-0431-x

REVIEW ARTICLE

Factors predicting outcome in whiplash injury: a systematic meta-review of prognostic factors

Pooria Sarrami[1,2] · Elizabeth Armstrong[3] · Justine M. Naylor[2,4] · Ian A. Harris[2,4]

CONCLUSION:

“The most consistent finding of the systematic reviews was the association of post-injury pain and disability with long-term pain and disability.”

Capturing Pain Intensity

Pain Intensity Instrument	Description
Verbal Rating Scale (VRS)	Patients read over a list of adjectives describing levels of pain intensity and choose the word or phrase that best describes their level of pain. (0-3 score, 3=worst).
Visual Analog Scale (VAS)	Patients place a mark on a 10 cm line (on paper, or using a mechanical device), with ends labeled as the extremes of pain (10=worst), to denote their level of pain intensity. A quantifiable score is derived from millimetric measurement (0-100).
Numerical Rating Scale (NRS)	Patients verbally (or using a pencil) rate their pain from 0-10 (11-point scale), 0-20 (21-point scale), or 0-100 (101-point scale) to rate their pain intensity (highest score worst).

Quad VAS

- Pain is reported:
  - Right Now
  - Average
  - At its Best
  - At its Worst

QUADRUPLE VISUAL ANALOGUE SCALE

Patient Name ______________________________ Date ______________

Please read carefully:

Instructions: Please circle the number that best describes the question being asked.

Note: If you have more than one complaint, please answer each question for each individual complaint and indicate the score for each complaint. Please indicate your pain level right now, average pain, and pain at its best and worst.

Example:

Headache Neck Low Back

No pain 0 1 (2) 3 4 (5) 6 7 (8) 9 10 **worst possible pain**

1 – What is your pain RIGHT NOW?

No pain 0 1 2 3 4 5 6 7 8 9 10 **worst possible pain**

2 – What is your TYPICAL or AVERAGE pain?

No pain 0 1 2 3 4 5 6 7 8 9 10 **worst possible pain**

3 – What is your pain level AT ITS BEST (How close to "0" does your pain get at its best)?

No pain 0 1 2 3 4 5 6 7 8 9 10 **worst possible pain**

4 – What is your pain level AT ITS WORST (How close to "10" does your pain get at its worst)?

No pain 0 1 2 3 4 5 6 7 8 9 10 **worst possible pain**

Spine (Phila Pa 1976). 2004 Jan 15;29(2):182-8.

Characterization of acute whiplash-associated disorders.

Sterling M[1], Jull G, Vicenzino B, Kenardy J.

80 whiplash subjects (WAD II or III) within 1 mo of injury, and 20 control subjects

- Motor function (cervical range of movement [ROM],
- joint position error [JPE];
- activity of the superficial neck flexors [EMG] during a test of cranio-cervical flexion),
- quantitative sensory testing (pressure, thermal pain thresholds, and responses to the brachial plexus provocation test),
- and psychological distress (GHQ-28, TAMPA, IES)

Conclusions: “Acute whiplash subjects with higher levels of pain and disability were distinguished by sensory hypersensitivity to a variety of stimuli, suggestive of central nervous system sensitization occurring soon after injury. These responses occurred independently of psychological distress. These findings may be important for the differential diagnosis of acute whiplash injury and could be one reason why those with higher initial pain and disability demonstrate a poorer outcome.”

2. Neck Disability Index

Predictors of Poor Prognosis after Acute WAD

#2 predictor that a patient will not fully recover to pre-injury status:

<u>Self-Reported Disability (NDI)</u>

Section 1 - Pain Intensity

- ❑ I have no neck pain at the moment.
- ■ The pain is very mild at the moment.
- ❑ The pain is moderate at the moment.
- ❑ The pain is fairly severe at the moment.
- ❑ The pain is very severe at the moment.
- ❑ The pain is the worst imaginable at the moment.

Section 2 - Personal Care

- ❑ I can look after myself normally without causing extra neck pain.
- ❑ I can look after myself normally, but it causes extra neck pain.
- ■ It is painful to look after myself, and I am slow and careful
- ❑ I need some help but manage most of my personal care.
- ❑ I need help every day in most aspects of self -care.
- ❑ I do not get dressed. I wash with difficulty and stay in bed.

Section 3 – Lifting

- ❑ I can lift heavy weights without causing extra neck pain.
- ❑ I can lift heavy weights, but it gives me extra neck pain.
- ■ Neck pain prevents me from lifting heavy weights off the floor but I can manage if items are conveniently positioned, ie. on a table.
- ❑ Neck pain prevents me from lifting heavy weights, but I can manage light weights if they are conveniently positioned
- ❑ I can lift only very light weights.
- ❑ I cannot lift or carry anything at all.

Section 4 – Reading

- ❑ I can read as much as I want with no neck pain.
- ❑ I can read as much as I want with slight neck pain.
- ❑ I can read as much as I want with moderate neck pain.
- ■ I can't read as much as I want because of moderate neck pain.
- ❑ I can't read as much as I want because of severe neck pain.
- ❑ I can't read at all.

Section 5 – Headaches

- ❑ I have no headaches at all.
- ❑ I have slight headaches that come infrequently.
- ■ I have moderate headaches that come infrequently.
- ❑ I have moderate headaches that come frequently.
- ❑ I have severe headaches that come frequently.
- ❑ I have headaches almost all the time.

Section 6 – Concentration

- ❑ I can concentrate fully without difficulty.
- ❑ I can concentrate fully with slight difficulty.
- ■ I have a fair degree of difficulty concentrating.
- ❑ I have a lot of difficulty concentrating.
- ❑ I have a great deal of difficulty concentrating.
- ❑ I can't concentrate at all.

Section 7 – Work

- ❑ I can do as much work as I want.
- ❑ I can only do my usual work, but no more.
- ■ I can do most of my usual work, but no more.
- ❑ I can't do my usual work.
- ❑ I can hardly do any work at all.
- ❑ I can't do any work at all.

Section 8 – Driving

- ❑ I can drive my car without neck pain.
- ❑ I can drive my car with only slight neck pain.
- ■ I can drive as long as I want with moderate neck pain.
- ❑ I can't drive as long as I want because of moderate neck pain.
- ❑ I can hardly drive at all because of severe neck pain.
- ❑ I can't drive my care at all because of neck pain.

Section 9 – Sleeping

- ❑ I have no trouble sleeping.
- ❑ My sleep is slightly disturbed for less than 1 hour.
- ■ My sleep is mildly disturbed for up to 1-2 hours.
- ❑ My sleep is moderately disturbed for up to 2-3 hours.
- ❑ My sleep is greatly disturbed for up to 3-5 hours.
- ❑ My sleep is completely disturbed for up to 5-7 hours.

Section 10 – Recreation

- ❑ I am able to engage in all my recreational activities with no neck pain at all.
- ❑ I am able to engage in all my recreational activities with some neck pain.
- ■ I am able to engage in most, but not all of my recreational activities because of pain in my neck.
- ❑ I am able to engage in a few of my recreational activities because of neck pain.
- ❑ I can hardly do recreational activities due to neck pain.
- ❑ I can't do any recreational activities due to neck pain.

Scoring the NDI

Section 1 - Pain Intensity	Points
❑ I have no neck pain at the moment. →	0
❑ The pain is very mild at the moment. →	1
❑ The pain is moderate at the moment. →	2
❑ The pain is fairly severe at the moment. →	3
❑ The pain is very severe at the moment. →	4
❑ The pain is the worst imaginable at the moment. →	5

Section 1 - Pain Intensity

- [ ] I have no neck pain at the moment.
- [x] The pain is very mild at the moment.
- [ ] The pain is moderate at the moment.
- [ ] The pain is fairly severe at the moment.
- [ ] The pain is very severe at the moment.
- [ ] The pain is the worst imaginable at the moment.

1

Section 2 - Personal Care

- [ ] I can look after myself normally without causing extra neck pain.
- [ ] I can look after myself normally, but it causes extra neck pain.
- [x] It is painful to look after myself, and I am slow and careful
- [ ] I need some help but manage most of my personal care.
- [ ] I need help every day in most aspects of self -care.
- [ ] I do not get dressed. I wash with difficulty and stay in bed.

2

Section 3 – Lifting

- [ ] I can lift heavy weights without causing extra neck pain.
- [ ] I can lift heavy weights, but it gives me extra neck pain.
- [x] Neck pain prevents me from lifting heavy weights off the floor but I can manage if items are conveniently positioned, ie. on a table.
- [ ] Neck pain prevents me from lifting heavy weights, but I can manage light weights if they are conveniently positioned
- [ ] I can lift only very light weights.
- [ ] I cannot lift or carry anything at all.

2

Section 4 – Reading

- [ ] I can read as much as I want with no neck pain.
- [ ] I can read as much as I want with slight neck pain.
- [ ] I can read as much as I want with moderate neck pain.
- [x] I can't read as much as I want because of moderate neck pain.
- [ ] I can't read as much as I want because of severe neck pain.
- [ ] I can't read at all.

3

Section 5 – Headaches

- [ ] I have no headaches at all.
- [ ] I have slight headaches that come infrequently.
- [x] I have moderate headaches that come infrequently.
- [ ] I have moderate headaches that come frequently.
- [ ] I have severe headaches that come frequently.
- [ ] I have headaches almost all the time.

2

Section 6 – Concentration

- [ ] I can concentrate fully without difficulty.
- [ ] I can concentrate fully with slight difficulty.
- [x] I have a fair degree of difficulty concentrating.
- [ ] I have a lot of difficulty concentrating.
- [ ] I have a great deal of difficulty concentrating.
- [ ] I can't concentrate at all.

2

Section 7 – Work

- [ ] I can do as much work as I want.
- [ ] I can only do my usual work, but no more.
- [x] I can do most of my usual work, but no more.
- [ ] I can't do my usual work.
- [ ] I can hardly do any work at all.
- [ ] I can't do any work at all.

2

Section 8 – Driving

- [ ] I can drive my car without neck pain.
- [ ] I can drive my car with only slight neck pain.
- [x] I can drive as long as I want with moderate neck pain.
- [ ] I can't drive as long as I want because of moderate neck pain.
- [ ] I can hardly drive at all because of severe neck pain.
- [ ] I can't drive my care at all because of neck pain.

2

Section 9 – Sleeping

- [ ] I have no trouble sleeping.
- [ ] My sleep is slightly disturbed for less than 1 hour.
- [x] My sleep is mildly disturbed for up to 1-2 hours.
- [ ] My sleep is moderately disturbed for up to 2-3 hours.
- [ ] My sleep is greatly disturbed for up to 3-5 hours.
- [ ] My sleep is completely disturbed for up to 5-7 hours.

2

Section 10 – Recreation

- [ ] I am able to engage in all my recreational activities with no neck pain at all.
- [ ] I am able to engage in all my recreational activities with some neck pain.
- [x] I am able to engage in most, but not all of my recreational activities because of pain in my neck.
- [ ] I am able to engage in a few of my recreational activities because of neck pain.
- [ ] I can hardly do recreational activities due to neck pain.
- [ ] I can't do any recreational activities due to neck pain.

2

SCORE=

20/50=

40%

Predictors of Poor Prognosis after Acute WAD

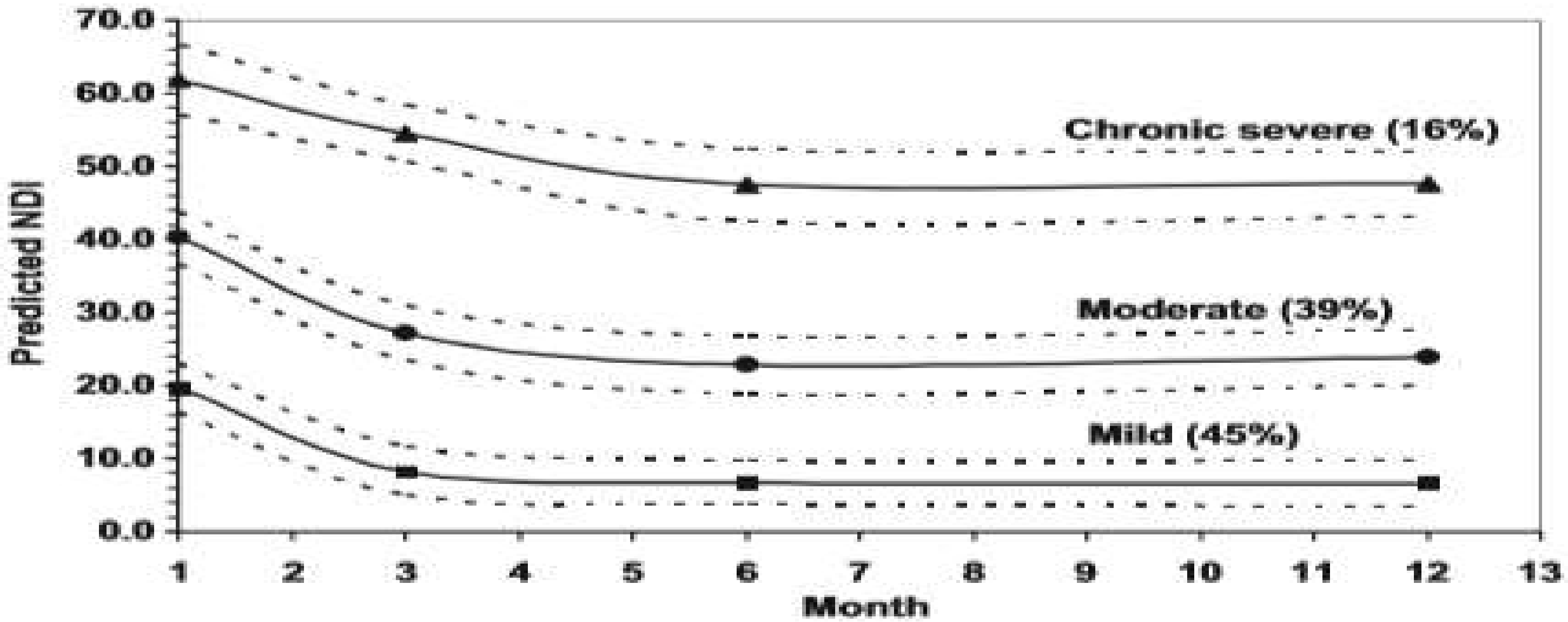


Figure 1. Predicted neck disability index (NDI) trajectories with 95% confidence limits and predicted probability of membership (%). Suggested cutoffs for the NDI are: 0% to 8% (no pain and disability); 10% to 28% (mild pain and disability), 30% to 48% (moderate pain and disability), 50% to 68% (severe pain and disability) and more than 70% complete disability. Reproduced with permission from Sterling *et al.*[3]

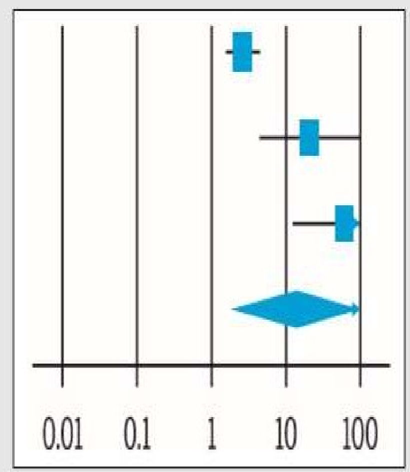
JOSPT Journal of Orthopaedic & Sports Physical Therapy

Risk factors for persistent problems following acute whiplash injury: update of a systematic review and meta-analysis.

Walton DM, et al. J Orthop Sports Phys Ther. 2013 Feb;43(2):31-43.

Neck Disability Index Greater Than 15

Study	Outcome	Follow-up, mo	Odds Ratio	Lower Limit	Upper Limit	z Value	P Value	Odds Ratio and 95% CI*
Atherton et al[1]	Pain	12	2.65	1.59	4.39	3.76	.00	
Nederhand et al[28]	Disability	6	20.24	4.34	94.36	3.83	.00	
Sterling[34]	Disability	6	59.50	12.10	292.57	5.03	.00	
...	...	...	13.24	1.68	104.36	2.45	.01	



The association between neck pain, the Neck Disability Index and cervical ranges of motion: a narrative review

J Can Chiropr Assoc 2011; 55(3)

Journal of the Canadian Chiropractic Association

Emily R. Howell, BPHE (Hons), DC*

Table 3 *NDI and whiplash*

Study	Design strength	Design limit	Measure	Results
Vernon 2008	41 NDI and WAD studies Review	Review done by NDI author himself (could have some bias)	NDI	NDI most widely used and strongly validated self-rated disability measure for neck pain; best outcome predictor (especially of longer term physiological dysfunction and physical impairment)
Kaale et al 2005	N = 92 chronic grade 2 WAD patients & 30 controls	Controls were being treated by physical therapist for other conditions (not specified); controls slightly older than WAD patients.	MRI , NDI	Transverse ligament and posterior atlanto-occipital membrane lesions relate to NDI scores.
Pereira et al 2008	N= 30 WAD and 30 controls Case control study	WAD patients older, had more driving experience, had higher composite driving tasks scores and used more assistance with driving than controls; measures were taken in laboratory and not in real driving context;	NDI, GHQ-28, IES-R, TSK, DHQ, CROM (with Fastrak), cervical joint position sense, smoother pursuit neck torsion test	WAD had CROM deficits (more so in flexion, extension and rotation); moderate correlation between driving task scores and pain and disability levels
Stewart et al 2007	N = 132 chronic WAD patients Cohort study	Baseline and 6 weeks follow-up measurement (after 12 session of exercise program); used diary (not supervised exercise).	NDI, pain intensity, bothersomeness, SF-36, PSFS, FRS, Copenhagen Scale, SF-36 physical summary	NDI and other region-specific measures no more responsive than other general disability measures; region-specific measures are easy to administer and score and are relevant to neck pain population
Vernon et al 2009	N = 107 chronic WAD Cross-sectional correlation design	Pain and disability status of sample higher than previous studies; referral bias of obtaining subjects; no-fault insurance system jurisdiction;	NDI, TSK, pain VAS, pain diagram.	Fear avoidance beliefs and pain amplification have some moderate influence on self-reported disability (and NDI scores) in WAD subjects; Pain diagram correlates with NDI scores

3. WAD Grade

Table 15
Croft's Grades of Injury[333]

Grades	Severity	Anatomical and Clinical Description
I	minimal	no limitation of range of motion, no ligamentous injury, no neurological symptoms
II	slight	limitation of range of motion, no ligamentous injury, no neurological findings
III	moderate	limitation of range of motion, some ligamentous injury, neurological findings present
IV	moderate to severe	limitation of range of motion, ligamentous instability, neurological findings present, fracture or disc derangement
V	severe	requires surgical treatment and stabilization.

Table. Quebec Task Force grades of whiplash-associated disorders

STI classification			
Grade I	Grade II	Grade III	Grade IV
No physical neck/upper back sign(s)	Neck/upper back musculoskeletal signs: • Decreased ROM • Point tenderness	Neck/upper back neurological signs: • Decreased reflexes • Decreased sensation • Decreased strength	Neck/upper back fracture/ dislocation

DAVID M. WALTON, PT, PhD[1] • **JOY C. MACDERMID,** PT, PhD[2] • **ANTHONY A. GIORGIANNI,** BSc, MPT[1]
JOANNA C. MASCARENHAS, BSc, MPT[1] • **STEPHEN C. WEST,** BSc, MPT[1] • **CAROLINE A. ZAMMIT,** BSc, MPT[1]

Risk Factors for Persistent Problems Following Acute Whiplash Injury: Update of a Systematic Review and Meta-analysis

"Having a WAD grade of 2 or 3 at inception increased the odds of being in the high-risk group 2-fold (OR = 2.00; 95% CI: 1.48, 2.71) compared to those with a WAD grade of 0 or 1."
" A WAD grade of 3 increased the odds of being in the high-risk group (OR = 2.43; 95% CI: 1.88, 3.15) when compared to those with a WAD grade of 2."

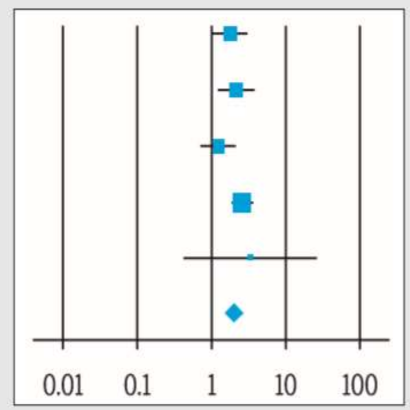
DAVID M. WALTON, PT, PhD[1] • JOY C. MACDERMID, PT, PhD[2] • ANTHONY A. GIORGIANNI, BSc, MPT[1]
JOANNA C. MASCARENHAS, BSc, MPT[1] • STEPHEN C. WEST, BSc, MPT[1] • CAROLINE A. ZAMMIT, BSc, MPT[1]

Risk Factors for Persistent Problems Following Acute Whiplash Injury: Update of a Systematic Review and Meta-analysis

WAD Grade: 3 or 2 Versus 0 or 1

Study	Outcome	Follow-up, mo	Odds Ratio	Lower Limit	Upper Limit	*z* Value	*P* Value
Hartling et al[10]	Pain	12	1.80	1.04	3.10	2.11	.03
Sterner et al[37]	Disability	16	2.17	1.23	3.83	2.67	.01
Atherton et al[1]	Pain	12	1.23	0.71	2.13	0.73	.47
Berglund et al[2]	Pain	12	2.61	1.88	3.62	5.71	.00
Kivioja et al[22]	Pain	12	3.36	0.43	26.56	1.15	.25
...	...	...	2.00	1.48	2.71	4.50	.00

Odds Ratio and 95% CI*

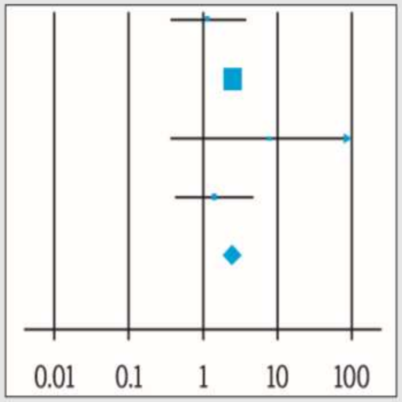


DAVID M. WALTON, PT, PhD[1] • JOY C. MACDERMID, PT, PhD[2] • ANTHONY A. GIORGIANNI, BSc, MPT[1]
JOANNA C. MASCARENHAS, BSc, MPT[1] • STEPHEN C. WEST, BSc, MPT[1] • CAROLINE A. ZAMMIT, BSc, MPT[1]

Risk Factors for Persistent Problems Following Acute Whiplash Injury: Update of a Systematic Review and Meta-analysis

WAD Grade: 3 Versus 2

Study	Outcome	Follow-up, mo	Odds Ratio	Lower Limit	Upper Limit	*z* Value	*P* Value	Odds Ratio and 95% CI*
Atherton et al[1]	Pain	12	1.18	0.37	3.80	0.28	.78	
Berglund et al[2]	Pain	12	2.57	1.96	3.38	6.77	.00	
Hartling et al[10]	Pain	12	7.97	0.37	169.42	1.33	.18	
Kivioja et al[22]	Pain	12	1.45	0.43	4.85	0.60	.55	
...	...	...	2.43	1.88	3.15	6.72	.00	



DAVID M. WALTON, PT, PhD[1] • JOY C. MACDERMID, PT, PhD[2] • ANTHONY A. GIORGIANNI, BSc, MPT[1]
JOANNA C. MASCARENHAS, BSc, MPT[1] • STEPHEN C. WEST, BSc, MPT[1] • CAROLINE A. ZAMMIT, BSc, MPT[1]

Risk Factors for Persistent Problems Following Acute Whiplash Injury: Update of a Systematic Review and Meta-analysis

TABLE 2

Number of Included Studies and Fail-Safe N for the 9 Significant Predictors Identified in This Meta-analysis*

	Number of Studies	Fail-Safe N
High pain intensity (greater than 5.5/10)†	11	405
Female†	14	109
Report of headache at inception†	5	64
Lower education (less than postsecondary)†	7	48
High NDI (greater than 14.5/50)†	3	39
WAD grade 2 or 3†	5	35
WAD grade 3 (versus 2)	4	18
Preinjury neck pain	8	16
Report of low back pain at inception	3	5

Abbreviations: NDI, Neck Disability Index; WAD, whiplash-associated disorder.

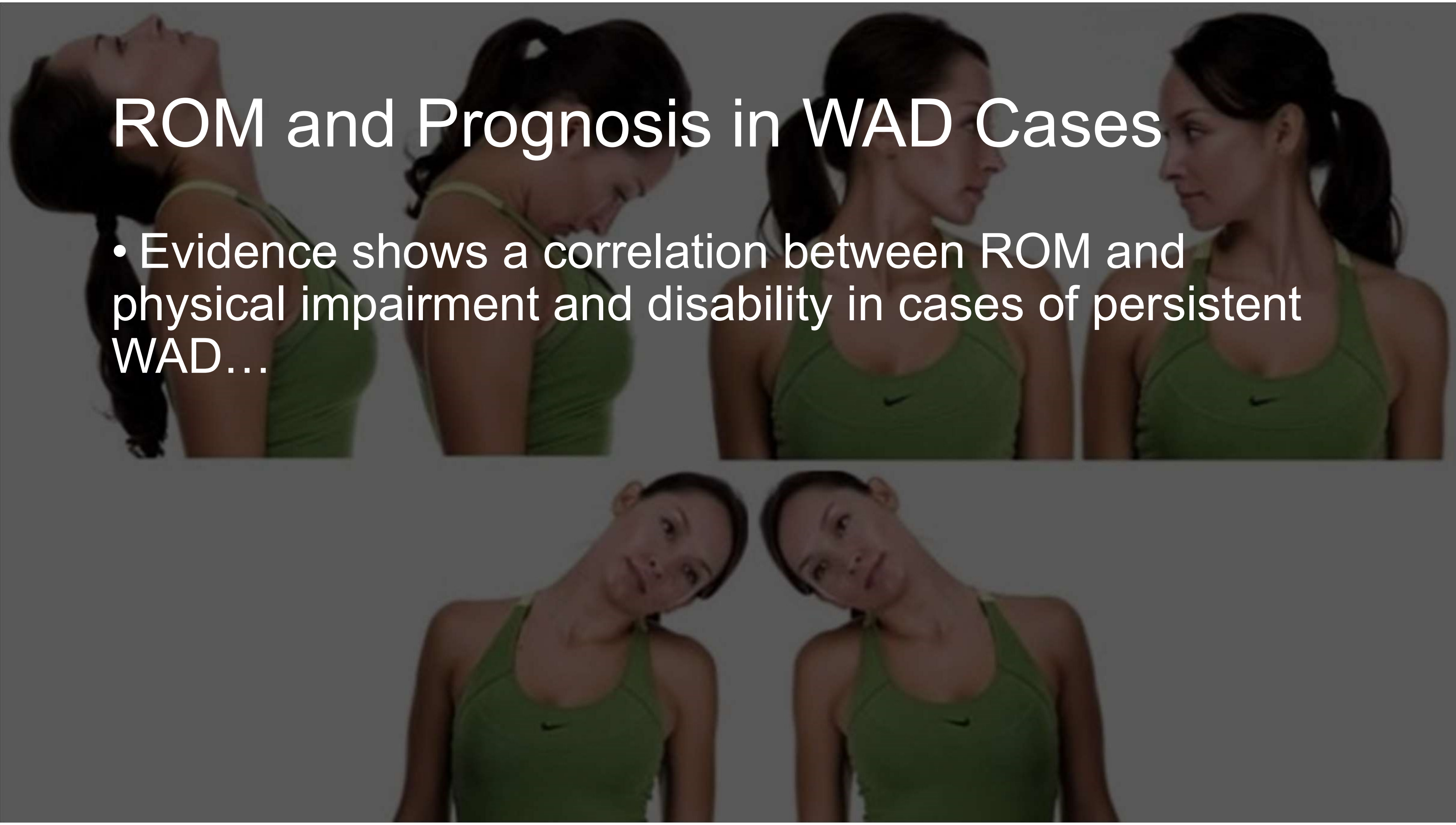
**Fail-safe N is not calculated for nonsignificant predictors. Fail-safe N can be interpreted as the number of studies with negative or nonsignificant results that would need to be included in the database to nullify the positive results found here.*

†Robust to publication bias based on: fail-safe N greater than 5 times the included study's criterion.

4. Initial ROM

ROM and Prognosis in WAD Cases

- Evidence shows a correlation between ROM and physical impairment and disability in cases of persistent WAD…



THE BEHAVIOURAL RESPONSE TO WHIPLASH INJURY

MARTIN GARGAN, GORDON BANNISTER, CHRIS MAIN, SALLY HOLLIS

From Southmead Hospital, Bristol, England

THE JOURNAL OF BONE AND JOINT SURGERY

VOL. 79-B, No. 4, JULY 1997

- Found that reduced ROM **3 months** after whiplash injury was a good predictor of persistent pain and disability **2 years** after injury.
- "Our findings suggest that the symptoms of whiplash injury have both physical and psychological components, and that the psychological response develops **after** the physical damage."
- "Both physical and behavioural responses to these injuries are established in most cases within **three months** of injury. This suggests that the greatest potential for influencing the natural history of the syndrome is within this period."

J Manipulative Physiol Ther. 1997 Sep;20(7):468-75.

A comparison of physical characteristics between patients seeking treatment for neck pain and age-matched healthy people.

Jordan A[1], Mehlsen J, Ostergaard K.

- There is a reduction in primary ROM in persons with WAD, when comparison was made with matched asymptomatic persons.
- “the greatest relative muscular deficiencies seem to be in the extensor muscle group. Additionally, most patients exhibit a significant decrease in active ROM during extension.”

SPINE Volume 26, Number 19, pp 2090–2094

Cervical Range of Motion Discriminates Between Asymptomatic Persons and Those With Whiplash

Paul T. Dall'Alba, BPhty (Hons), Michele M. Sterling, MPhty, Julia M. Treleaven, BPhty, Sandra L. Edwards, MPhtySt, and Gwendolen A. Jull, PhD

- 89 asymptomatic (41 men, 48 women; mean age 39.2 years)
- 114 patients with persistent whiplash-associated disorders (22 men, 93 women; mean age 37.2 years

- The discriminant analysis resulted in correct categorization of 90.3% of participants (sensitivity 86.2%, specificity 95.3%)

- “The results of the present study indicate that ROM was a significant discriminator between asymptomatic persons and those with persistent WAD. This discriminative ability strengthens the case for using ROM as an indicator of physical impairment.”

RESEARCH ARTICLE

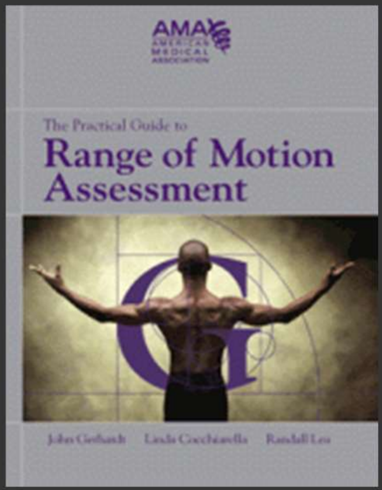
Reproducibility and Validity of Digital Inclinometry for Measuring Cervical Range of Motion in Normal Subjects

Tamara Prushansky*, Orly Deryi & Bahaa Jabarreen

Physiother. Res. Int. 15 (2010) 42–48 © 2009 John Wiley & Sons, Ltd.

- 15 healthy men and 15 healthy women
- Compared Zebris vs dual digital inclinometry (DI) CROM obtained 2 times, 7 days apart
- No significant differences (Coefficient of Variations) were found between the Zebris- and DI measures
- No significant difference in test-retest values of DI
- ICC’s for individual movements ranged from 0.82-0.94

AMA Guides 5th ed



AMA Guides 5th ed

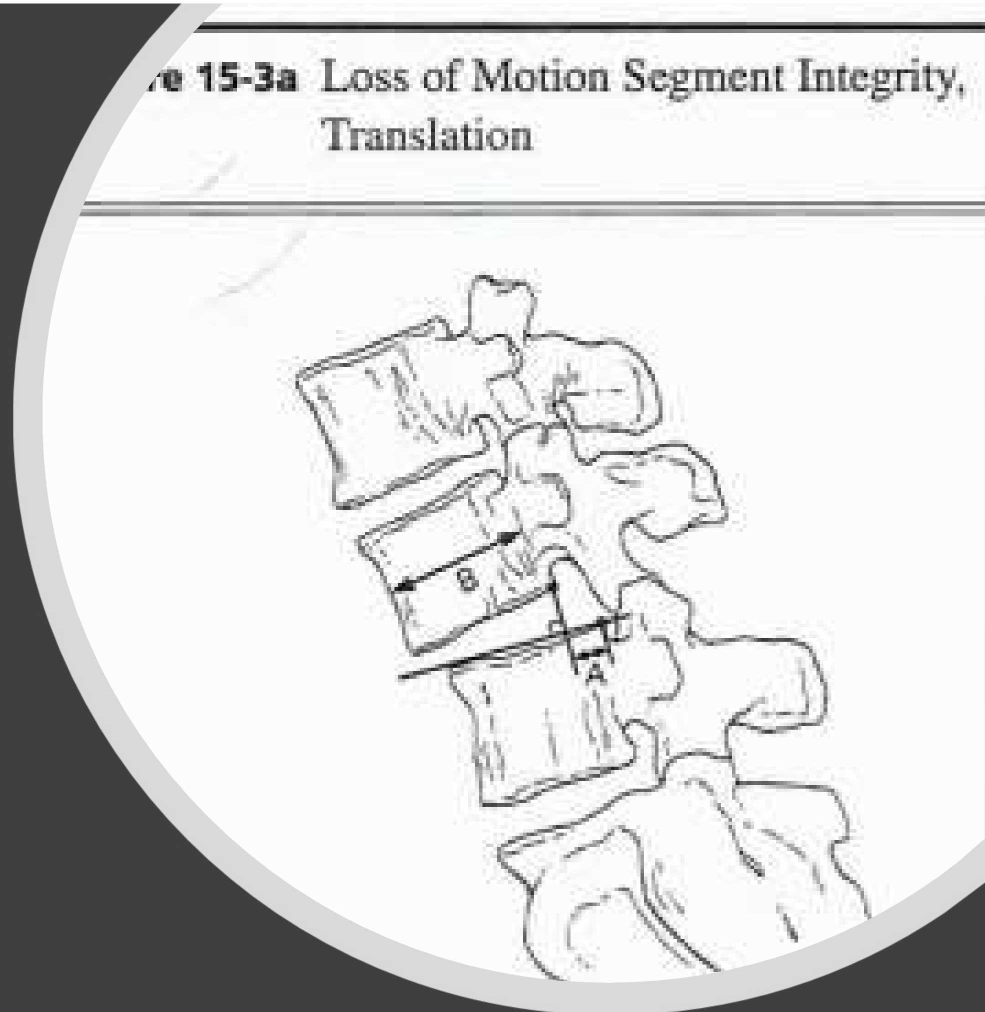
- DRE (Diagnosis-Related Estimate) vs ROM method
- Only “Rate” an individual when they have reached MMI
- Use ROM method when condition is NOT caused by an injury or when an injury is not well represented by a DRE category

AMA Guides 5^{th} ed

- Use ROM method for injuries to more than one level in same spinal region and in certain individuals with recurrent pathology
- Use ROM method if cause of condition cannot be determined

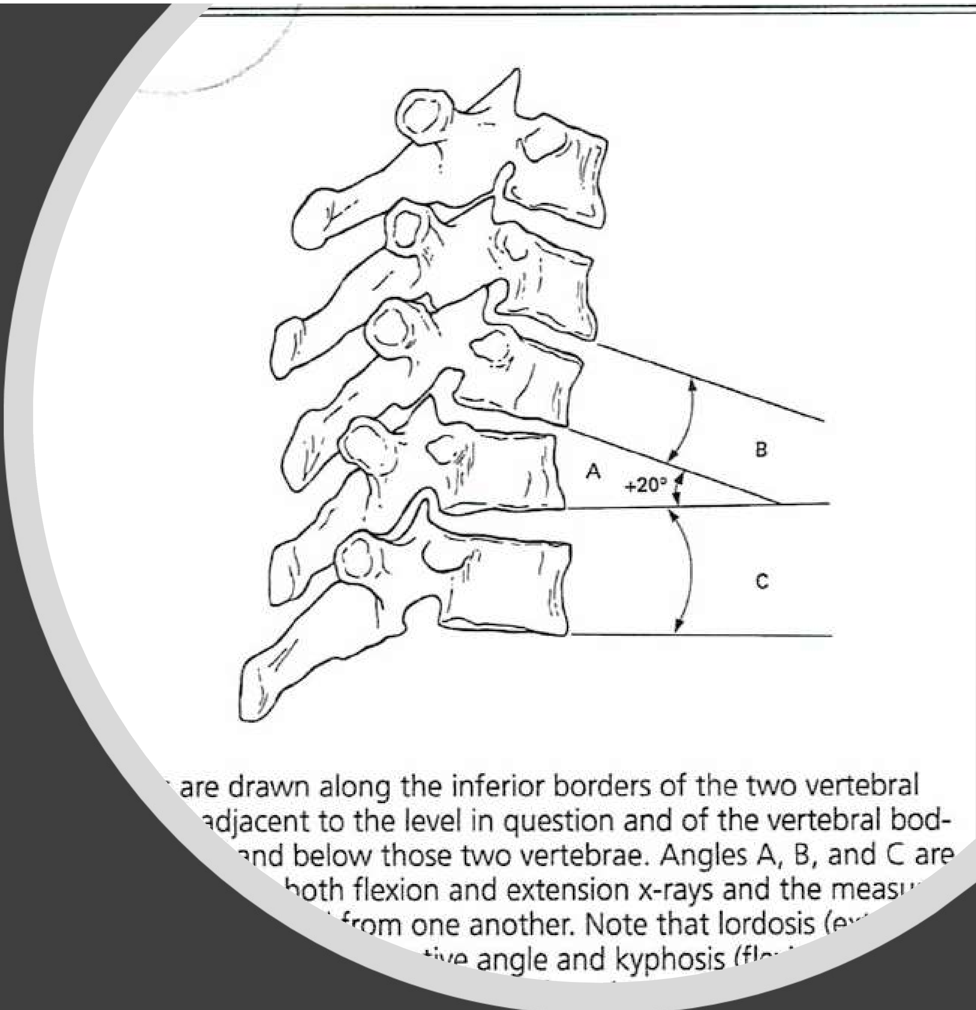
AMA Guides 5th ed

- Loss of Motion Segment Integrity, Translation
  - >3.5 mm cervical
  - >2.5 mm thor
  - >4.5mm lumb
- DRE Category IV (25-28%) or V (35-38%)



AMA Guides 5th ed

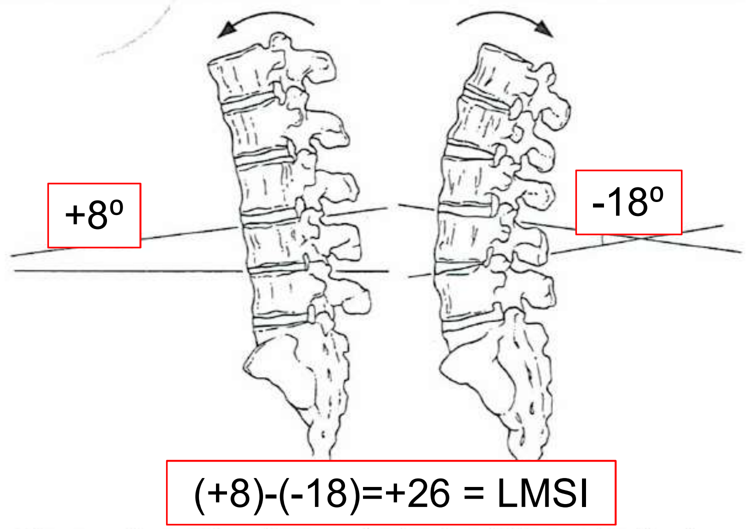
- Loss of Motion Segment Integrity, Rotation
- 11º cervical
- DRE Category IV (25-28%) or V (35-38%)



AMA Guides 5^{th} ed

- Loss of Motion Segment Integrity, Rotation
- >15º @ L1/2, L2/3, L3/4
- >20º @ L4/5
- >25º @ L5/S1
- DRE Category IV (20%)

Figure 15-3b Loss of Motion Segment Integrity, Angular Motion (Sagittal Rotation), Lumbar Spine



Lines are drawn along the superior border of the vertebral body of the lower vertebrae and the superior border of the body of the upper vertebrae and the lines extended until they join. The angles are measured and subtracted. Note that lordosis (extension) is represented by a negative angle and kyphosis (flexion) by a positive angle. Loss of motion segment integrity is defined as motion greater than 15° at L1-2, L2-3, and L3-4 and greater than 20° at L4 to L5. Loss of integrity of the lumbosacral joint is defined as angular motion between L5 and S1 that is greater than 25°. The flexion angle is +8° and the extension angle is –18°. Therefore (+8) – (–18) = +26° and would qualify for loss of structural integrity at any lumbar level.

AMA Guides 5th ed

- ROM Method—3 Components:
  - ROM of spine region
  - Accompanying Dx (Table 15.7)
  - Any spinal nerve deficit

- Whole person impairments obtained by combining all 3 components (p602)
- Must have permanent anatomic and/or physiologic residual dysfunction

AMA Guides 5th ed

- ROM Method—DUAL Inclinometry
  - Mandatory Warm-Up
    - 2x Flex/Ext 2x Lat Flex 2x Axial Rot 1x Flex/Ext
  - 3 Consecutive measurements-take average
  - If avg measure is <50°, all 3 must fall within 5° of the mean
  - If avg measure is >50°, all 3 must fall within 10% of the mean
  - Repeat test until consistency is obtained (max of 6 attempts)

AMA Guides 5th ed

- ROM Method—DUAL Inclinometry
  - Use maximum motion for each movement from a valid set to use in the AMA Tables
  - Combine ROM, Dx, nerve deficit for EACH region, if applicable and combine using p. 604

Measuring Cervical ROM—Age Factor

Spine (Phila Pa 1976). 2009 Aug 15;34(18):1910-6. doi: 10.1097/BRS.0b013e3181afe826.

Active head and cervical range of motion: effect of age in healthy females.

Tommasi DG[1], Foppiani AC, Galante D, Lovecchio N, Sforza C.

- Three groups of females were compared:
  - 22 aged 15 to 18 years (adolescents),
  - 25 aged 20 to 30 years (young adults), and
  - 16 aged 35 to 45 years (mid-aged women).
- Used Optoelectric Measurement
- **CONCLUSION:** In healthy females, between 15 and 45 years old, cervical ROM in the principal planes decrease (except for rotation), but these variations are NOT statistically significant ($P > 0.05$).

Research Report

Normal Range of Motion of the Cervical Spine: An Initial Goniometric Study

Physical Therapy / Volume 72, Number 11/November 1992

James W Youdas
Tom R Garrett
Vera J Suman
Connie L Bogard
Horace O Hallman
James R Carey

- 337 healthy volunteers
- 171 females and 166 males
- Ranging in age from 11 to 97 years
- 40 subjects (20 females and 20 males) in each of the nine age groups, except for the 90- to 97-year-old age group (14 subjects)

Table 2. *Descriptive Statistics for Active Range of Motion (AROM) of Neck Extension and Left and Right Lateral Flexion of the Neck*

Age Group (y)	No. of Subjects	AROM (°) Extension $\bar{X}$	SD	Range	Left $\bar{X}$	SD	Range	Right $\bar{X}$	SD	Range
11–19										
Male	20	85.6	11.5	61–106	46.3	6.7	33–60	44.8	7.7	30–66
Female	20	84.0	14.9	56–110	46.6	7.3	35–60	48.9	7.1	35–62
20–29										
Male	20	76.7	12.8	60–108	41.4	7.1	30–58	44.9	7.2	34–58
Female	22	85.6	10.6	65–111	42.8	4.6	34–56	46.2	6.7	30–56
30–39										
Male	20	68.2	12.8	36–92	41.2	10.3	20–60	42.9	8.5	27–58
Female	21	78.0	13.8	52–102	43.6	7.9	30–60	46.5	8.4	32–62
40–49										
Male	20	62.5	12.2	40–90	35.6	8.0	18–53	38.0	10.9	18–63
Female	22	77.5	13.2	45–102	40.8	9.3	20–58	42.5	9.2	30–65
50–59										
Male	20	59.9	10.4	39–74	34.9	6.6	22–48	35.6	5.4	26–44
Female	20	65.3	16.0	30–98	35.1	6.0	18–42	37.3	6.8	20–50
60–69										
Male	20	57.4	10.5	42–82	30.4	4.7	20–39	29.8	5.4	20–38
Female	20	65.2	13.3	44–90	34.4	8.1	22–50	32.7	9.6	12–49
70–79										
Male	20	53.7	14.4	20–86	25.0	8.4	10–38	25.8	7.3	16–39
Female	20	54.8	10.2	34–70	26.9	6.7	16–40	27.7	7.3	19–50
80–89										
Male	20	49.4	11.5	28–68	23.5	6.8	14–43	23.8	6.2	16–37
Female	18	50.3	14.5	20–72	22.6	7.1	10–40	26.3	5.7	16–38
90–97										
Male	6	52.3	17.2	22–68	22.0	6.6	14–30	22.2	9.1	11–30
Female	8	54.5	18.1	20–74	26.6	8.1	12–38	22.6	7.2	12–32

Table 3. *Descriptive Statistics for Active Range of Motion (AROM) of Left and Right Rotation of the Neck*

Age Group (y)	No. of Subjects	AROM (°) Left $\bar{X}$	Left SD	Left Range	Right $\bar{X}$	Right SD	Right Range
11–19							
Male	20	72.3	7.0	55–88	74.1	7.6	56–92
Female	20	70.5	9.8	50–88	74.9	9.8	52–94
20–29							
Male	20	69.2	7.0	52–83	69.6	6.0	59–80
Female	22	71.6	5.7	62–85	74.6	5.9	62–85
30–39							
Male	20	65.4	9.1	50–82	67.1	7.4	50–78
Female	21	65.9	8.1	52–84	71.7	5.7	60–78
40–49							
Male	20	62.0	7.6	44–74	64.6	9.6	45–78
Female	22	64.0	7.9	50–80	70.2	6.6	56–83
50–59							
Male	20	58.0	8.8	40–70	61.0	7.7	40–72
Female	20	62.8	8.4	40–74	61.2	8.6	42–75
60–69							
Male	20	56.6	6.7	40–66	53.6	7.4	37–63
Female	20	59.7	9.1	36–70	65.2	9.7	35–80
70–79							
Male	20	49.7	8.8	30–64	50.0	10.2	28–68
Female	20	50.1	7.9	39–61	53.4	8.8	30–68
80–89							
Male	20	46.8	9.2	31–70	46.4	8.2	28–63
Female	18	50.5	10.7	32–70	52.6	10.5	30–70
90–97							
Male	6	45.2	16.8	26–74	44.2	14.3	26–67
Female	8	53.5	7.5	46–70	51.8	8.7	45–72

Cervical ROM in Elderly

Arch Phys Med Rehabil. 1993 Oct;74(10):1071-9.

Cervical range of motion in the elderly.

Kuhlman KA[1].

Author information

Abstract

This study was conducted to establish normative cervical range of motion values for the elderly and to compare those values to standard young adult cervical range of motion values. Differences in range of motion between men and women were also assessed. A gravity goniometer was used to measure six cervical motions in 42 subjects aged 70 to 90 years and 31 subjects aged 20 to 30 years. The elderly group had significantly less motion than the younger group for all six motions measured ($p < .001$). A comparison of the mean range of motion values between the two groups found that the elderly group had approximately 12% less flexion, 32% less extension, 22% less lateral flexion, and 25% less rotation. The elderly group also had a wider variation of cervical range of motion values as compared to the younger group. Women had greater cervical range of motion values than men in both age groups.

Cervical ROM—Testing Protocol

Physiother Res Int. 2002;7(3):136-45.

The effect of measurement protocol on active cervical motion in healthy subjects.

Dvir Z[1], Werner V, Peretz C.

- Used an ultrasound-based system
- Protocol A: reciprocal-intermittent testing (pause @ neutral)
- Protocol B: reciprocal-continuous testing (no pause)
- Protocol C: consisted of three repetitions of the same primary direction with a break between two consecutive primary directions.
- Protocol D: Three sets of six randomly ordered primary directions
- CONCLUSION: A, B, C all okay. Protocol D underestimates

What About ROM Tests that are Normal? Who does that help?

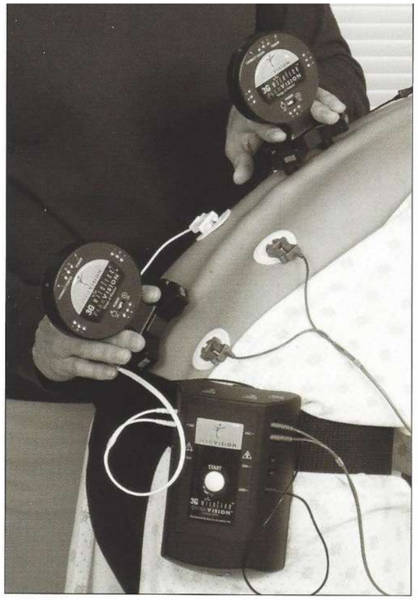
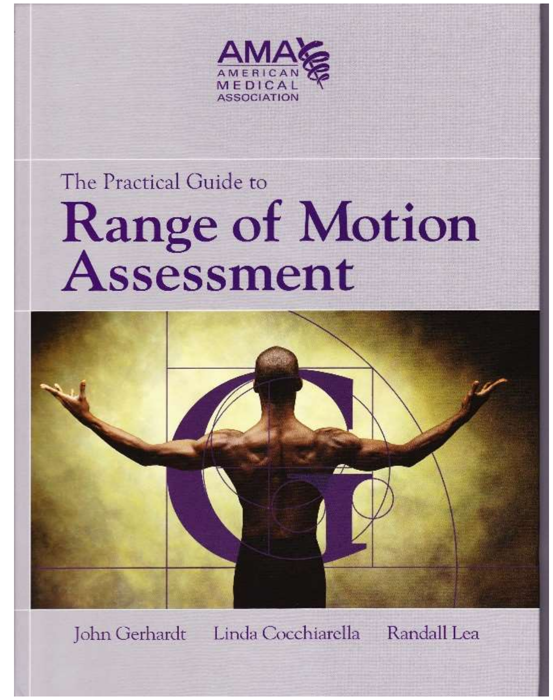


FIGURE 2-27
Measuring lumbar spine flexion. Position and stabilization of the electronic wireless dual inclinometers and placement of the S-EMG with electrodes are shown.

"…has achieved a level of medical acceptance as a valuable diagnostic tool for injuries of the spine and upper and lower back"

DONE AND ORDERED!

Diane Cleavinger
DIANE CLEAVINGER
Administrative Law Judge

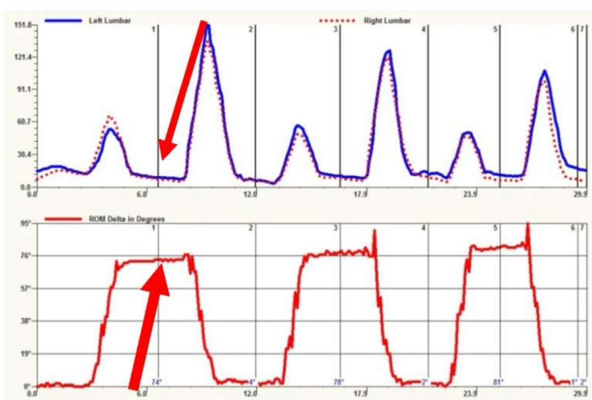


DynaROM: Establishing need for care, with normal MRI, normal CT, Normal X-rays and Normal ROM

ROM, sEMG & WAD

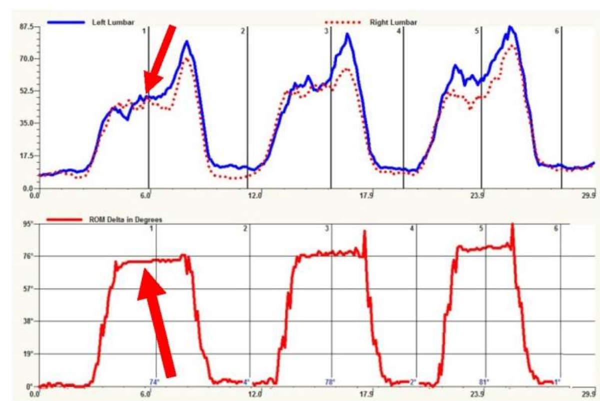
Combine Range of Motion and Dynamic sEMG shows ROM & Muscle Guarding: Crucial to "Seal" the Case.

Normal Range of Motion, No bracing (normal sEMG)



Top graph shows Lumbar Muscle activity, Bottom graph shows Range of Motion: Graph to right proves that normal ROM can be accompanied with guarding and bracina& iniurv

Normal ROM, Abnormal Muscle Bracing: Establishes ROM without Dynamic sEMG ("guarding" lacks clinical accuracy



The ability of the device to evaluate for “soft tissue injury”: Patented !!!!

(12) **United States Patent**
Marcarian

(10) **Patent No.: US 9,808,172 B2**
(45) **Date of Patent: Nov. 7, 2017**

(54) **SYSTEMS AND METHODS FOR PERFORMING SURFACE ELECTROMYOGRAPHY AND RANGE-OF-MOTION TEST**

(75) Inventor: **David Marcarian**, Seattle, WA (US)

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,320,767	A *	3/1982	Villa-Real	600/493
4,492,029	A *	1/1985	Tanaka et al.	33/366.14

(Continued)

(57) **ABSTRACT**

A soft-tissue-injury diagnostic system for diagnosing soft tissue injury within a patient includes a set of hand-held inclinometers configured and arranged for measuring angles formed between a first inclinometer disposed in proximity to a patient joint and a second inclinometer disposed distal to the joint during controlled patient movements of the joint. A plurality of measuring electrodes are coupleable in proximity to the patient's spine along the body portion that moves along the joint. The measuring electrodes are configured and arranged for measuring action potentials along patient muscle groups during the controlled patient movements of the joint and transmitting the measured action potentials to a dynamic surface electromyograph ("sEMG") module. A hub receives and processes data from the inclinometers and the dynamic sEMG module. A visual display is configured and arranged for receiving and displaying the processed data.

Flexion-Relaxation Phenomenon

THE LANCET
Volume 257, Issue 6647, 20 January 1951, Pages 133-134

ORIGINAL ARTICLES

FUNCTION OF ERECTORES SPINÆ IN FLEXION OF THE TRUNK

W.F. Floyd B.Sc. Lond., F.Inst.P., A.M.I.E.E. (SENIOR LECTURER IN PHYSIOLOGY), P.H.S. Silver M.B. Lond. (SENIOR DEMONSTRATOR OF ANATOMY)

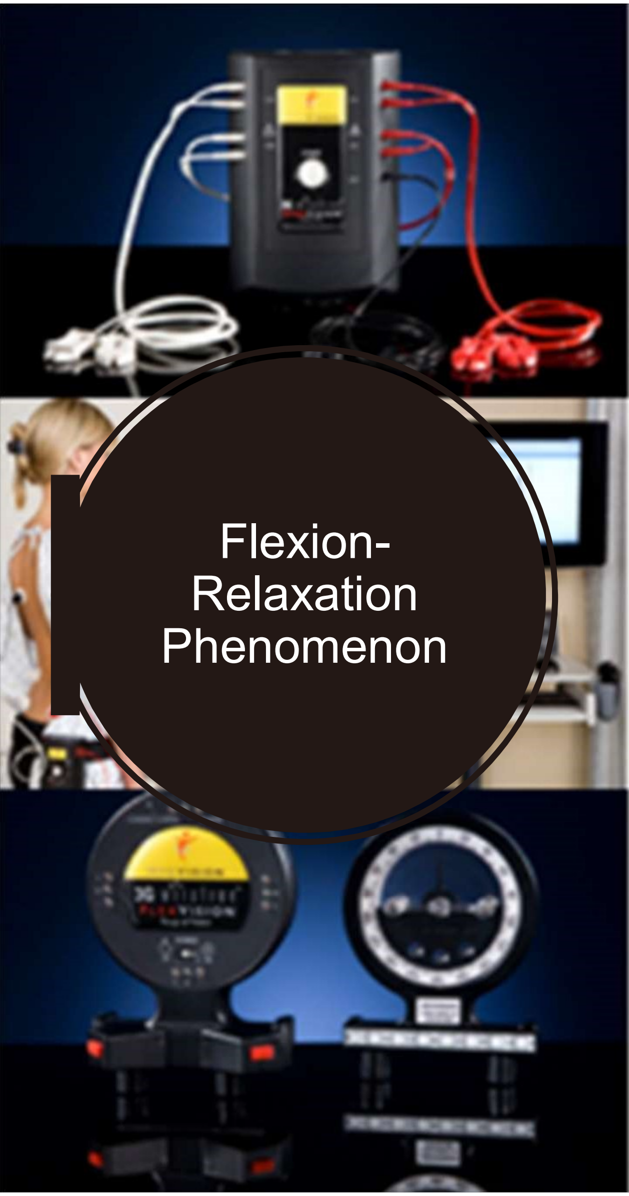
The Journal of Physiology
Volume 129, Issue 1, 28 July 1955, Pages 184-203

The function of the erectores spinae muscles in certain movements and postures in man (Article)

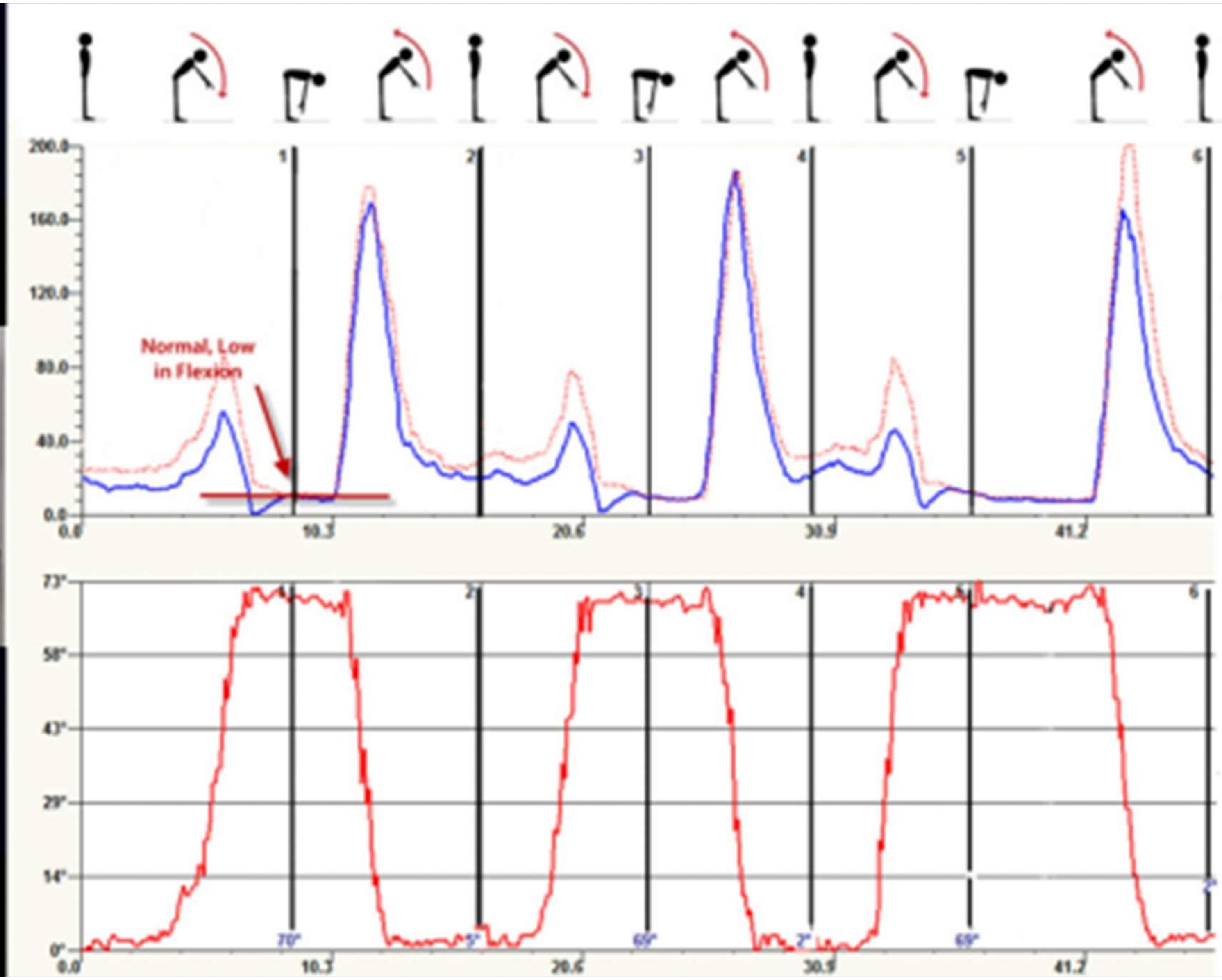
Floyd, W.F., Silver, P.H.S.

Flexion-Relaxation Phenomenon

- The flexion–relaxation (FR) phenomenon, a normal pattern in muscle activation, originates from the lumbar region and is defined as an electrical silence response in the erector spinae muscles during a full forward-bending trunk posture (Floyd and Silver, 1951).
- The causes of this phenomenon were seen as transferring extensor moment from superficial erector spinae to passive paraspinal structures or deep muscle such as quadratus lumborum.



Flexion-Relaxation Phenomenon



Pain-Related Fear, Lumbar Flexion, and Dynamic EMG Among Persons With Chronic Musculoskeletal Low Back Pain

Michael E. Geisser, PhD, Andrew J. Haig, MD,*† Agnes S. Wallbom, MD,* and Elizabeth A. Wiggert, PT**

Clin J Pain • Volume 20, Number 2, March/April 2004

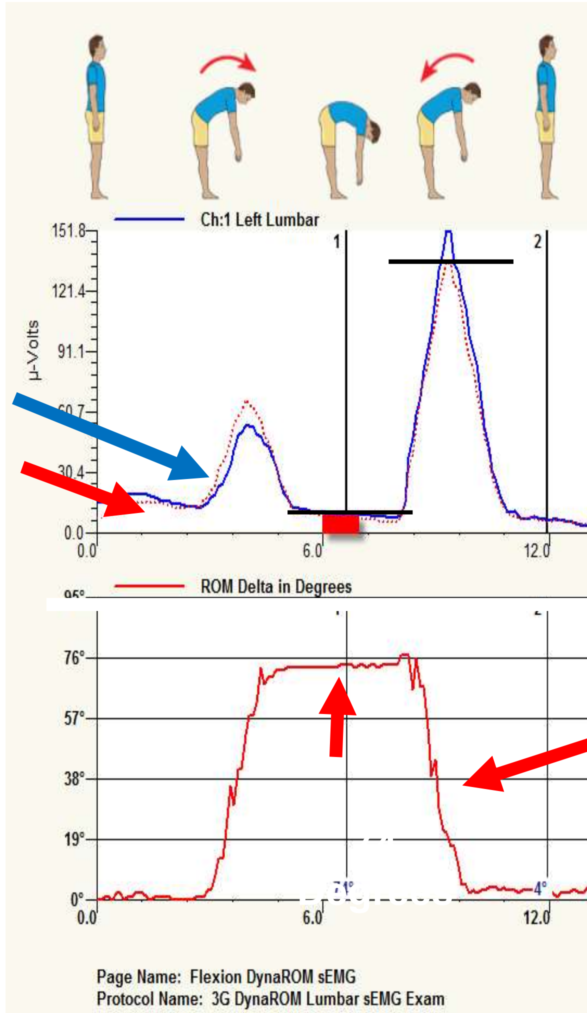
- Explore the relationship between pain-related fear, angle of flexion, and EMG activity
- Pain-related fear is significantly associated with decreased lumbar flexion in persons with CLBP
- Pain-related fear influences the FRR both through its association with maximal muscle activity during flexion, as well as increased muscle activity in full flexion

Attached Electrode Dynamic sEMG

Left Lumbar Blue, Right Lumbar Red

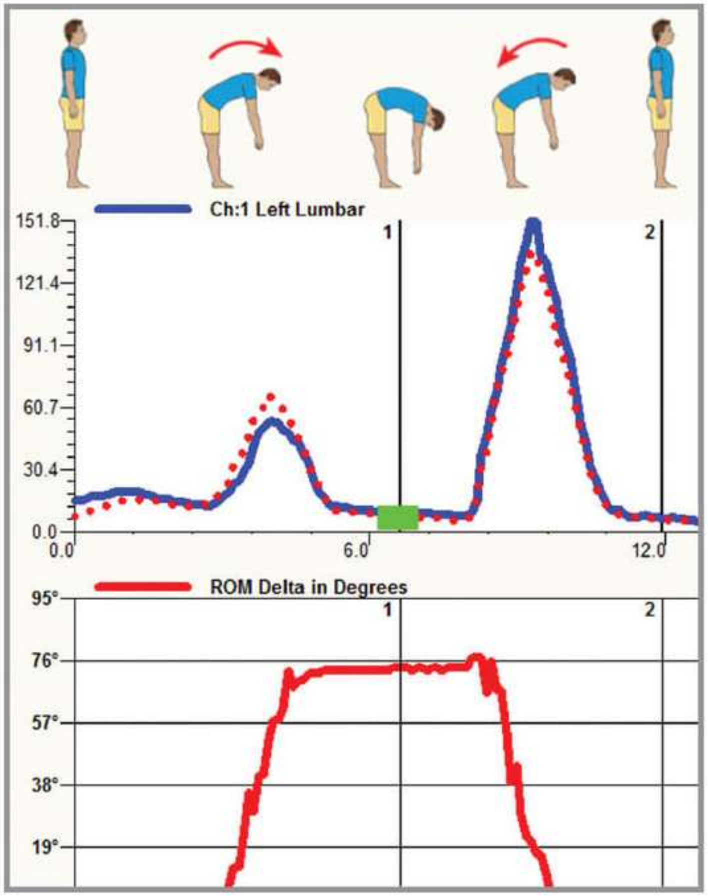
Graphed Range of Motion.

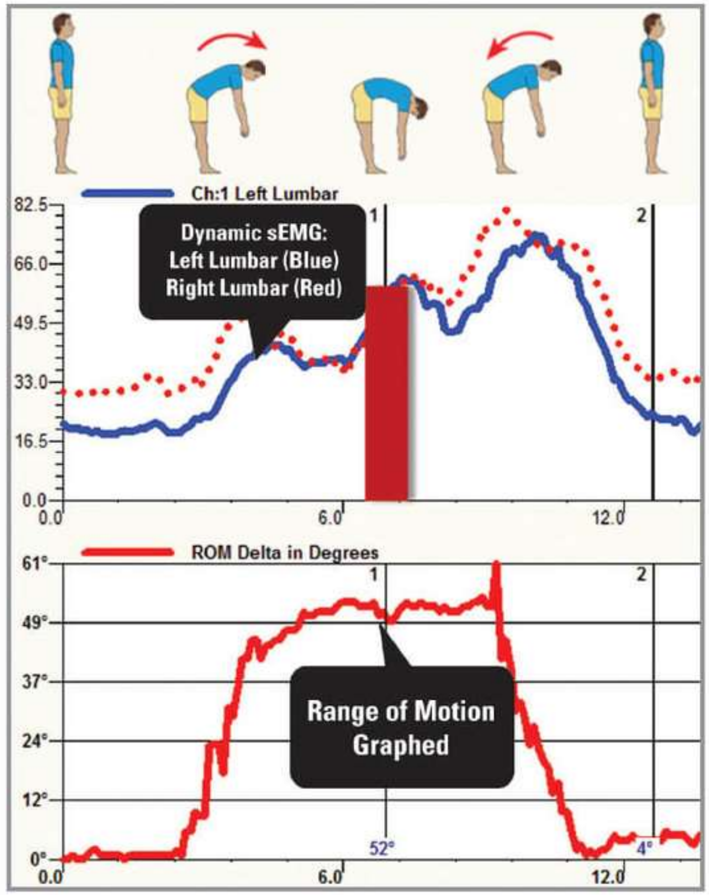
Shows "Quality" of Motion, not just end point value.



FR Ratio (FRR):
Mean at extension
TO
Mean at FR
(N=3:1 to 4:1)

Show Guarding and Pain Even if End-ROM Point is Normal





Eur Spine J (2013) 22:162–168
DOI 10.1007/s00586-012-2517-3

ORIGINAL ARTICLE

A comparative investigation of flexion relaxation phenomenon in healthy and chronic neck pain subjects

Nader Maroufi · Amir Ahmadi ·
Seyedeh Roghayeh Mousavi Khatir

- 22 women with chronic neck pain (VAS 20.9 mm) vs 21 healthy controls
- Avg age 23 yo, avg cervical flexion 50° and 51°
- Measured ROM using electrogoniometers simultaneously with and SEMG on cervical erector spinae

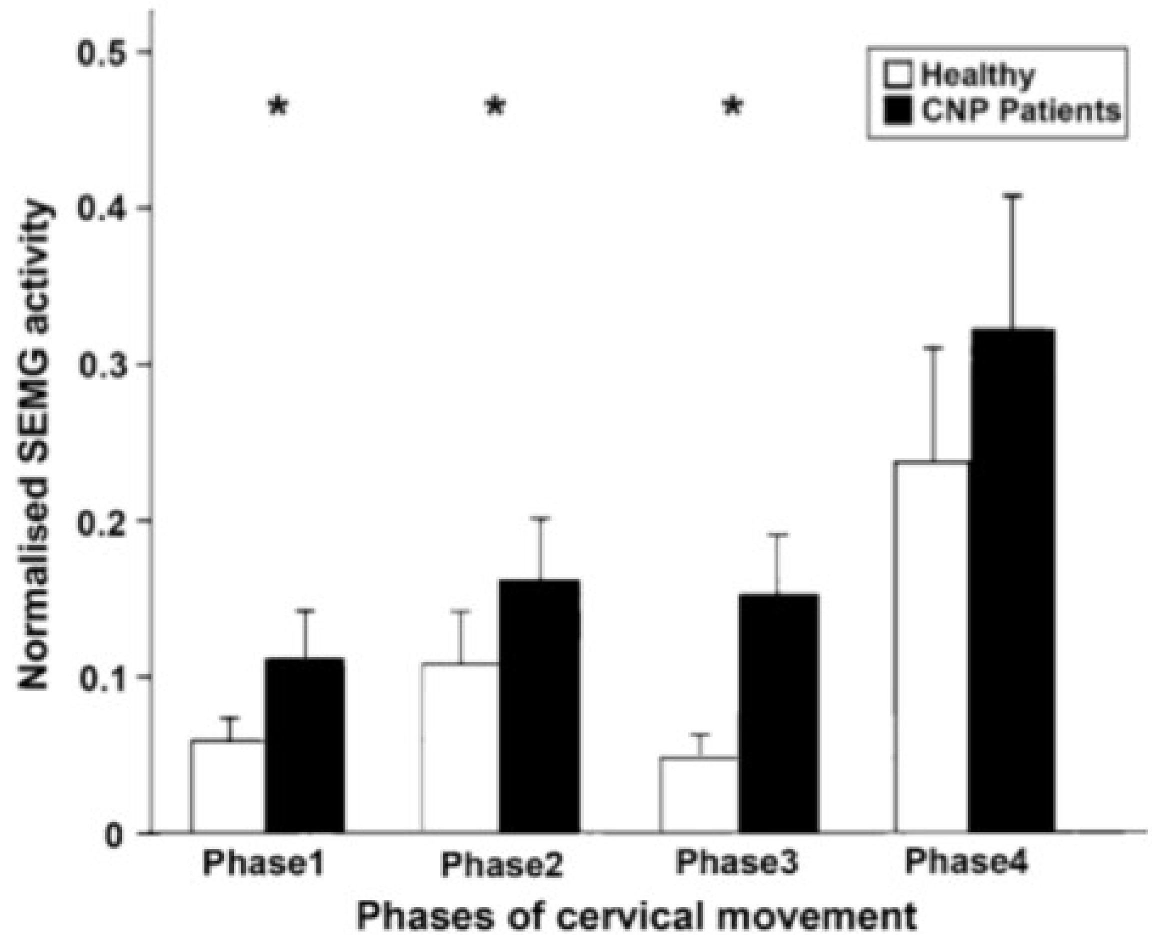


Fig. 3 Normalised SEMG activity of CES muscles in different phases of movement. *Phase 1* Maintain the starting position. *Phase 2* Complete cervical flexion. *Phase 3* Sustain cervical full flexion. *Phase 4* Extension with return to the starting position

Journal of Electromyography and Kinesiology 26 (2016) 8–17

Contents lists available at ScienceDirect

Journal of Electromyography and Kinesiology

journal homepage: www.elsevier.com/locate/jelekin

Flexion–relaxation ratio in computer workers with and without chronic neck pain

Carina Ferreira Pinheiro [a,b,1], Marina Foresti dos Santos [a,c,1], Thais Cristina Chaves [a,b,d,*,1]

Cervical Flexion-Relaxation Phenomenon

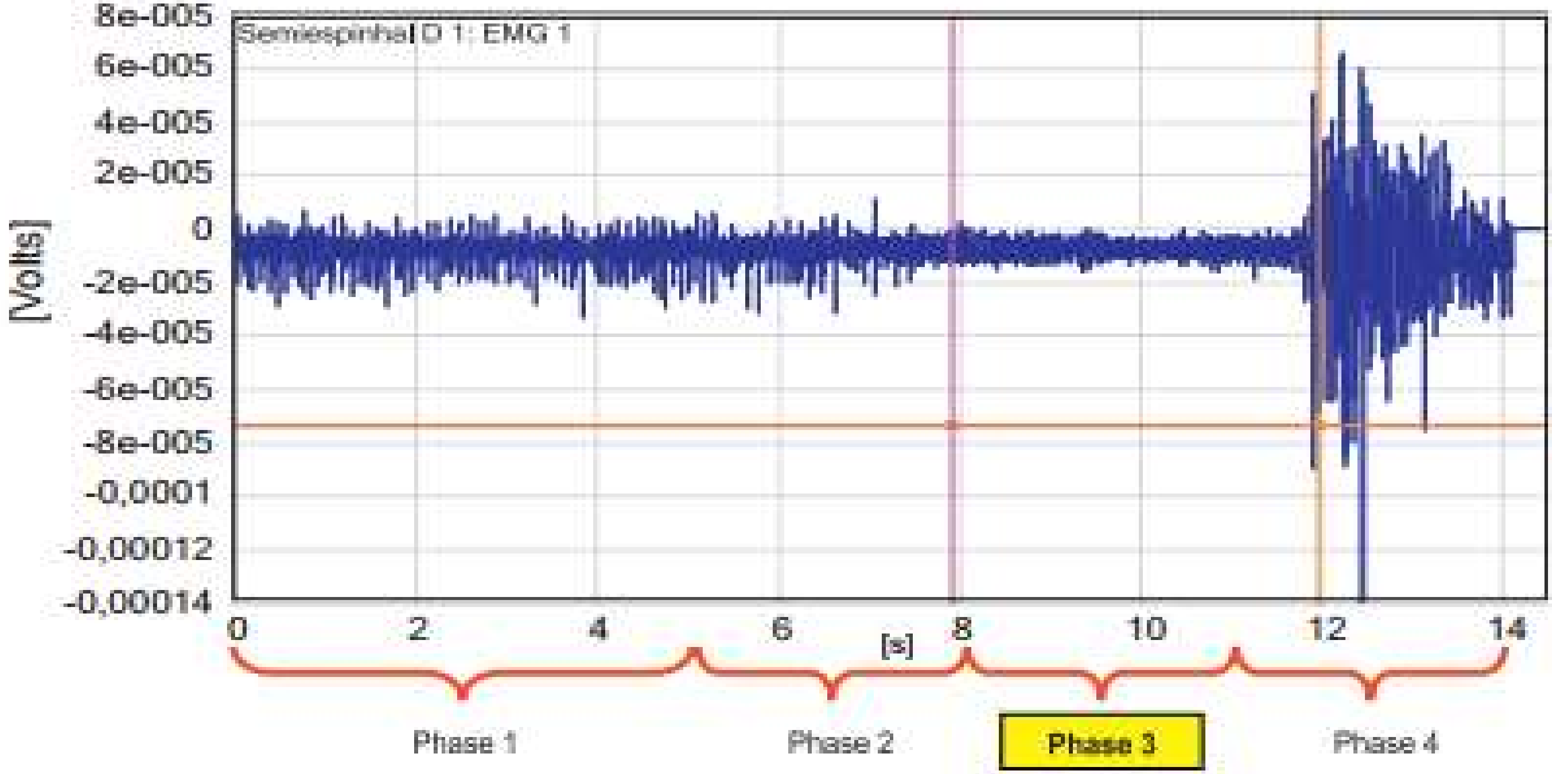


Fig. 2. Electromyography signal showing task phases and flexion–relaxation phenomenon during the 3-s full flexion hold phase (phase 3). Phases: Phase 1 – Rest (5 s); Phase 2 – Flexion (3 s); Phase 3 – Full Flexion (3 s); Phase 4 – Re-extension (3 s).

Journal of
PHYSIOLOGICAL
ANTHROPOLOGY

Relationship between Active Cervical Range of Motion and Flexion–Relaxation Ratio in Asymptomatic Computer Workers

Won-Gyu Yoo[1], Se-Yeon Park[2] and Mi-Ra Lee[3]

1) Department of Physical Therapy, College of Biomedical Science and Engineering, Inje University, Republic of Korea
2) Department of Physical Therapy, The Graduate School, Inje University, Republic of Korea
3) Department of Physical Therapy, Dong Rae Wooridul Hospital and Department of Physical Therapy & The Graduate School, Inje University, Republic of Korea

- 20 asymptomatic male computer workers
- Average age 23

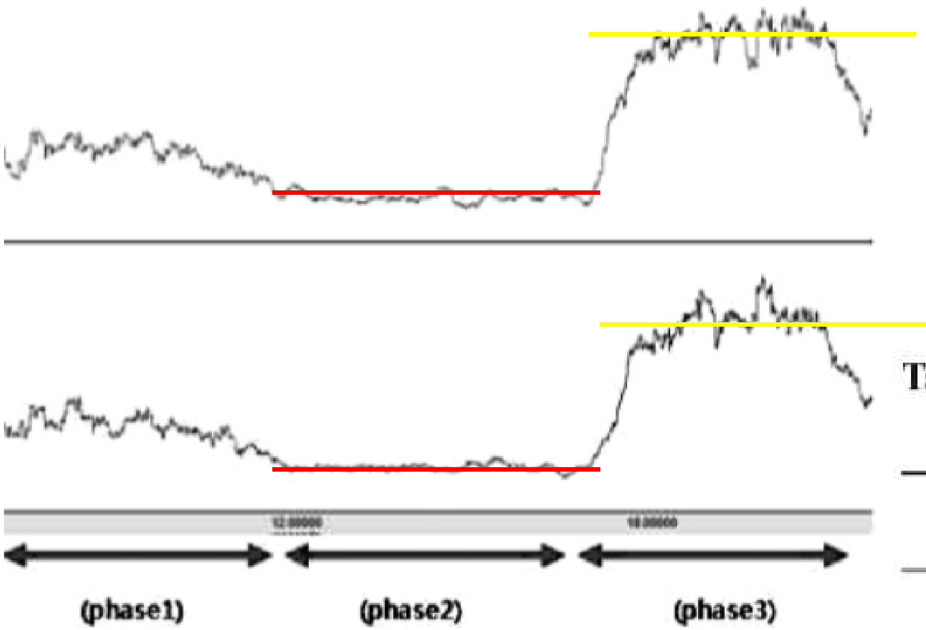


Table 1 Descriptive statistics for the active cervical range of motion and the FR ratio

Cervical range of motion	Mean±SD
Flexion	59.2±12.9
Extension	68.4±8.0
Right lateral flexion	42.7±8.0
Left lateral flexion	46.6±10.1
Right rotation	64.5±10.3
Left rotation	69.3±7.9
FR ratio	**Mean±SD**
Right side	2.60±1.11
Left side	2.54±1.08

Original Article

Comparison of Cervical Range of Motion and Cervical FRR between Computer Users in Their Early and Late 20s in Korea

Won-gyu Yoo[1)]

J. Phys. Ther. Sci.
26: 753–754, 2014

- Small study comparing asymptomatic computer users in early 20’s vs late 20’s
- The cervical FRR in the late 20s computer users (1.2±4.8) was significantly lower compared with the cervical FRR in the early 20s computer users (2.2±1.0).
- Cervical flexion (degrees) was equal between groups

Clinical Biomechanics 29 (2014) 277–282

Contents lists available at ScienceDirect

Clinical Biomechanics

ELSEVIER

journal homepage: www.elsevier.com/locate/clinbiomech

Impact of shoulder position and fatigue on the flexion–relaxation response in cervical spine

Ashish D. Nimbarte *, Majed Zreiqat, Xiaopeng Ning

- FRP doesn't occur in shrugged shoulder position
- Induced fatigue (Sorenson protocol) causes earlier onset of FRP

Nimbarte, et al, 2014

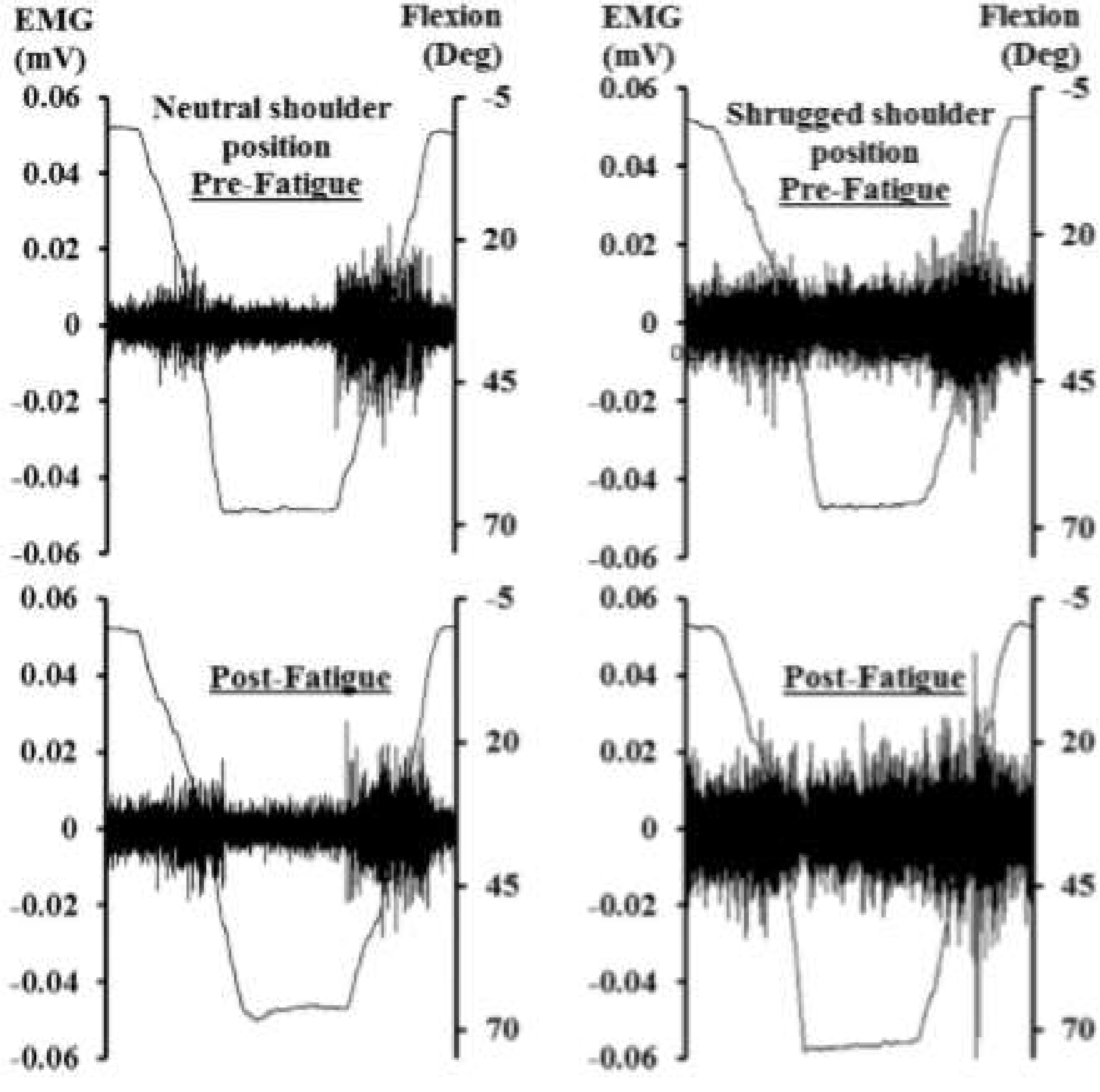


Fig. 2. Raw EMG and head flexion extension data for one of the subjects during four experimental conditions.

Pialasse *et al. BMC Musculoskeletal Disorders* 2010, **11**:46
http://www.biomedcentral.com/1471-2474/11/46

BMC Musculoskeletal Disorders

RESEARCH ARTICLE Open Access

Load and speed effects on the cervical flexion relaxation phenomenon

Jean-Philippe Pialasse[1,3*], Danik Lafond[1], Vincent Cantin[1], Martin Descarreaux[2]

- Studying the load and speed on cervical FRP EMG and kinematic parameters
  - 5s,3s,5s vs 2s,3s,2s
- Also assessed FRP repeatability
- Load affected FRP, speed had no effect
- Moderate to excellent repeatability for the kinematics was observed in all phases

Spine (Phila Pa 1976). 2010 Nov 15;35(24):2103-8. doi: 10.1097/BRS.0b013e3181cbc7d8.

The cervical flexion-relaxation ratio: reproducibility and comparison between chronic neck pain patients and controls.

Murphy BA[1], Marshall PW, Taylor HH.

- 14 Chronic NP vs 14 control (no neck pain)
- Measured at baseline and 4 weeks later
- Pain gr: FRR=1.93 +/-0.8, and 1.73 +/-0.61 at 4-wks
- Pain gr: intraclass correlation coefficient (ICC) was 0.83 (95% CI 0.67–0.92)
- Control gr: FRR=4.09 +/-1.58 at baseline and 4.27 +/-.71 on retest 4 weeks late
- Control gr: ICC was 0.89 (95% confidence interval 0.76–0.95)

Spine (Phila Pa 1976). 2010 Nov 15;35(24):2103-8. doi: 10.1097/BRS.0b013e3181cbc7d8.

The cervical flexion-relaxation ratio: reproducibility and comparison between chronic neck pain patients and controls.

Murphy BA[1], Marshall PW, Taylor HH.

- "The cervical extensor muscles exhibit a consistent flexion-relaxation phenomenon in healthy control subjects and the measurement is **highly reproducible** when measured 4 weeks apart in both controls and chronic neck pain patients."
- "The FRR in neck pain patients is significantly higher than in control subjects suggesting that this measure may be a useful marker of altered neuromuscular function."

Journal of Chiropractic Medicine (2016) 15, 102–111

ELSEVIER

JOURNAL of CHIROPRACTIC MEDICINE

www.journalchiromed.com

Novel Electromyographic Protocols Using Axial Rotation and Cervical Flexion-Relaxation for the Assessment of Subjects With Neck Pain: A Feasibility Study

James W. DeVocht, DC, PhD [a,*], Kalyani Gudavalli, PT, MS [b], Maruti R. Gudavalli, PhD [c], Ting Xia, PhD [d]

Devocht, et al 2016…

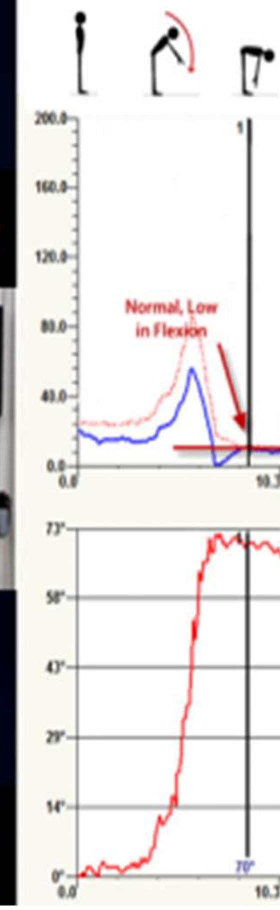
- Cervical FRP was conducted as reported in the literature with the participants seated, except that they started with the head fully flexed instead of being erect.
- Data were also collected with participants laying prone, starting with their head hanging over the edge of the table.
- Additional data were collected from cervical paraspinal and sternocleidomastoid (SCM) muscles while the seated participants rotated their head fully to the right and left.

Devocht, et al 2016…

Fig 1. Participant performing axial rotation to the left showing the EMG electrodes attached for the right paraspinal and sternocleidomastoid muscles with the ground attached over the right clavicle.

Used MyoVision sEMG technology w/out ROM

Fig 2. Participant in the starting prone position for flexion-relaxation with the head over the end of the table and fully relaxed.



Devocht, et al 2016…

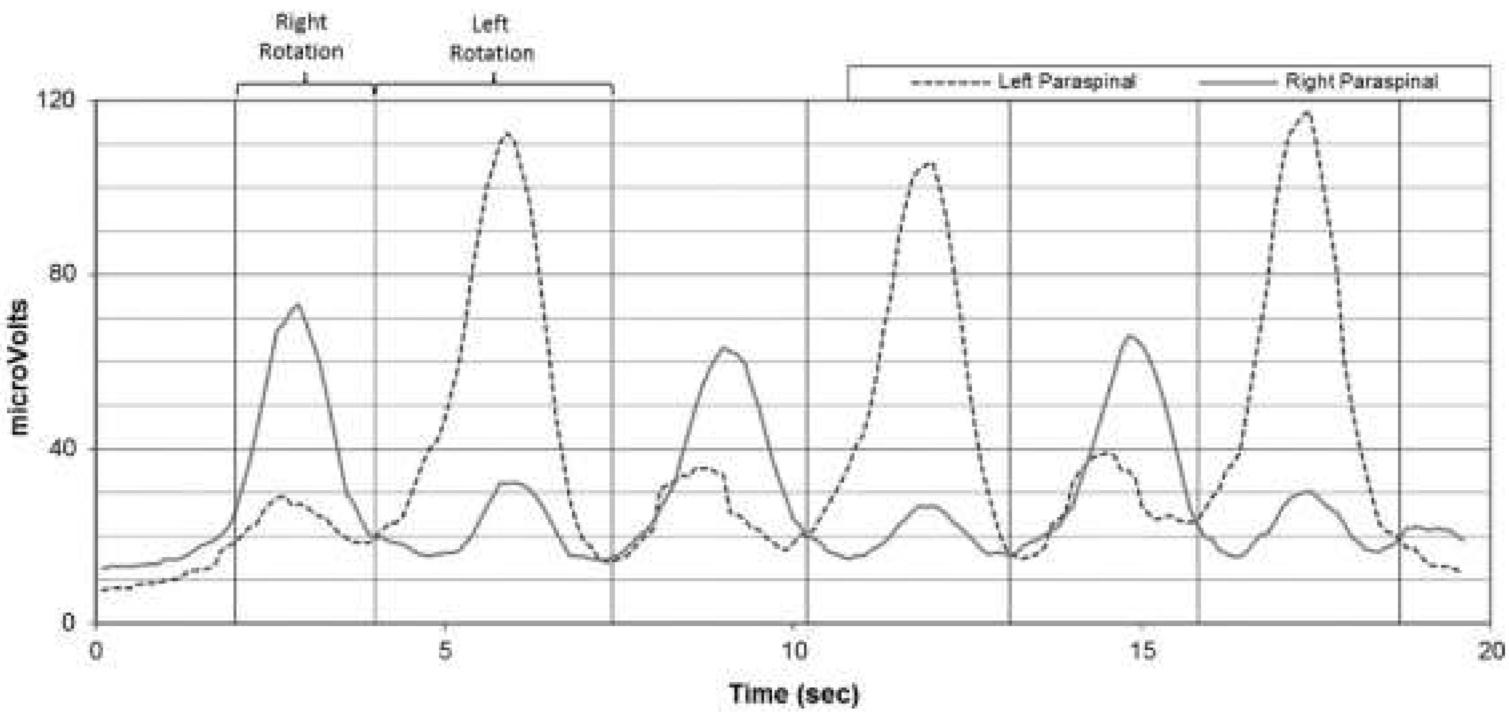


Fig 4. Plot of EMG data taken from the left and right cervical paraspinal muscles while performing cervical axial rotation by first rotating right and then left, repeated 3 times. The vertical lines indicate borders of regions where the maximum peak values are determined by a custom Microsoft Excel macro.

Devocht, et al 2016…

Table 1 Means and SDs of EMG Ratios for FRR and ARR of 4 Assessment Protocols for 5 Participants With Neck Pain (P) and 5 Controls Without Neck Pain (C)

Method	Group	Both Sides Mean (SD)
FRR: sitting	C	2.7 (1.4)
	P	1.5 (0.6)
FRR: prone	C	2.9 (1.0)
	P	1.8 (1.0)
ARR: paraspinals	C	2.6 (0.7)
	P	2.0 (1.2)
ARR: SCMs	C	5.4 (2.2)
	P	2.6 (2.3)

ARR, axial rotation ratios; *FRR*, flexion-relaxation ratio; *SCM*, sternocleidomastoid; *SD*, standard deviation.

Coding for ROM Testing

- 1st visit using 9920x code—cannot bill for computerized ROM
- Perform visual estimation day 1… order computerized ROM w/without SEMG
- Day 2, do computerized dual inclinometry ROM w/without simultaneous SEMG (dynaROM)

Coding for ROM Testing

- 95851 - Range of motion measurements and report (separate procedure); each extremity (excluding hand) or each trunk section (spine)
  - 2 Units if doing cervical and lumbar regions
- 95852- Range of motion measurements, and report, hand, with or without comparison with normal side.

- If w/ E&M code, can try using modifier -25
  - CCI edits will bundle them

Coding for SEMG

- 96002, dynamic surface electromyography, during walking or other functional activities
- 96004, Physician review and interpretation of comprehensive dynamic surface electromyography during walking or other functional activities, with written report

Denials for Dynamic SEMG

This denial is based upon an incomplete reference of the American Academy of Neurology and the American Association of Neuro Muscular & Electrodiagnostic Medicine (AANEP), giving a date of 2008 in your denial letter. A pubmed search of 2008 for the AANEP gives a paper that was published in the journal "Muscle & Nerve".[1] This paper was a review of the literature that included papers from 1994-2006 and included a review of 53 papers on the diagnostic utility of sEMG. The authors state, "The present review concludes that sEMG may be useful to detect the presence of neuromuscular disease (level C rating, class III data)…" [1] Therefore, your interpretation of this article and referencing it as justification that the sEMG testing and interpretation should not be covered, is inaccurate and unrepresentative of the findings and therefore, incorrect.

In addition, an additional Systematic Review article on this topic has been published since 2007. This study reviewed original papers not included in the 2008 paper by the AANEP. [1] This is a 2014 systematic review of the literature by Mohseni Bandpei.[2] The investigators reviewed 178 studies and included 12 studies published between 2000 and 2012 in the publication. They concluded, "The results suggest that there seems to be a convincing body of evidence to support the merit of surface EMG in the assessment of paraspinal muscle fatigue in healthy subject and in patients with LBP." [2]

Based upon a consensus of the literature, we are appealing the decision to deny payment for sEMG with simultaneous range of motion (96002), and the interpretation/reporting of the findings (96004).

REFERENCES:

1. Meekins GD1, So Y, Quan D. American Association of Neuromuscular & Electrodiagnostic Medicine evidenced-based review: use of surface electromyography in the diagnosis and study of neuromuscular disorders. Muscle Nerve. 2008 Oct;38(4):1219-24. doi: 10.1002/mus.21055.
2. Mohseni Bandpei MA, Rahmani N, Majdoleslam B, Abdollahi I, Ali SS, Ahmad A. Reliability of surface electromyography in the assessment of paraspinal muscle fatigue: an updated systematic review. J Manipulative Physiol Ther. 2014 Sep;37(7):510-21. doi: 10.1016/j.jmpt.2014.05.006.
3. Drost G, Stegeman DF, van Engelen BG, Zwarts MJ. Clinical applications of high-density surface EMG: a systematic review. J Electromyogr Kinesiol. 2006 Dec;16(6):586-602.

5. Hyperalgesia

ELSEVIER

Manual Therapy

Volume 17, Issue 5, October 2012, Pages 402-410

Systematic review

Cold hyperalgesia as a prognostic factor in whiplash associated disorders: A systematic review

Robert Goldsmith [a], Chris Wright [b], Sarah F. Bell [a], Alison Rushton [b]

- 6 prospective studies on 4 cohorts were identified and reviewed.
- “Findings from all four cohorts supported cold hyperalgesia as a prognostic factor in WAD.”
- “There is moderate evidence supporting cold hyperalgesia as a prognostic factor for long-term pain and disability outcome in WAD.”

PLOS ONE

RESEARCH ARTICLE

Quantitative and Qualitative Responses to Topical Cold in Healthy Caucasians Show Variance between Individuals but High Test-Retest Reliability

Penny Moss*, Jasmine Whitnell, Anthony Wright

School of Physiotherapy and Exercise Science, Curtin University of Technology, Perth, Western Australia

How to Determine Cold Hyperalgesia in Practice

TSA-II: NeuroSensory Analyzer

https://medoc-web.com/products/tsa-ii/

ELSEVIER

Manual Therapy

Volume 18, Issue 2, April 2013, Pages 172-174

Technical and measurement report

An investigation of the use of a numeric pain rating scale with ice application to the neck to determine cold hyperalgesia

Samuel Maxwell [b], Michele Sterling [a]

Gehling *et al. BMC Neurology* (2016) 16:125
DOI 10.1186/s12883-016-0650-z

BMC Neurology

RESEARCH ARTICLE Open Access

Short-term test-retest-reliability of conditioned pain modulation using the cold-heat-pain method in healthy subjects and its correlation to parameters of standardized quantitative sensory testing

Julia Gehling[1†], Tina Mainka[1,2†], Jan Vollert[1], Esther M. Pogatzki-Zahn[3], Christoph Maier[1] and Elena K. Enax-Krumova[4*]

Gehling, et al. BMC Neurology 2016

- Sixty-three participants with chronic Whiplash Associated Disorder (WAD) (grade II and III)
- Laboratory testing equipment vs. ICE CUBE with reported pain intensity (NRS) after 10 s of ice application at the same sites.

Vs.

Gehling, et al. BMC Neurology 2016

- Apply ice cube to skin hold for 10 sec, ask 0-10
  - Trapezius, Cervical Paraspinal
  - Perform 3X… take average

Gehling, et al. BMC Neurology 2016

- “Pain sensation on ice application was significantly better than chance in discriminating between cold hyperalgesic and non-cold hyperalgesic sites (AUC 0.822 (95% CI 0.742–0.886); $p < 0.0001$).”
- “A pain intensity rating of >5 gave a positive likelihood ratio of 8.44 suggesting that if this value is reported, clinicians could be suspicious of the presence of cold hyperalgesia.”

6. Expectation of Recovery

OPEN ACCESS Freely available online PLoS MEDICINE

Expectations for Recovery Important in the Prognosis of Whiplash Injuries

Lena W. Holm[1*], Linda J. Carroll[2,3], J. David Cassidy[4,5], Eva Skillgate[6], Anders Ahlbom[1,7]

May 2008 | Volume 5 | Issue 5 | e105

- Expectations for recovery were measured with a numerical rating scale (NRS 0–10) where the respondents were asked to rate "how likely it was that he/she would have a complete recovery".

- The anchors were labeled ''not likely'' (0) and ''very likely'' (10).

not likely 0 1 2 3 4 5 6 7 8 9 10 very likely

OPEN ACCESS Freely available online PLOS MEDICINE

Expectations for Recovery Important in the Prognosis of Whiplash Injuries

Lena W. Holm[1*], Linda J. Carroll[2,3], J. David Cassidy[4,5], Eva Skillgate[6], Anders Ahlbom[1,7]

May 2008 | Volume 5 | Issue 5 | e105

- After controlling for severity of physical and mental symptoms, individuals who stated that they were less likely to make a full recovery (NRS 5–10), were more likely to have a high disability compared to individuals who stated that they were very likely to make a full recovery (odds ratio [OR] 4.2 [95% confidence interval (CI) 2.1 to 8.5].
- For the intermediate category (NRS 1–4), the OR was 2.1 (95% CI 1.2 to 3.2).
- “Individuals’ expectations for recovery are important in prognosis, even after controlling for symptom severity”

Pain Physician 2017; 20:487-500 • ISSN 1533-3159

Systematic Review

What Are the Predictors of Altered Central Pain Modulation in Chronic Musculoskeletal Pain Populations? A Systematic Review

Jacqui Clark, MSc[1,2,3], Jo Nijs, PhD[2,3], Gillian Yeowell, PhD[1], and Peter Charles Goodwin, PhD[1]

"We found moderate strength of evidence to suggest that sensory hypersensitivity and somatization pre-morbidly, or higher sensory sensitivity and low expectation of recovery at the acute stage of pain are predictors of altered central pain modulation in some musculoskeletal pain conditions."

Journal of Zhejiang University SCIENCE B

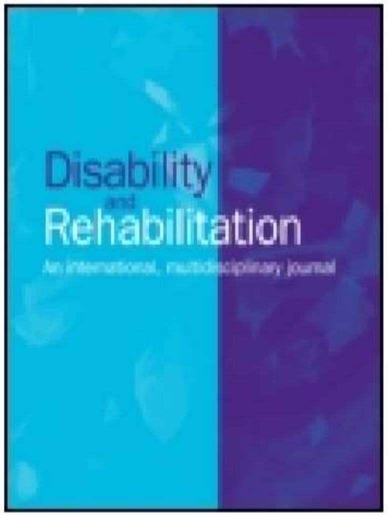
J Zhejiang Univ Sci B. 2011 Aug; 12(8): 683–686.
doi: 10.1631/jzus.B1100097

PMCID: PMC3150723
PMID: 21796810

Correlation between expectations of recovery and injury severity perception in whiplash-associated disorders

Robert Ferrari[†] and Deon Louw

"After adjusting for the effect of sociodemographic characteristics, post crash symptoms as well as pain, prior health status, and collision-related factors, those who expected to get better soon recovered over three times as quickly (hazard rate ratio=3.62, 95% CI 2.55–5.13)."



Disability and Rehabilitation

ISSN: 0963-8288 (Print) 1464-5165 (Online) Journal homepage: http://www.tandfonline.com/loi/idre20

If they can put a man on the moon, they should be able to fix a neck injury: a mixed-method study characterizing and explaining pain beliefs about WAD

Geoff P. Bostick, Cary A. Brown, Linda J. Carroll & Douglas P. Gross

7. Initial Emotional State

Premise—Recovery following a whiplash injury is varied:

- approximately 50% of individuals fully recover,
- 25% develop persistent moderate/severe pain and disability, and
- 25% experience milder levels of disability.

IASP

PAIN® 154 (2013) 2198–2206

PAIN®

www.elsevier.com/locate/pain

Derivation of a clinical prediction rule to identify both chronic moderate/severe disability and full recovery following whiplash injury

Carrie Ritchie*, Joan Hendrikz, Justin Kenardy, Michele Sterling

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

IASP

PAIN® 154 (2013) 2198–2206

PAIN®

www.elsevier.com/locate/pain

Derivation of a clinical prediction rule to identify both chronic moderate/ severe disability and full recovery following whiplash injury

Carrie Ritchie *, Joan Hendrikz, Justin Kenardy, Michele Sterling

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

"An increased probability of developing chronic moderate/severe disability was predicted in the presence of <u>older age</u> and initially higher levels of <u>NDI</u> and <u>hyperarousal symptoms (PDS)</u> (positive predictive value [PPV] = 71%). The probability of full recovery was increased in younger individuals with initially lower levels of neck disability (PPV = 71%)."

Hyperarousal Symptoms

Hyperarousal symptoms form 1 of the 3 necessary clusters of symptoms in the diagnosis and presentation of posttraumatic stress disorder (PTSD)

It occurs when a person's body suddenly kicks into high alert as a result of thinking about their trauma. Even though real danger may not be present, their body acts as if it is, causing lasting stress after a traumatic event.

- sleeping problems
- difficulties concentrating
- irritability
- anger and angry outbursts
- panic
- constant anxiety
- easily scared or startled
- self-destructive behavior (such as fast driving or drinking too much)
- a heavy sense of guilt or shame

Posttraumatic Diagnostic Scale (PDS)

Journal of Traumatic Stress, Vol. 6, No. 4, 1993

The PDS is a 49-item self-report measure recommended for use in clinical or research settings to measure severity of PTSD symptoms related to a single identified traumatic event.

Reliability and Validity of a Brief Instrument for Assessing Post-Traumatic Stress Disorder

Edna B. Foa,[1] David S. Riggs,[1] Constance V. Dancu,[1] and Barbara O. Rothbaum[1]

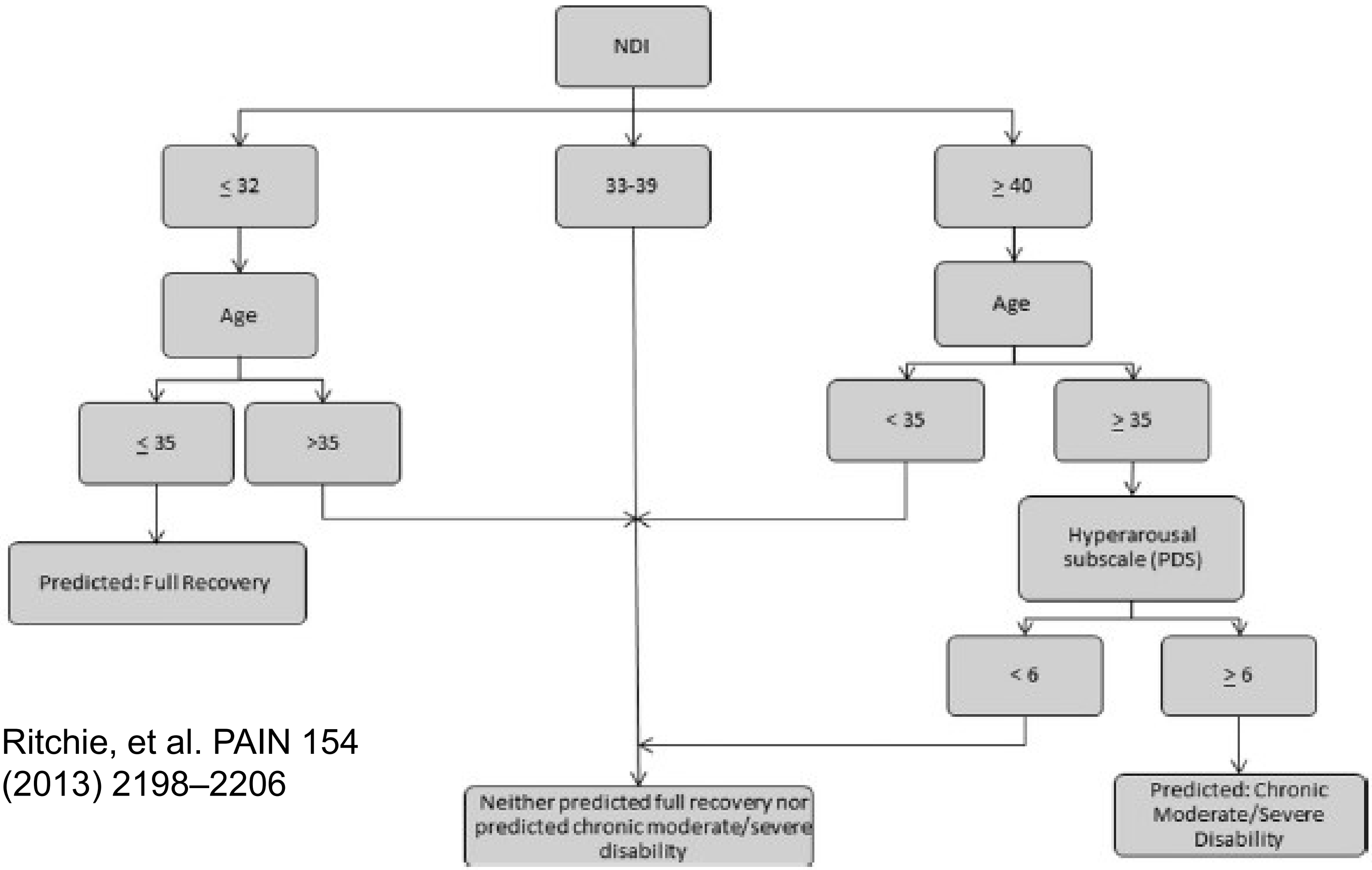
https://eprovide.mapi-trust.org/instruments/posttraumatic-diagnostic-scale-r#member_access_content

Posttraumatic Diagnostic Scale (PDS)

The PDS has four sections.

- Part 1: trauma checklist.
- Part 2: respondents are asked to describe their most upsetting traumatic event. Questions specifically ask about when it happened, if anyone was injured, perceived life threat, and whether the event resulted in helplessness or terror.
- Part 3: assesses the 17 PTSD symptoms. Respondents are asked to rate the severity of the symptom from 0 ("not at all or only one time") to 3 ("5 or more times a week / almost always").
- Part 4: assesses interference of the symptoms.

Clinical Prediction Rule



Ritchie, et al. PAIN 154 (2013) 2198–2206

Journal of
PHYSIOTHERAPY
journal homepage: www.elsevier.com/locate/jphys

Appraisal — Trial Protocol

Trauma-focused cognitive behaviour therapy and exercise for chronic whiplash: protocol of a randomised, controlled trial

Letitia Campbell [a], Justin Kenardy [b,c], Tonny Andersen [d], Leanne McGregor [a], Annick Maujean [a], Michele Sterling [a]

Several RCT's are underway looking at coordinating care with a specialist in trauma-focused behavioral therapy in combination with traditional care

Angst et al. BMC Musculoskeletal Disorders 2014, **15**:130
http://www.biomedcentral.com/1471-2474/15/130

BMC Musculoskeletal Disorders

RESEARCH ARTICLE Open Access

Multidimensional associative factors for improvement in pain, function, and working capacity after rehabilitation of whiplash associated disorder: a prognostic, prospective outcome study

Felix Angst[1*], Andreas R Gantenbein[1], Susanne Lehmann[1], Françoise Gysi-Klaus[1], André Aeschlimann[1], Beat A Michel[2] and Frank Hegemann[1]

Angst et al. BMC Musculo Dis 2014

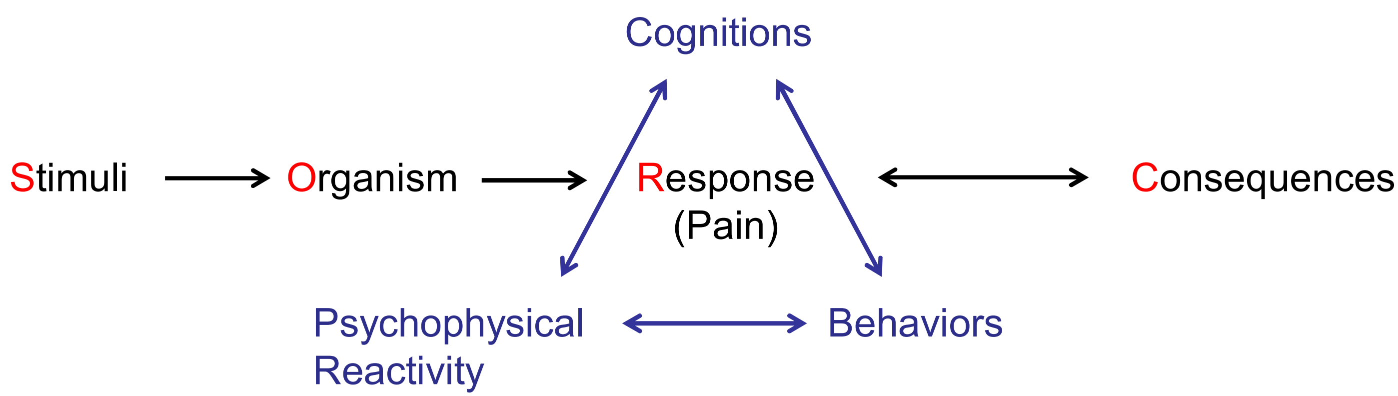
- “Pain relief, improved physical function and working capacity were circularly associated with each other. This empirical finding supports the existence of a corresponding hypothetical circle as postulated by previous studies, clinical experience and intuition. Coping (catastrophizing and ability to decrease pain) and depression may act as important effect modifiers in this circle.”
- For improved function at discharge, reduction of catastrophizing was the most important predictor (explained variance 19.4%).

Cognitive Behavioral Therapy: Based on Bio-Psychosocial Model

- Bio-psychosocial model: introduced by Fordyce in 1976
  - Nociceptive structures are held responsible for the pain awareness of the patient
  - Also emphasizes the role of psychologic and social factors in the development and maintenance of symptoms

  - This can lead to a response in one of the following three response systems that characterize emotional experiences:
    - the psychophysiological system such as feelings, increase muscle tension, etc.;
    - the cognitive system, such as thoughts, catastrophizing, fear, etc.; and
    - the motor system such as pain behavior, disuse syndrome, etc

SORC Model Applied to Pain from Injury



As DC's we don't do CBT. But can we change the way we communicate and set goals for patients during care to help with the psychosocial side of injuries?

ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Manual Therapy 11 (2006) 297–305

MANUAL THERAPY

www.elsevier.com/locate/math

Original article

Comparison of the effectiveness of a behavioural graded activity program and manual therapy in patients with sub-acute neck pain: Design of a randomized clinical trial

Jan J.M. Pool[a,b,*], Raymond W.J.G. Ostelo[a,c], Albere J. Köke[d], Lex M. Bouter[e], Henrica C.W. de Vet[a]

Core elements:

(1) decrease in the pain behavior and increase in "well" or "healthy" behavior;

(2) improving function and not the reduction of pain;

(3) the patient is responsible for the treatment and has an active role; and

(4) the therapist acts as a coach

ELSEVIER

Available online at www.sciencedirect.com

ScienceDirect

Manual Therapy 11 (2006) 297–305

MANUAL THERAPY

www.elsevier.com/locate/math

Original article

Comparison of the effectiveness of a behavioural graded activity program and manual therapy in patients with sub-acute neck pain: Design of a randomized clinical trial

Jan J.M. Pool[a,b,*], Raymond W.J.G. Ostelo[a,c], Albere J. Köke[d], Lex M. Bouter[e], Henrica C.W. de Vet[a]

Teach the patient that pain is not solely the result of underlying tissue damage, but is also influenced by:

- the patient's expectations, beliefs, and fear, as well as
- activity levels and home and work environment.

The patient is then taught that it is safe to move the cervical spine or other parts of the body.

Choose 2 ADL's that are most impacted by the pain and must be performed…

Example: Walking duration

The quotas should always be exactly followed, neither over-performed nor under-performed.

Thus there is a shift from pain-contingency (baseline) to time-contingency (quotas) management.

Positive reinforcement is a key principle in operant conditioning theory

Journal of Manipulative and Physiological Therapeutics
Volume 23 • Number 5 • June 2000
Behavioral-Graded Activity • *Ostelo et al*

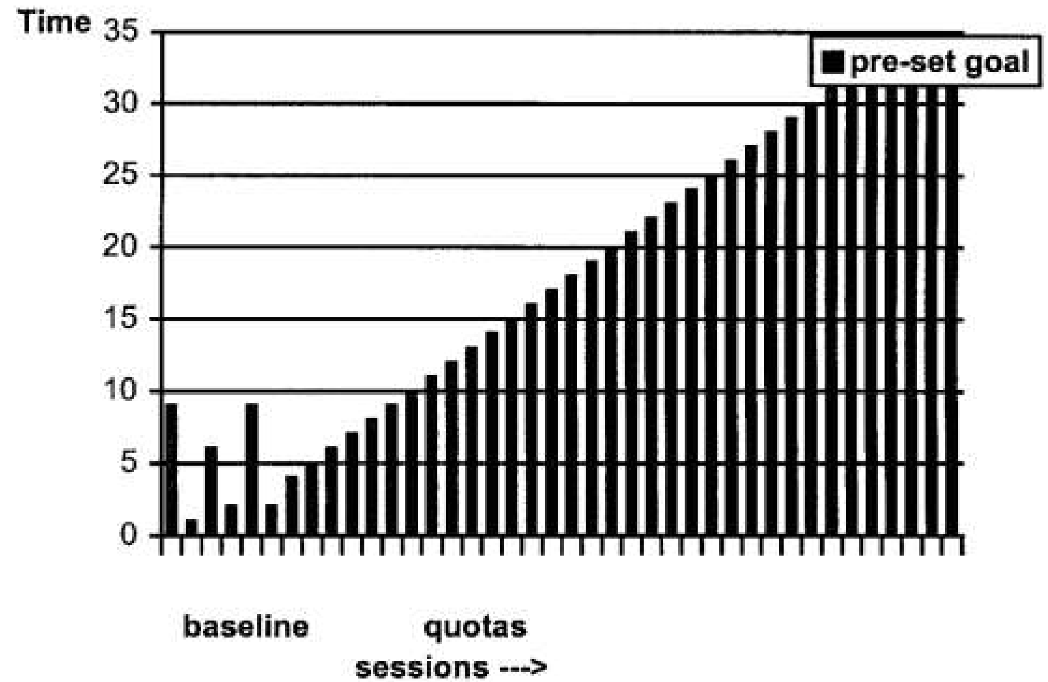


Fig 3. *Walking in a behavioral-graded activity program.* Time, *Walking time;* baseline, *baseline measurement;* pre-set goal, *patient goal for time he or she wants to walk;* quotas, *time contingent gradually increased quotas toward the preset goal.*

8. Muscular Fatty Infiltration

Predictive Factor: Muscular Fatty Infiltration

- Background:
  - The aging process causes skeletal muscle mass to decrease and be replaced by noncontractile connective tissue (sarcopenia).
  - Due to a reduction in both number and size of muscle fibers, mainly the fast twitch muscle fibers, Type IIX, and is to some extent caused by a slowly progressive neurogenic process.
  - Associated with stroke, spinal cord injury, diabetes, and COPD. MRI, MR spectroscopy, or US can measure fatty infiltration in a noninvasive manner.

Muscular Fatty Infiltration

Proposed Physiology…

- Expression of fat cells is the result of an injury induced inflammatory response and the subsequent increase in DNA synthesis of the many different cells within the peri-muscular connective tissue e.g. mast cells, satellite cells, muscle precursor cells, fibroblasts and preadipocytes.
- These cells, after injury, are responsible for secreting pro-inflammatory cytokines that could stimulate their trans-differentiation into adipose tissue.

- Dulor JP, Cambon B, Vigneron P, Reyne Y, Nougues J, et al. (1998) Expression of specific white adipose tissue genes in denervation-induced skeletal muscle fatty degeneration. FEBS Lett 439: 89–92.
- Floss T, Arnold HH, Braun T (1997) A role for FGF-6 in skeletal muscle regeneration. Genes Dev 11: 2040–2051.
- Lefaucheur JP, Gjata B, Lafont H, Sebille A (1996) Angiogenic and inflammatory responses following skeletal muscle injury are altered by immune neutralization of endogenous basic fibroblast growth factor, insulin-like growth factor-1 and transforming growth factor-beta 1. J Neuroimmunol 70: 37–44.
- Teboul L, Gaillard D, Staccini L, Inadera H, Amri EZ, et al. (1995) Thiazolidinediones and fatty acids convert myogenic cells into adipose-like cells. J Biol Chem 270: 28183–28187.

Chronic WAD: Muscular Fatty Infiltration

- Quantification: semiquantitative or quantitative
  - Semiquantitative: Sorensen et al. [*Acta Radiologica,2006*] visually graded fatty infiltration using the standard criteria in adults:
    - 0 (no fat), 1 (slight infiltration), and 2 (severe infiltration) if present at one or more lumbar levels.
  - Kalichman et al. [*JSDT 2016*] defined the assessment as more quantitative:
    - Grade 1: a normal muscle condition, fatty infiltration up to 10% of the muscle's CSA;
    - Grade 2: moderate muscle degeneration, 10–50% of fatty infiltration;
    - Grade 3: severe muscle degeneration, >50% of fatty infiltration

Chronic WAD: Muscular Fatty Infiltration

Grade 0 (a) | Grade 1 (b) | Grade 2 (c)

FIGURE 2: An example of different fatty infiltration grades in lumbar paraspinal muscles observed on a lumbar spine CT, imaged with a 64-slice CT scanner (Philips Medical, Brilliance Power 64). (a) A 23-year-old male; (b) a 61-year-old male; (c) a 72-year-old female.

Normal Values Low Back

Table 1: Cross-sectional area of back muscles and association with LBP.

Research	Modality	Participants	Segments measured	Level of measurement	Position	Orientation of cross section	CSA multifidus (cm^2)	CSA erector spinae (cm^2)	Association with LBP
Danneels et al. [50]	CT	23 healthy volunteers 32 patients with LBP	L3 L4 L4 L3 L4 L4	Superior endplate Superior endplate Inferior end plate Superior endplate Superior endplate Inferior end plate	Supine	Adjacent to the vertebral endplate	4.7 ± 1.4 6.3 ± 1.4 9.0 ± 1.5 4.1 ± 1.0 5.7 ± 1.1 7.7 ± 1.4		A significant difference between the two groups, especially at the L4 inferior endplate. Healthy individuals have a larger CSA of the multifidus
Hides et al. [51]	US	10 young male elite cricketers with LBP 16 young male elite cricketers asymptomatic	L2 L3 L4 L5 L2 L3 L4 L5	Spinous process of the vertebra	*Prone* with flattened lumbar lordosis	Between the spinous process and the lamina	3.4 ± 1.4 5.1 ± 1.9 7.1 ± 2.7 7.4 ± 2.1 2.8 ± 1.1 4.3 ± 1.5 6.5 ± 2.2 8.0 ± 1.7		Multifidus muscle atrophy can exist in highly active, elite athletes with LBP. Specific retraining resulted in an improvement in multifidus CSA that was concomitant with pain decrease
Stokes et al. [19]	US	68 females 52 males	L4 L5 L4 L5		*Prone* with flattened lumbar lordosis	Between the spinous process and the lamina	5.6 ± 1.3 6.7 ± 1.0 7.9 ± 1.9 8.9 ± 1.7		
Chan et al. [27]	US	12 asymptomatic men 12 men with LBP	L4 L4	Vertebral lamina	Prone Standing Prone Standing		6.16 ± 0.09 7.16 ± 0.10 5.37 ± 0.06 6.58 ± 0.20		Smaller multifidus CSA in chronic LBP patients than that in controls at all postures
Fortin et al. [33]	MRI	33 patients diagnosed with posterolateral disc herniation at L4-L5	L3-L4 L4-L5 L5-S1 S1	The center of each intervertebral disc The center of S1 vertebral body	Supine	Perpendicular to the muscle mass	6.5 ± 1.4 9.6 ± 2.1 11.7 ± 2.3 13.2 ± 2.7	20.0 ± 4.4 16.3 ± 4.1 10.2 ± 4.1 9.1 ± 4.0	There was no significant asymmetry of the multifidus at spinal level above, same level, or level below the disc herniation
D'Hooge et al. [25]	MRI	13 individuals with recurrent nonspecific LBP, and 13 asymptomatic individuals	L3 L4 L4	Superior endplate Superior endplate Inferior end plate	Supine	Adjacent to the vertebral endplate	Normalized values to L4 superior endplate		No difference in CSA between individuals with LBP and controls
Niemeläinen et al. [35]	MRI	126 asymptomatic men	L3-L4 L4-L5 L5-S1	Not described in the manuscript	Supine	Not described in the manuscript	Rt: 7.3, Lt: 6.9 Rt: 10.1, Lt: 9.5 Rt: 11.1, Lt: 9.8	Rt: 19.6, Lt: 19.7 Rt: 14.3, Lt: 15.3 Rt: 9.4, Lt: 10.4	Paraspinal muscle asymmetry > 10% was commonly found in men without a history of LBP. This suggests caution in using level- and side-specific paraspinal muscle asymmetry to identify subjects with LBP and spinal pathology
Sions et al. [36]	MRI	13 older adults with chronic LBP, age 60–85 y	L2 L3 L4 L5	Through vertebral body			3.44 ± 0.94 5.07 ± 2.02 8.76 ± 3.02 9.35 ± 1.83	18.76 ± 4.46 17.63 ± 4.00 13.51 ± 2.00 3.61 ± 1.19	

LBP: low back pain, CSA: cross-sectional area, Rt: right side, and Lt: left side.

OPEN ACCESS Freely available online

June 2011 | Volume 6 | Issue 6 | e21194

PLoS one

The Temporal Development of Fatty Infiltrates in the Neck Muscles Following Whiplash Injury: An Association with Pain and Posttraumatic Stress

James Elliott[1,2,3,4]*, Ashley Pedler[2], Justin Kenardy[2], Graham Galloway[3], Gwendolen Jull[1], Michele Sterling[2]

- All of the groups entered the study at 4-week post-injury with similar levels of MFI.
- However, the group with poor functional recovery at 6-months uniquely demonstrated increased MFI between 4-weeks and 3-months post-injury and these changes persisted at 6-months.

OPEN ACCESS Freely available online

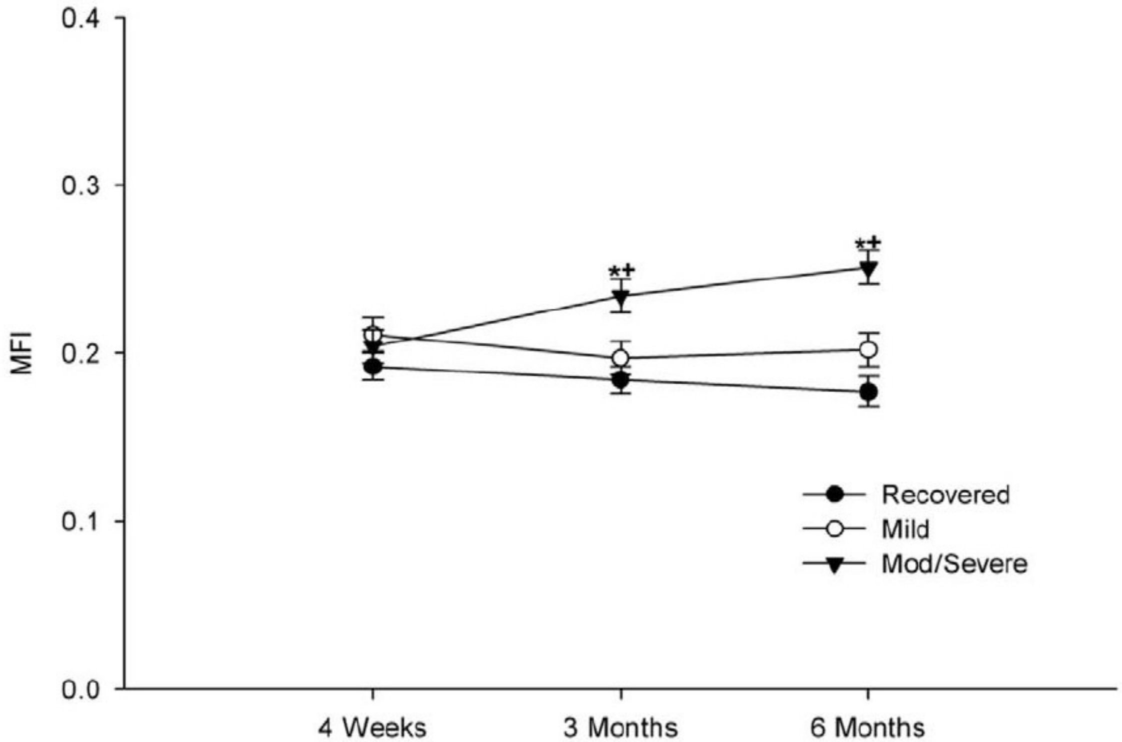
PLoS one

The Temporal Development of Fatty Infiltrates in the Neck Muscles Following Whiplash Injury: An Association with Pain and Posttraumatic Stress

James Elliott[1,2,3,4]*, Ashley Pedler[2], Justin Kenardy[2], Graham Galloway[3], Gwendolen Jull[1], Michele Sterling[2]

- Found a relationship between high initial pain and MFI was mediated by the presence of PTSD symptoms at 4-weeks post-injury.

Elliott, etal, June 2011



HHS Public Access
Author manuscript
Spine (Phila Pa 1976). Author manuscript; available in PMC 2016 June 15.

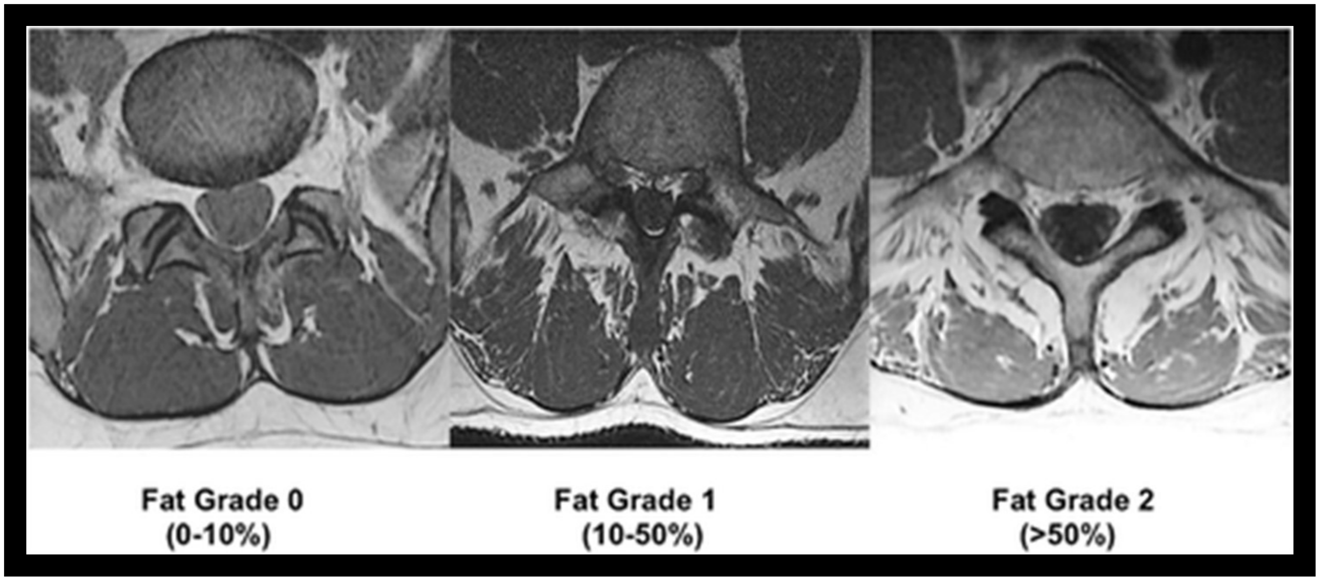
Published in final edited form as:
Spine (Phila Pa 1976). 2015 June 15; 40(12): E694–E700. doi:10.1097/BRS.0000000000000891.

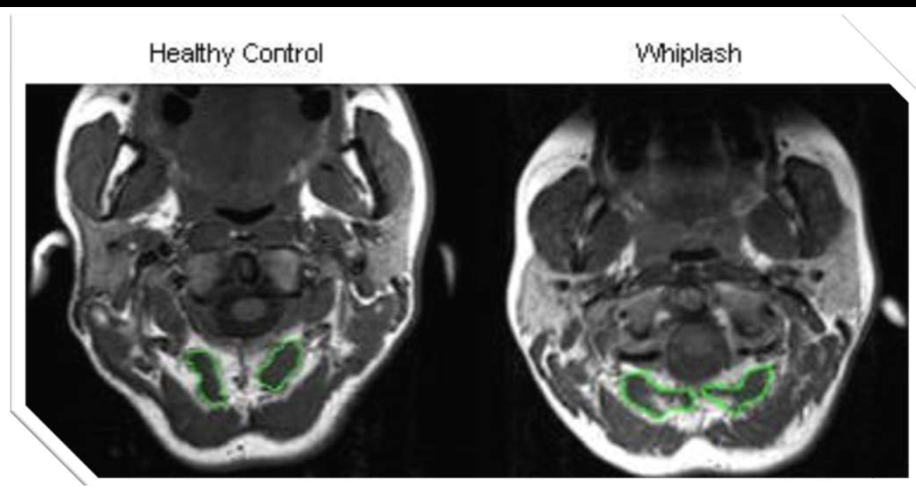
The Rapid and Progressive Degeneration of the Cervical Multifidus in Whiplash: A MRI study of Fatty Infiltration

James M. Elliott, PhD, PT[a,b], D. Mark Courtney, MD[c], Alfred Rademaker, PhD[d], Daniel Pinto, PhD, PT[a,d], Michele M. Sterling, PhD, PT[e,f], and Todd B. Parrish, PhD[g,h]

- Conclusions: muscle degeneration occurs soon after injury but only in those patients with poor functional recovery.
- MFI values were significantly higher in the severe group when compared to the recovered/mild group at 2-weeks and 3-months.
- The ROC analysis indicated that MFI levels of 20.5% or above resulted in a sensitivity of 87.5% and a specificity of 92.9% for predicting outcome at 3 months.

Muscular Fatty Infiltration





Expectations in WAD Cases after 3 Months

Clinical state is more difficult to improve after pain has been present >3 months…

WHY??

Pain Becomes "Chronic"

- "central sensitization" is an umbrella term comprising a multitude of different mechanisms taking place in the dorsal horn of the spinal cord, ascending and descending pathways in the dorsal column, the brainstem and pain centers in the forebrain, all leading ultimately to <u>amplification of innocuous and painful stimuli and to the extension of receptive fields</u>

ADVANCES IN THE MANAGEMENT OF TRAUMATIC INJURIES (AMTI)

- Module 2: March 23-24 (Denver, CO)
- Module 3: June 1-2 (Denver, CO)
- Module 4: September 7-8 (Denver, CO)
- Module 5: November 2-3 (Denver, CO)
- Module 6: Home Study/Certification Exam