

Sensorimotor Impairment In Whiplash Injury & Neck Pain

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Whiplash – Clinical Features

- Subjective:
 - Pain / Neuropathic Pain
 - Disability.
 - Psychological distress / Post-traumatic stress symptoms.
 - Dizziness.
- Objective:
 - Sensorimotor disturbance.
 - Joint positioning error / Oculomotor control / Postural stability
 - Muscle & motor control impairment.
 - Sensory changes.

Sensorimotor impairment: overview

- ◎ Symptoms of sensorimotor impairment
- ◎ Causes of sensorimotor impairment
- ◎ Objective examination:
 - Proprioception / Joint Position Error
 - Oculomotor control
 - Postural Stability

Symptoms of sensorimotor impairment:

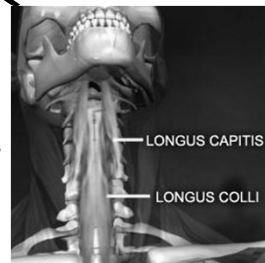
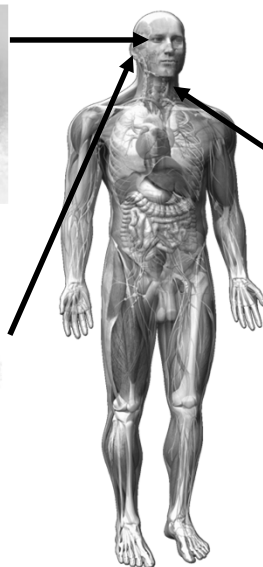
- Dizziness / giddiness
- Light headedness / feeling off balance
- Unsteadiness
- Walking on cotton wool
- 33% neck pain vs 74% whiplash (Humphreys et al 2002, Treleaven et al 2003)

NOT True vertigo 'illusion of movement' – room spinning.

Dizziness in whiplash: causes

- Cervical arterial dissection
- Side effects of medication / anxiety – but no association (Treleaven et al 2006)
- Peripheral vestibular lesions
 - Benign Paroxysmal Positional Vertigo
- Sensorimotor dysfunction
 - ‘cervical afferent disturbance.’

Sensorimotor disturbance



Muscle spindle input augmented with input from visual and vestibular system: Extensive anatomical connections.

Gosselin *et al.* (2004)
Schiepatti *et al.* (2003)
Vuillerme *et al.* (2005)
Stapley *et al.* (2006)

Sensorimotor disturbance: muscle spindles

- ⊙ High density of muscle spindles in small intrinsic deep dorsal and suboccipital muscles (Peck 1984, Richmond & Bakker 1982)
- ⊙ Localised in slow twitch fibres – role in postural control.
- ⊙ Important role in postural control
 - LA injected into cervical tissues = ataxia (deJong et al 1977)
 - Neck muscle vibration = ↓ postural control (Pyykko et al 1989)
 - Neck muscle fatigue = ↓ postural control (Gosselin et al 2004)

What is the mechanism affecting cervical afferent activity ?

- ⊙ No evidence of muscle damage in whiplash
 - “Prolonged symptoms following whiplash injury cannot be explained by biochemically measurable muscle damage.” (Scott and Sanderson 2002)
- ⊙ Fatty infiltration (Elliott et al 2006)
- ⊙ Cervical muscular fatigue – ‘overactivity’ (Stapley et al 2006).
- ⊙ Disturbed afferent input ? Facet joint mechanoreceptors / dorsal root ganglion trauma
- ⊙ Stress response & sympathetic nervous system.

Sensorimotor impairment: overview

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Assessing Proprioception

- Sherrington (1900)
 - Defined proprioception as awareness of body position and orientation.
- **Contralateral angles:** matched and compared or body segment repositioned in space without the aid of vision.
- **Problems:** No side for comparison.

Assessing Joint Position Error - research

- Reliability of 'laser & target' method:
 - N=40 healthy controls, 10 trials 1 hour apart
 - Mean of 8 trials ensures fair to excellent reliability
 - ICC 0.52 to 0.81 for global error (Pinsault et al 2008)

Assessing Joint Position Error - research

	Healthy Controls	Whiplash
Heikkila (1996)	2.73cm ± 1.89cm	4.15cm ± 2.93cm
Heikkila (1998)	2.79cm ± 1.89cm	3.70cm ± 2.90cm

N= 27, mean of ten trials.

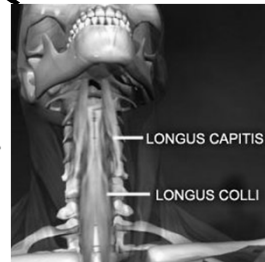
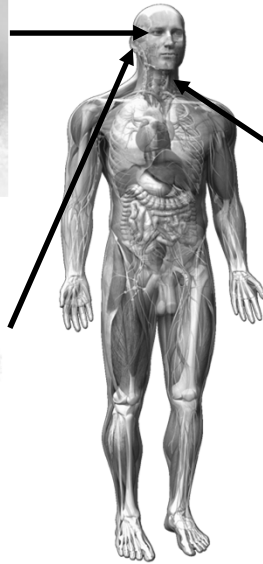
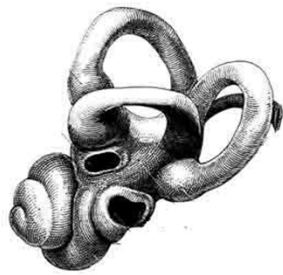
Assessing Joint Position Error - research

- JPE increases with age (Vuillerme et al 2007)
- No predictive utility – not related to outcome.
- Dizziness = increased JPE (Treleaven et al 2003)
- Vestibular vs whiplash subjects = no difference but whiplash group main complaint dizziness / unsteadiness (Treleaven et al 2008)

Assessing Joint Position Error - summary

- Good reliability with laser and target with mean of eight trials.
- Appears to discriminate between normals and whiplash subjects.
- Normal approx. 3cm / Abnormal > 5cm
- May not be a specific test of cervical afferent function.

Sensorimotor disturbance



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Sensorimotor control: SPNT

- Smooth Pursuit Neck Torsion Test (Tjell and Rosenhall 1998)



Images courtesy of 'Whiplash, Headache and Neck Pain.' Jull *et al.* Churchill Livingstone Elsevier, 2008.

Sensorimotor control: postural stability

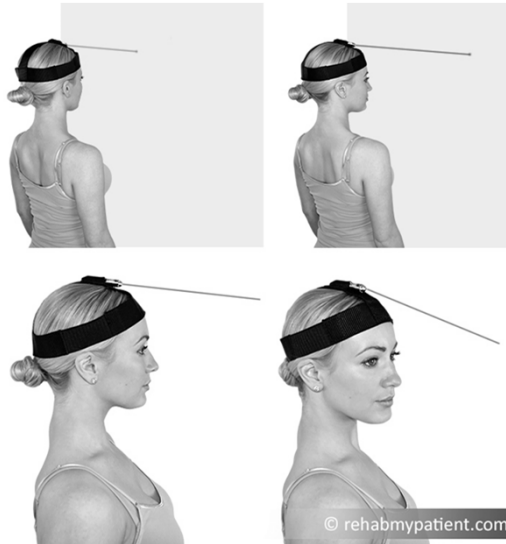
◎ Standing balance:

- Increased AP sway in whiplash subjects > idiopathic neck pain > normal (Field et al 2008)
- 50% non dizzy whiplash unable tandem stand eyes closed (Field et al 2008).
- 74% Dizzy whiplash subjects unable tandem stand eyes closed (Treleaven et al 2008).



“A battery of balance tests that include comfortable, narrow and tandem stances with eyes open and eyes closed should be included in the routine examination of all neck pain patients even in those not complaining of dizziness or unsteadiness.” (Field et al 2008)

Sensorimotor control: laser & target



Courtesy of rehabmypatient.com

Sensorimotor control: SPNT

Smooth Pursuit Neck Torsion Test (Tjell and Rosenhall 1998)



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Sensorimotor control rehabilitation

“Work on what turns on the dizziness”

– Progression

- Target: dot – word – business card
- Position: sit – stand – tandem stand - walking
- Speed: slow – medium – fast
- Range: small – medium - large
- Neck Torsion: neutral – 30 degs – 45 degs
- Vision: Unrestricted – Restricted Peripheral
- Duration: 30s 2 x day – 1-2 min 3 x day – 5 min 5 x day

Case Study

- MVA 6/12 ago:
 - Constant R sided neck pain
 - I/M unsteadiness
 - I/M blurred vision
- Questionnaire scores:
 - High disability levels
 - VAS 7/10
 - Neuropathic screen +ve
 - PTSD screen +ve
 - Perceived dizziness ‘handicap’ high
- Decreased ROM
- Joint dysfunction (R) C1/2, C2/3
- Decreased pressure pain thresholds
- Cold hyperalgesia
- BPPT +ve bilaterally
- Dix Hallpike –ve
- JPE (L) 12.5cm, (R) 3cm, E 3cm
- SPNT +ve with dizziness / blurred vision.
- Gaze stability sitting unable (R) rotation with dizziness / blurred vision.
- Saccades sitting difficult to (R).
- Postural stability: unable tandem stand eyes closed – 5secs - with dizziness.

Case Study: sensorimotor

Initial: 2 x day, 3 reps.

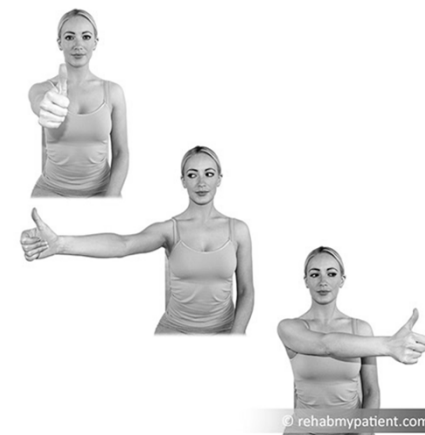
- ⦿ Balance comfortable & narrow stance eyes open / closed 30 secs attempts.
- ⦿ JPE to (L) only
- ⦿ Smooth pursuit neutral
- ⦿ Gaze stability to (R) rotation only

Progress: 5 x day, 5 mins.

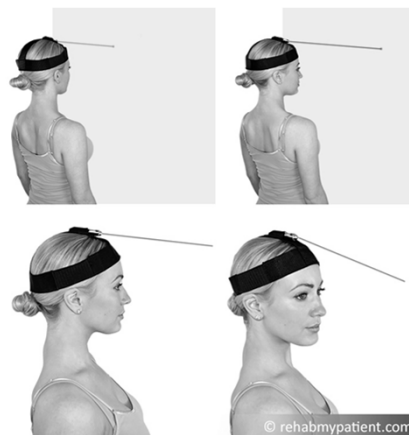
- ⦿ Saccades sitting to (R).
- ⦿ Tandem stand eyes closed.
- ⦿ JPE in neck torsion
- ⦿ Smooth pursuit torsion
- ⦿ Gaze stability in sitting
- ⦿ Increase speed
- ⦿ Change dot to word
- ⦿ Restrict vision

Case Study: sensorimotor

Neutral Smooth Pursuit



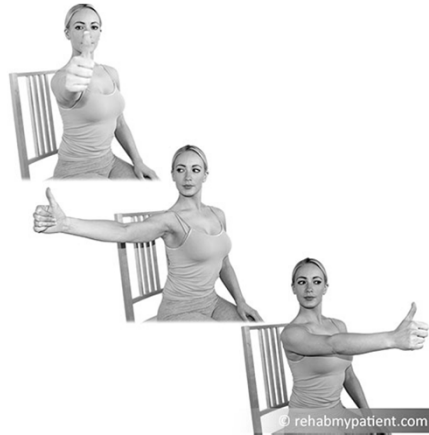
Neutral Laser



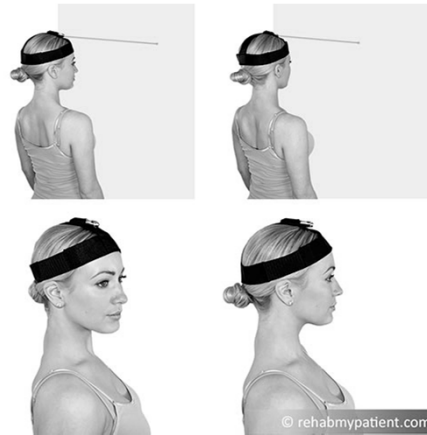
Courtesy of rehabmypatient.com

Case Study: sensorimotor

Smooth Pursuit Neck Torsion



Laser points in range



Courtesy of rehabmypatient.com

Sensorimotor control: the evidence

- Oculomotor training alone reduces pain and improves ROM (n= 60, [neck pain](#), Revel et al 1994)
 - 8 week oculomotor & laser training.
 - VAS change for training group 21.8mm decrease.
 - -decreased medication usage.

