Clinical approaches to cervical spine sensorimotor rehabilitation

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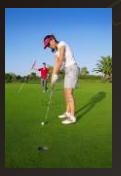


Sensorimotor impairment: overview

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

Neck pain – Clinical features

- Subjective:
  - Pain / neuropathic Pain
  - Disability.
  - Psychological distress / stress response symptoms.
  - Dizziness
- Objective:
  - Sensorimotor disturbance.
    - Joint positioning error / oculomotor control / postural stability
  - Muscle and motor control impairment.
  - Sensory changes.

Symptoms of sensorimotor impairment:

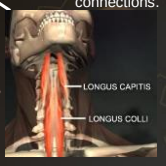
- Not a true vertigo 'illusion of movement' – room spinning.
- Dizziness / giddiness
- Light headedness / feeling off balance
- Unsteadiness
- Walking on cotton wool
- 33% neck pain vs 74% neck trauma (Humphreys et al 2002, Treleaven et al 2003)

Dizziness in neck pain: causes

- Cervical arterial dysfunction.
- Side effects of medication / anxiety – but no association (Treleaven et al 2006)
- Peripheral vestibular lesions – BPPV
- 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 injury
  - "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 / DRG trauma
- Stress response & sympathetic nervous system.

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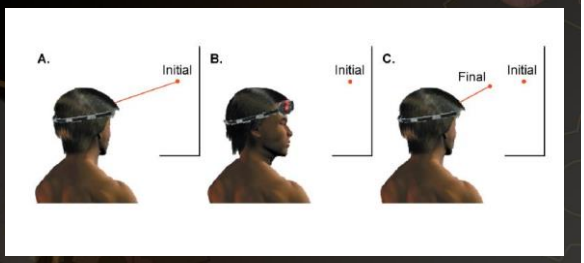
Assessing Proprioception

- Goldscheider (1889)
  - 4000 measurements of the smallest joint rotations detectable.
- 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.

Sensorimotor control: laser & target



Assessing Joint Position Error - reliability

- Reliabililty 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
  - Reliability not evaluated in whiplash subjects.

(Pinsault et al 2008)

Assessing Joint Position Error

	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.

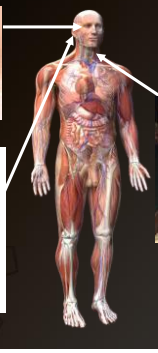
Assessing Joint Position Error

- 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

- 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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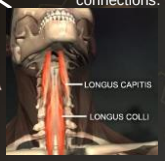

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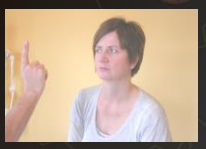
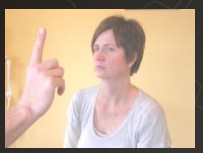
Sensorimotor control: oculomotor control

- Oculomotor control in soft tissue neck trauma:
  - 62% impaired (Heikilla 1998)





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.

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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 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

- Football injury - Neck strain 3/12 ago:
  - Constant R sided neck pain
  - I/M unsteadiness
  - Decreased ROM
  - Joint dysfunction (R) C1/2, C2/3
  - JPE (L) 12.5cm, (R) 3cm, E 3cm
  - SPNT +ve with dizziness / blurred vision.
  - Postural stability: unable tandem stand eyes closed – 5secs - with dizziness.

Case Study: sensorimotor

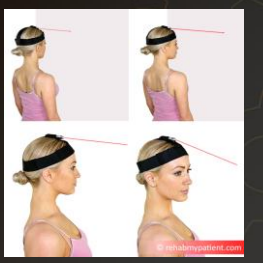
Initial: 2 x day, 3 reps.
- Balance comfortable & narrow stance eyes open / closed 30 secs attempts.
- JPE to (L) only
- Smooth pursuit neutral

Progress: 5 x day, 5 mins.
- Saccades sitting to (R).
- Tandem stand eyes closed.
- JPE in neck torsion
- Smooth pursuit torsion
  - Increase speed
  - Change dot to word
  - Restrict vision

Case Study: sensorimotor

Neutral Smooth Pursuit

Neutral Laser

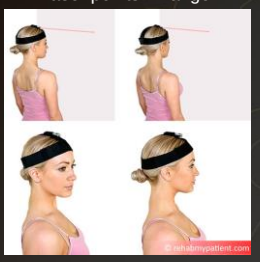


Courtesy of rehabmypatient.com

Case Study: sensorimotor

Smooth Pursuit Neck Torsion

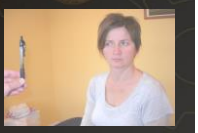
Laser points in range



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.



Sensorimotor control: the evidence

Journal of Motor Behavior, Vol. 45, No. 3, 2013

RESEARCH ARTICLE

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

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ABSTRACT. The authors' aim was to evaluate the effect of balance training on cervical joint position sense in people with subclinical neck pain. Thirty-four participants were randomly assigned to balance training or to stay active. Sensorimotor function was determined before and after 5 weeks of training by assessing the ability to reproduce the neutral head position and a predefined rotated head position. After balance training, the intervention group showed improved joint repositioning accuracy and decreased pain whereas no effects were observed in the control group. A weak correlation was identified between reduced neck pain intensity and improved joint repositioning. The present data demonstrate that balance training can effectively improve cervical sensorimotor function and decrease neck pain intensity.

Keywords: balance exercise, cervical spine, postural control, proprioception

tasks of the head (Jull et al., 2007; Revel et al., 1994; Rojezzon, Bjorklund, Gergenheim, & Djupsjobacka, 2008; Taimela et al., 2000). In contrast, neck muscles during balance exercises are unconsciously activated while the primary intention is to maintain body equilibrium. Therefore, in the present study we aimed to clarify the influence of five weeks of balance training on the sensorimotor function of the cervical spine. Based on the strong interrelation of neck muscles and posture, it was hypothesized that improved balance performance would reduce the errors when repositioning the head. Furthermore, it was hypothesized that improvements in sensorimotor function would be accompanied by a reduction of the neck pain intensity.

Sensorimotor control: the evidence

FIGURE 2. Three balance tasks were performed: single leg stance, tandem stance, and standing on a wobble board.

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