Increased MRI signal intensity and morphological changes in the brachial plexus and median nerves of patients diagnosed with WAD II

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The Social Economic Problem

- Majority of patients WAD II
- 30-50% develop chronic symptoms, including neck complaint, tenderness and musculoskeletal signs

- UK economy cost £3.1 billion per year (Galasko et al. BCMJ 2002).

- AXA 2013 – As reported for the Transport Select Committee
- Whiplash now accounts for 78 per cent of all personal injury claims in the UK

The clinical problem......

WADII supposedly no neurological signs but many patients report allodynia and hyperalgesia

Such sensory responses often associated with a neuropathic pain condition

Reports of pain responses to clinical tests that stretch the brachial plexus

Mainly attributed to central sensitisation

Central sensitisation is not self sustaining

Persistent nociceptive input from peripheral tissue

Spinal cord changes

Brain

Neuritis

Woolf Pain 2011; Haroutounian et al Pain 2014; Satkeviciute & Dilley, Mol Pain 2018
Using MRI to determine whether there are signs of neuritis in patients with WAD 2 (>3 months duration)

MRI T2 Stir Brachial plexus and median nerve at the wrist

Increase in T2 signal indicator of nerve oedema caused by inflammatory and vascular changes, which would indicate a neuritis


N=23 (10 patients chronic WADII)

Greening et al, JOSPT 2018
Neuromusculoskeletal examination including

Nerve palpation: B Plexus supra clavicular fossa, median nerve at wrist

Brachial plexus movement test, median bias
MRI 1.5 tesla

**Patients:** Imaged brachial plexus + wrist: Imaged most symptomatic side

**Controls:** Brachial plexus + Wrist: Imaged dominant side

Images coded, analysed blind

BP: C5-C8 roots mean gray scale value normalised to a region of spinal cord

Transverse image Median nerve: wrist mean gray scale value normalised to underlying bone. Circularity and aspect ratio
Clinical results

Age, weight, height and gender were comparable between groups

| Time since injury (months), median (IQR) | 18 (22.0) |
| Bilateral symptoms, n (%) | 4 (44.4) |
| Reduced cutaneous sensitivity in median nerve distribution | 4 (44.4) |
| on clinical sensory testing, n (%) |  |
| Visual analogue scale (cm), mean (SD) | 7.3 (1.9) |

<table>
<thead>
<tr>
<th>Nerve movement tests n(%)</th>
<th>Most symptomatic side</th>
<th>Least symptomatic side</th>
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<tbody>
<tr>
<td>Median nerve</td>
<td>9 (100.0)</td>
<td>4 (44.4)</td>
</tr>
<tr>
<td>Brachial plexus</td>
<td>8 (88.9)</td>
<td>4 (44.4)</td>
</tr>
<tr>
<td>Median nerve</td>
<td>5 (55.6)</td>
<td>1 (11.1)</td>
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Results

MRI T2 signal brachial plexus

Patient: 13.6% increase signal intensity
Results

MRI median nerve T2 signal at wrist
Results Area/aspect ratio

Median nerve patients:
Nerve larger & flatter
Flatter nerves correlated positively with signal intensity
Discussion

- Greater T2 signal intensity in roots BP and median nerve in patients following a whiplash injury indicates a neuropathy.

**Neuritis**

- Mild compression / traction
- Mild sensory loss but no sign of traumatic nerve injury
- Mechanical sensitivity (nerve movement tests)

- Consistent with a model of neuritis
- Neuropathic pain behaviours in absence of axonal degeneration
- Neuritis causes intact C-fibre axons to develop ongoing activity and mechanical sensitivity

Dilley et al Pain 2005; Dilley & Bove J Physiol 2008; Pulman et al 2013; Satkeviciute et al., J Neurophysiol 2018
Discussion: Brachial Plexus

MRI: most affected roots C5 C6 / may correspond to rotation angle during flexion extension phase injury

? Increased stretch to neural tissue
Discussion: Wrist

Median nerve changes on MRI are similar to those reported in Carpal Tunnel Syndrome

- Sensory changes in median nerve distribution
- Painful responses to digital palpation

- Nerve inflammation disrupts axonal transport
- Double crush?
- Nerve inflammation at one site may cause inflammatory processes at other distal sites

Implications

- A neuropathic component should be considered in patients with WAD II

- May be applicable to those patients who experience pain on nerve trunk mechanical sensitivity testing

- Effective pain control in the acute stage would enhance specific rehabilitation programmes, since normal movement may be crucial in the resolution of inflammation

Future work – Longitudinal MRI study: ‘Neuritis as a predictor of chronicity following whiplash’.
Categorize Quebec grade I and II as below the threshold of compensation while grade III and IV injuries receive compensation

This does not look so good! (on many levels..)