Magnetic resonance imaging of subjects with acute unilateral neck pain and restricted motion: a feasibility study

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Gary Fryer, Ph.D., B.Sc.(Osteopathy)1,2 James Adams, D.O.1

1 A.T. Still Research Institute, A.T. Still University, Kirksville, MO, USA
2 School of Biomedical & Health Sciences, Victoria University, Melbourne, Australia

Introduction

- Palpation of soft tissue texture and subtle joint motion are considered important for the assessment of somatic dysfunction
- Clinical indicators of dysfunction are said to be
  - Tissue texture change
  - Asymmetry
  - Range of motion disturbance
  - Tenderness

Etiology and pathophysiology of somatic dysfunction are speculative

- Proposed that segmental dysfunction is not a single clinical entity
  - potentially a number of distinct pathologies and functional disturbances
  - related by a natural history of strain and degeneration
- When acute, palpable signs may be related to tissue inflammation, and range of motion disturbance to zygapophysial synovitis & effusion

Few studies have examined volunteers with spinal pain & dysfunction for signs of inflammation in deep spinal structures

- Nazarian et al. used diagnostic ultrasound to detect signs of cervical and lumbar zygapophysial joint inflammation in patients with neck and LBP
  - Did not demonstrate abnormal echogenicity in or adjacent to these joints
  - Did not report the duration of symptoms, and it is likely the subjects were suffering from sub-acute or chronic pain

Possible that zygapophysial joint effusion may only be evident in the very acute stage of joint injury

MRI in arthritides

- Established as a sensitive and specific tool to detect sacroiliitis
- Used to detect periarticular inflammation in the lumbar and thoracic spines of people with ankylosing spondylitis

Therefore, MRI may be useful in the detection of spinal inflammation in acute nontraumatic spinal pain

Acute ‘crick in the neck’ pain

- Acute neck pain with marked restricted motion (typically of rotation & sidebending to side of pain)
- Benign self-limiting condition that affects adults
  - Typically involves trivial or no trauma
  - Clinical signs of acute somatic dysfunction (TART)

May be an ideal condition to explore deep spinal structures for signs of inflammation
Aims of study

1. Examine the feasibility of recruiting subjects with acute neck pain of less than 48 hours duration
2. Investigate the cervical spine with MRI for inflammation and joint effusion in subjects with acute neck pain
3. Correlate abnormal MRI findings with palpatory findings

Methods

- Recruitment
  - Posters displayed at ATSU and Truman State at participating medical clinics
  - E-mails circulated to student & employees
  - ATSU IRB Ethics approval
  - Was necessary to create awareness of study so that individuals contact the researchers on the day of onset of pain

Participant eligibility

- Inclusion criteria
  - Acute unilateral neck pain of less than 48 hours duration
  - Physical examination confirms
  - Painless limitation of full movement in cervical extension, sidebending, and/or rotation to the side of pain
- Exclusion criteria:
  - Recent history of major trauma (e.g. whiplash)
  - Radiation of pain or neurological signs
  - Previous diagnosis of cervical disc prolapsed
  - Use of anti-inflammatory medication in the previous six hours
  - Contraindications for MRI examination such as cardiac pacemakers & metal implants

Procedure

- Posters and e-mails
  - Necessary to create awareness of study so that individuals contact the researchers on the day of onset of pain

MRI examination

- MRI imaging was performed with a 0.35-T MRI system (Signa Ovation; GE Medical Systems, Milwaukee, WI) using a dedicated phased-array C-T-L spine surface coil
- Dedicated radiology PACS workstation (eFilm Workstation 3.0, Merge Healthcare, Milwaukee, WI)
- Board-certified diagnostic radiologist with added qualification and fellowship training in body imaging cross sectional (JA) with 13 years experience

MRI Protocol

1. Sagittal images through entire neck: Fast spin-echo (FSE) STIR, repetition time (TR) 3450 milliseconds, echo time (TE) 28 milliseconds, inversion time 85 milliseconds, echo train length (ETL) 6, field of view (FOV) 280 millimeters, slice 5 mm/2 mm interspace, number of excitations (NEX) 3, and bandwidth 10.42 kHz.
2. Sagittal images through only the cervical spine: Fast Recovery FSE T2-weighted, TR 3450, TE 95, ETL 10, FOV 280, slice thickness 4.5 mm/0 mm interspace, NEX 3, and bandwidth 8.33.
3. Axial images from C2 to T1: Series one: FSE STIR, TR 4250, TE 27, inversion time 80, ETL 6, FOV 280, slice 5 mm/0 mm interspace, NEX 3, and bandwidth 9.62. Series two: SE T1, TR 550, TE 31, FOV 280, slice 5 mm/0 mm interspace, NEX 3, and bandwidth 6.96.
STIR – heavily T2 weighted, suppression of fat signal
Very sensitive for the detection of fluid

Sagittal FSE STIR (TR 5400, TE 28, inversion time 85 milliseconds (msec), echo train length (ETL) 6, FOV 280 mm, slice 5 mm/1 mm interspace, NEX 3, BW 10.42);

Sagittal images through only the cervical spine - fast recovery fast spin-echo (FSE) T2-weighted (TR 3450, TE 95, ETL 10, FOV 280 mm, slice thickness 4.5 mm/0 mm interspace, NEX 3, BW 8.33);

Coronal images were used to assess sidebending

Sagittal images from C2 to T1 were FSE STIR (TR 4250, TE 27, inversion time 80 msec, ETL 6, FOV 280 mm, slice 5 mm/0 mm interspace, NEX 3, BW 9.62);

Axial T1 and STIR

MRI findings were correlated with:
- Symptoms (side of pain, level)
- Palpatory findings (side of pain, level, restriction)

MRI analysis

- Evidence of capsule or periarticular oedema and joint space T2 increase was recorded
  - signs were to be ranked on a Berlin scoring system

- Additionally, other signs recorded:
  - muscle oedema
  - alignment (lordosis, side bending)
  - disc disease
  - facet arthritic change
  - spinal stenosis

Results

Subjects

- Five subjects were recruited over a 3-month period
- 3 females, 2 males, Mean age 31.6 years (SD 12.4)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Side of Pain</th>
<th>Level of Pain</th>
<th>Current Pain</th>
<th>Worst Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Left</td>
<td>All</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>Left</td>
<td>Upper</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>Right</td>
<td>Upper</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Right</td>
<td>Lower</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Left</td>
<td>Lower</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td></td>
<td>Mean (SD)</td>
<td>4.8 (1.6)</td>
<td>7.0 (0.7)</td>
</tr>
</tbody>
</table>

- Symptoms
  - Mean current pain = 4.8 (SD 1.6, visual analogue scale 0-10)
  - Worst pain since onset = 7.0 (SD 0.7)
  - Mean duration of symptoms = 12.4 hours (SD 14.1)
Results

Limited active motion
- Rotation to the painful side
- Followed by side bending to the painful side and extension

<table>
<thead>
<tr>
<th>Subject</th>
<th>Side Bending</th>
<th>Rotation</th>
<th>Flexion</th>
<th>Extension</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ipsilateral</td>
<td>Opposite</td>
<td>Ipsilateral</td>
<td>Opposite</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Mean: 1.8 0.8 1.6 0.8 1.8 1.4
SD: 0.8 0.8 0.9 0.8 1.1 1.3

0-3 point scale: 0 = no restriction, 1 = mild restriction, 2 = moderate restriction, and 3 = marked restriction

Palpation
- Most symptomatic segment varied from subject to subject
- Perceived degree of restriction at that segment varied from mild to markedly restricted

<table>
<thead>
<tr>
<th>Subject</th>
<th>Side</th>
<th>Spinal Level</th>
<th>Restriction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Left</td>
<td>C4</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Left</td>
<td>C2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Right</td>
<td>C2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Right</td>
<td>C6</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Left</td>
<td>C7</td>
<td>2</td>
</tr>
</tbody>
</table>

Mean (SD): 1.8 (0.6)

Segmental motion restriction ranked on a 0-2 scale, where 0 = no restriction, 1 = mild restriction, and 2 = moderate restriction

MRI findings

- No findings on MRI examination demonstrated clear evidence of either synovial effusion or inflammation around the joints of the cervical spine
- In some individuals, signs of muscle oedema, altered alignment, disc and facet arthrosis, and spinal stenosis were noted

MRI findings

- No findings on MRI examination demonstrated clear evidence of either synovial effusion or inflammation around the joints of the cervical spine

MRI findings

<table>
<thead>
<tr>
<th>Subject</th>
<th>Muscle oedema (signal increase)</th>
<th>Alignment</th>
<th>Alignment</th>
<th>Disc Degeneration</th>
<th>Facet Arthrosis</th>
<th>Spinal Stenosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Subtle increase right inferior paraspinals</td>
<td>Straightened mid cervical</td>
<td>Left, minimal</td>
<td>C6/7, mild bilateral</td>
<td>No</td>
<td>C6/7, mild central canal</td>
</tr>
<tr>
<td>2</td>
<td>Subtle increase left trapezius and lower cervical region</td>
<td>Near straightened</td>
<td>Right, mild</td>
<td>C4/5, mild; C6/7, mild</td>
<td>No</td>
<td>C6/7, mild central canal</td>
</tr>
<tr>
<td>3</td>
<td>Subtle increase left trapezius and lower cervical region</td>
<td>Kyphotic mid cervical</td>
<td>Left, mild</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>Subtle increase left paraspinal region and mid-neck</td>
<td>Kyphotic mid cervical</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Mild unicartilaginous arthritis C6/7</td>
</tr>
<tr>
<td>5</td>
<td>Subtle increase right paraspinal and mid-upper cervical</td>
<td>Kyphotic mild lower cervical</td>
<td>No</td>
<td>C6/7, mild</td>
<td>C6/7, minimal</td>
<td>No</td>
</tr>
</tbody>
</table>

These did not appear to be related to the symptomatic segmental level or side of pain

T1

STIR

Subtle left trapezius muscle oedema
Assessment of sidebending from initial localizer images

Disc degeneration, with posterior disc bulging greater at C5-6 than at C4-5. C5-6 has a right-central herniation

No signs of facet degeneration

Discussion

- Very few researchers have attempted to investigate the deep structures of the spine in patients with pain for signs of inflammation
- No study examined patients with acute pain

This feasibility study established that subjects with acute neck pain (less than 48 hours) could be recruited, albeit with difficulty and over a substantial period
- Failed to find any indication of inflammation in the deep spinal structures using MRI

Zygapophysial joint has been implicated as a major pain generator in chronic cervical and LBP

- Underlying etiology has not been determined
  - Capsule sprain and tears demonstrated
  - Association with acute or chronic neck or back pain unknown
- Although sample size was small, no relevant signs of inflammation were found in any of the five subjects
- Suggests that inflammation is not likely detectable using these methods even in a larger cohort
- Consistent with findings of Nazarian et al.
  - Ultrasonography less sensitive, subjects not acute

Consistent with evidence that
- Degree of cervical lordosis/kyphosis cannot accurately identify ‘cervical muscle spasm’
- Degenerative changes observed in MRI are common in asymptomatic subjects and are not well correlated with neck pain

Minor pathologies were detected in all subjects

- No obvious relation to side and level of pain
- Likely these pathologies were incidental and unrelated to the current presentation of pain or the findings on palpation
Palpation

- Palpation of the most sensitive and restricted segment coincided with the side of pain and the region of symptoms in all subjects
- Identified segment appeared markedly restricted with motion palpation in all cases
- Lends support for the validity of palpation

Feasibility of recruitment

- Feasible, but difficult
  - Within 48 hours of onset of pain
- Concordance alone is therefore not convincing evidence of the reliability and validity of palpation

Limitations & recommendations

- Small sample size
- Does not rule out inflammatory changes associated with acute neck pain
  - Low grade sprains of much larger joints can be occult to MRI and other imaging
  - Imaging with higher field strength systems may possibly detect very subtle inflammation
    - Tailored techniques at 3 Tesla (or even the ultra-high 7 tesla)
    - Gadolinium IV-enhancement

Conclusion

- Recruitment of subjects with acute ‘cric in the neck’ pain is difficult but feasible over a long data collection period
- No evidence of cervical joint inflammation was detected
  - A variety of degenerative features were identified which appeared incidental to the presenting complaint
  - If inflammatory changes exist in or around the cervical joints in subjects with acute neck pain, more sensitive imaging methods are required to detect it

Questions?