Clinical tests of musculoskeletal dysfunction in the diagnosis of cervicogenic headache

G. Zito, G. Jull, I. Story

School of Physiotherapy, The University of Melbourne, Vic. 3010, Australia
Division of Physiotherapy, The University of Queensland, Australia
Faculty of Health and Behavioural Sciences, Deakin University, Australia

Received 20 January 2003; received in revised form 22 March 2005; accepted 27 April 2005

Abstract

Persistent intermittent headache is a common disorder and is often accompanied by neck aching or stiffness, which could infer a cervical contribution to headache. However, the incidence of cervicogenic headache is estimated to be 14–18% of all chronic headaches, highlighting the need for clear criterion of cervical musculoskeletal impairment to identify cervicogenic headache sufferers who may benefit from treatments such as manual therapy.

This study examined the presence of cervical musculoskeletal impairment in 77 subjects, 27 with cervicogenic headache, 25 with migraine with aura and 25 control subjects. Assessments included a photographic measure of posture, range of movement, cervical manual examination, pressure pain thresholds, muscle length, performance in the cranio-cervical flexion test and cervical kinesthetic sense.

The results indicated that when compared to the migraine with aura and control groups who scored similarly in the tests, the cervicogenic headache group had less range of cervical flexion/extension ($P = 0.048$) and significantly higher incidences of painful upper cervical joint dysfunction assessed by manual examination (all $P < 0.05$) and muscle tightness ($P < 0.05$). Sternocleidomastoid normalized EMG values were higher in the latter three stages of the cranio-cervical flexion test although they failed to reach significance. There were no between group differences for other measures. A discriminant analysis revealed that manual examination could discriminate the cervicogenic headache group from the other subjects (migraine with aura and control subjects combined) with an 80% sensitivity.

$^1$Corresponding author. Tel.: +613 8344 4171; fax: +613 8344 4188. E-mail address: g.zito@unimelb.edu.au (G. Zito).

Keywords: Cervicogenic headache; Migraine; Cervical movement; Muscle function

1. Introduction

Headache is a common disorder with an estimated lifetime prevalence of 96% and a point prevalence of 16% (Rasmussen et al., 1991). Henry et al. (1987) determined that approximately 70% of persons with frequent intermittent headache report neck symptoms associated with their headache, which may encourage delivery of treatment to the cervical region. Whilst it is proposed that the cervical spine may contribute to different types of headache such as migraine and tension type headache (Watson, 1995), studies estimate that only 14–18% of chronic headaches are cervicogenic, that is, headaches which actually result from musculoskeletal dysfunction in the cervical spine (Pfaffenrath and Kaube, 1990; Nilsson, 1995). There is the potential for many headache patients to receive ongoing physical treatments even when there is a high possibility that such treatments are likely to be unsuccessful (Parker et al., 1978; Tuchin et al., 2000; Astin and Ernst, 2002). The call for substantiation of efficacy of manual therapy emphasizes the need for accurate diagnosis to distinguish cervicogenic headache from other causes of
chronic headache so that the appropriate patients receive manual therapy treatment.

Comparatively little research has been conducted on characterizing the physical impairments which might confirm a cervical cause. The International Headache Society (IHS) has published criteria for the classification of headache (IHS, 2004) although Sjaastad et al. (1998) has provided more detailed criteria for cervicogenic headache. Such criteria are based mainly on the history, temporal pattern and aggravating features of headache. However, there is considerable overlap in symptoms of headache of various origins. Furthermore, the musculoskeletal criteria to identify a cervical cause of headache are general in nature. More specific descriptions might assist differential diagnosis.

Research has begun to identify impairments in the musculoskeletal system, which could assist in diagnosing cervicogenic headache. Studies have investigated features of the articular, muscle and neural systems. For example, Zwart (1997) using Cybex dynamometry (albeit without reported reliability), showed that cervical flexion, extension and rotation ranges were significantly less in subjects with cervicogenic headache in comparison to those with migraine and tension headache. Additionally, a number of studies have consistently linked cervicogenic headache to painful dysfunction in the upper three cervical segments (C0–3) (Trevor-Jones, 1964; Bogduk and Marsland, 1986; Bovim et al., 1992; Dreyfuss et al., 1994; Lord and Bogduk, 1996). Tenderness is also a feature. Bovim (1992) measured pressure pain thresholds (PPTs) at 10 points on the head and suboccipital region in subjects with cervicogenic, tension and migraine headaches and found that when all PPT values were summed, the score was significantly lower in the cervicogenic headache group than for the tension and migraine headache and control groups. A relationship has been proposed between a forward head posture and cervicogenic headache although the evidence is not definitive (Watson and Trott, 1993; Treleaven et al., 1994; Haughie et al., 1995). In relation to muscle function, several studies using different tests of the cervical flexor muscles have identified dysfunction in this muscle group in neck pain and headache subjects (Watson and Trott, 1993; Treleaven et al., 1994; Jull et al., 1999). Two studies have noted a higher prevalence of cervico-brachial muscle tightness, assessed clinically, in cervicogenic headache subjects as compared to control subjects (Treleaven et al., 1994 Jull et al., 1999). Deficits in cervical kinaesthesia have been identified in various neck syndromes (Revel et al., 1991; Loudon et al., 1997; Heikkilä and Wenngren, 1998) but no studies to date have investigated cervical kinaesthesia in cervicogenic headache. There is little knowledge of the prevalence of mechanosensitive neural tissue, although its occurrence has been described (Rumore 1989) and its involvement alluded to in a small pilot study, which suggested altered mechanosensitivity in patients with cervicogenic headache (Rankin, 1993).

Previous studies have examined one or two features of the cervical musculoskeletal system in cervicogenic headache patients. The aim of this study therefore was to investigate the sensitivity of these tests as a group to determine if there was a pattern of musculoskeletal dysfunction, which might better characterize cervicogenic headache for differential diagnosis. Three groups of subjects were compared, cervicogenic headache, migraine with aura and a non-headache control group. Migraine with aura was chosen as there is no evidence that cervical musculoskeletal dysfunction has a role in its pathogenesis.

2. Methods

2.1. Subjects

Seventy-seven female volunteers aged between 18 and 34 years were invited to join the study. The cross-sectional study was conducted under single blind conditions in that the principal investigator, an experienced musculoskeletal physiotherapist, was blind to the diagnostic category of the subjects. The subjects were recruited from neurologists, general medical practitioners and musculoskeletal physiotherapists or by advertisement (control subjects). They entered one of three groups, a control group (n = 25, mean age 22.9 ± 3.5 years), a cervicogenic headache group (n = 27, mean age 25.3 ± 3.9 years) or a migraine with aura group (n = 25, mean age 22.9 ± 3.5 years) and comparisons between the three groups were made. Headache subjects entered their respective groups according to established diagnostic criteria for migraine with aura (IHS, 2004) and cervicogenic headache (Sjaastad et al., 1998). Anaesthetic blockades were not used as a criterion for cervicogenic headache as the procedure was considered too invasive and costly for this study and is not readily accessible to most clinicians. The total length of the history of the headache ranged from 9 months to more than 10 years (Table 1). Young subjects were selected as it is the period of life when vascular symptoms are more frequently encountered (Lance and Goadsby, 1998), and when the effects of age or disease in the musculoskeletal system are still

<table>
<thead>
<tr>
<th></th>
<th>9 months–5 years</th>
<th>5–10 years</th>
<th>&gt;10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEH</td>
<td>18 (67%)</td>
<td>6 (22%)</td>
<td>3 (11%)</td>
</tr>
<tr>
<td>Migraine</td>
<td>6 (24%)</td>
<td>10 (40%)</td>
<td>9 (36%)</td>
</tr>
</tbody>
</table>

Table 1

Total length of history of headaches

relatively negligible. The inclusion criteria for control subjects were no history of headache, cervical pain or injury for which they had sought treatment. Headache subjects were deemed ineligible if they had a history of combined forms of headache, were involved in compensation or, in the case of migraine with aura subjects, if they had a history of a neck injury or condition. Ethical clearance for the study was granted by the Human Research Ethics Committee of The University of Melbourne and all participants gave their informed consent.

2.2. Measurements

**Questionnaires:** Headache subjects completed a questionnaire about the history and nature of headache to ensure they fulfilled the diagnostic criteria of their headache group (Appendix A) as well as the McGill Pain Questionnaire (Melzack, 1975).

**Physical examination:** The sequence and content of the physical examination is summarized in Table 2.

**Postural measurement:** A photographic measurement of posture was taken according to the method of Refshauge et al. (1994). Subjects were photographed looking straight-ahead in their natural stance using a Kodak DC50 digital camera and postural angles were calculated using NIH Image software (National Institutes of Health, USA). The cranio-vertebral angle (CV), reflecting the forward head posture position, was the acute angle created between the horizontal plane and the line from the tip of the C7 spinous process to the tragion. Head posture was measured as the acute angle between the horizontal plane and the line from the corner of the eye to the tragion (ETH).

**Pressure pain thresholds (PPTs):** PPTs were measured with a pressure algometer (PD&T—Italy) applied at a constant rate of approximately 1 kg/cm²/s until the subjects reported a change of sensation from pressure to pain. A familiarization session was first performed on the wrist. The following sites were identified and tested with the subject in prone lying: the areas over the C2 nerve root, the greater occipital nerve, the transverse process of C4 (Fredriksen et al., 1987; Pfaffenrath et al., 1988; Sjaastad et al., 1998) and the C2/3 zygapophyseal joint (Lord et al., 1994). Five readings were taken over each site and averaged for analysis.

**Range of cervical movement:** A cervical range of movement device CROM (Performance Attainment Associates, St. Paul, MN, USA) was used to measure the mobility of the cervical spine (Youdas et al., 1991) using the standard protocol for upper cervical flexion/extension, cervical flexion/extension, lateral flexion and rotation. In this study, rotation of the head was also measured in a position of full flexion of the neck as an estimate of upper cervical spine rotation (Dvorak et al., 1984). For this measure, the research assistant held the magnetic yoke of the CROM in a plane parallel to the compass on the subject’s head so that the compass meter could be seen in between the two magnetic rods. All movements were performed twice and averaged for analysis.

**Cervicocephalic kinaesthetic sense:** The protocol of Revel et al. (1991) was used to measure the subject’s ability (while blindfolded) to relocate the natural head

---

**Table 2**

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Domains</th>
<th>Clinical utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postural measurement</td>
<td>- Eye-tragion angle (ETH)</td>
<td>Head on neck posture Forward head posture position</td>
</tr>
<tr>
<td></td>
<td>- Craniovertebral angle (CV)</td>
<td></td>
</tr>
<tr>
<td>Pressure pain threshold</td>
<td>- C4 transverse process</td>
<td>Pressure points associated with CEH</td>
</tr>
<tr>
<td></td>
<td>- C2/3 z-joint</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- C2 nerve root</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Greater occipital nerve</td>
<td></td>
</tr>
<tr>
<td>Cervical range of movement</td>
<td>- Flexion, extension, rotation lateral flexion</td>
<td>Decreased mobility associated with CEH</td>
</tr>
<tr>
<td></td>
<td>- Upper cervical rotation, lateral flexion</td>
<td></td>
</tr>
<tr>
<td>Cervicocephalic kinaesthetic sense</td>
<td>Flexion, extension, rotation</td>
<td>Assessing repositioning error associated with cervical dysfunction</td>
</tr>
<tr>
<td>Manual assessment</td>
<td>O/C1, C1/2, C2/3 and C3/4</td>
<td>Hypomobility and pain associated with cervical z-joints dysfunction</td>
</tr>
<tr>
<td>Muscle extensibility</td>
<td>Upper trapezius, Scalenes, Levator Scapulae, Short Cx Extensors, Pec major &amp; minor</td>
<td>Muscle tightness associated with cervical dysfunction</td>
</tr>
<tr>
<td>Mechano sensitivity of neural tissues</td>
<td>Pre-tensioning dura with upper Cx flexion whilst adding brachial plexus provocation test and SLR</td>
<td>Increased sensitivity of neural tissues associated with cervical dysfunction</td>
</tr>
<tr>
<td>Cranio cervical flexion test</td>
<td>Progressively inner range cranio cervical flexion positions head nodding tests aiming to reach and hold steadily targeted pressure (22, 24, 26, 28, 30 mm Hg) for 5s</td>
<td>To detect excessive synergistic activity of long neck flexors</td>
</tr>
</tbody>
</table>
posture (NHP) following the movements of left and right rotation, flexion and extension. The relocation error (joint position error, JPE) was the difference between the starting position and the NHP after movement. Five trials were undertaken for each movement and the average JPE was calculated for analysis. The value was the absolute error, that is, the positive and negative values (undershoot or overshoot of the target) were not considered.

**Manual examination of the upper cervical joints:** A manual examination of the upper four cervical spine segments was conducted by the principal researcher as per the normal clinical procedure (Maitland et al., 2001). Joint motion was rated on a conventional 7-point scale (hypermobility (grades 1–3) normal (4) hypomobility (grades 5–7) as proposed by Jull et al. (1994). The subject rated verbally any pain provoked by the examination (local or referred) at any joint on an 11-point scale (verbal analogue scale; VAS). To emphasize the essential differences between the groups, the joint motion rating was collapsed to a 3-point scale prior to analysis: normal (ratings 3, 4, 5), hypermobile (ratings 1, 2) and hypomobile (ratings 6, 7).

**Muscle extensibility:** Extensibility of selected cervical and axio-scapular muscles was assessed using standard clinical tests of muscle length (Evjenth and Hamberg, 1984; Janda, 1994). Extensibility was initially rated on a 4-point scale as used by Treleaven et al. (1994), normal, slightly, moderately and very tight which, for analysis, was collapsed into a 2-point scale: normal (normal and slightly) and tight (moderate and very).

**Mechanosensitivity of neural tissues:** Neural tissue mechanosensitivity was assessed by holding an upper cervical flexion position and then tensioning neural tissues by placing the upper and lower limbs in the cervical flexion position and then tensioning neural tissues. The cranio-cervical flexion test was blinded to the subject's group status. The data for neural tissue mechanosensitivity were analysed descriptively. One-way analysis of variance (ANOVA) was used for all other data. The level of significance was 0.05.

**Muscle extensibility 0.4–1.0**

This is a compensatory strategy was confirmed by Falla et al. (2004) who demonstrated that this higher activity was associated with lesser measured activity in the deep neck flexors in neck pain patients. In this study, pairs of standard EMG Red-Dot Bipolar Ag–AgCl electrodes were positioned along the muscle bellies of the SCM, following skin preparation. Signals were amplified (Associated Measurements Pty Ltd., Australia, Amlab), passed through a 20–500 Hz bandwidth filter and sampled at 1000 Hz. Data were analysed with a third party software program (Igor Pro V3). The maximum root mean squared (RMS) value for signal amplitude was identified for each trace using a 1 s sliding window, incremented in 100 m s steps. RMS values were normalized for each subject to the RMS of the resting level for that subject. Subjects first practised the cranio-cervical flexion test and then performed the test formally for measurement.

**Repeatability tests:** Prior to the commencement of the main study, the principal investigator undertook repeatability studies for each measure. The ranges of the ICC and Kappa scores for the tests are summarized in Table 3. The results indicated that there was acceptable intra-examiner repeatability for the measures used in this study.

### Table 3

<table>
<thead>
<tr>
<th>Test</th>
<th>ICC value range</th>
<th>Kappa score range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postural angles</td>
<td>0.96–0.99</td>
<td></td>
</tr>
<tr>
<td>Pressure pain thresholds</td>
<td>0.82–0.98</td>
<td></td>
</tr>
<tr>
<td>Cervico-cephalic kinesthetic sense</td>
<td>0.51–0.62</td>
<td></td>
</tr>
<tr>
<td>Range of movement</td>
<td>0.86–0.97</td>
<td>0.78–1.0</td>
</tr>
<tr>
<td>Manual examination (Jull et al., 1997)</td>
<td></td>
<td>0.78–1.0</td>
</tr>
<tr>
<td>Muscle extensibility</td>
<td>0.4–1.0</td>
<td></td>
</tr>
</tbody>
</table>
significance was set at \( P \leq 0.05 \). A discriminant function analysis was conducted to determine if any physical measures discriminated cervicogenic headache from the migraine with aura and control subjects.

3. Results

All subjects fulfilled the inclusion criteria for their diagnostic classification and the groups were deemed to be representative of cervicogenic headache, migraine with aura and asymptomatic control populations.

The data for the postural, PPT and JPE are presented in Table 4. The results of the analyses of variance showed no significant between group differences in postural angles and no relationship between CV angle and ETH angle was evident. There were no between group differences in PPTs with the exception of the area over the transverse process of C4 where both the headache groups had significantly lower PPTs than did the control group \( (P < 0.05) \). There were no significant between group differences in JPEs in any movement.

The data for the measurement of cervical range of movement are presented in Fig. 1. The cervicogenic headache group demonstrated consistently less movement than the migraine and control groups, although this was statistically significant only for cervical flexion/extension \( (P = 0.048) \). The frequency of findings of painful and stiff joints in the manual examination for the three groups is presented in Table 5. As can be observed, the cervicogenic headache group had a high incidence of pain associated with joint hypomobility while in contrast the incidence in both the control and migraine groups was relatively low. The majority of joints in these latter two groups were rated as normal motion (88% control group and 84% migraine with aura group). The analyses \( (\chi^2) \) confirmed the observed differences for the cervicogenic headache group for all segments when compared to the migraine and control groups \( (all \ P < 0.05) \). Similarly pain was provoked more frequently and to a greater extent in the manual joint examination in the cervicogenic headache group \( (all \ P < 0.005) \) with the exception of the C3–4 segment, the segment with least perceived dysfunction in any group \( (Table 5) \). It should be noted that whilst all hypomobile joints were not necessarily painful, all painful joints were hypomobile.

### Table 4

The means (SD) for the postural angles, pressure pain thresholds (PPTs) and joint position errors (JPE) in the tests of kinaesthetic sensibility for the three subject groups

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Controls ( (n = 25) )</th>
<th>Cervicogenic ( (n = 27) )</th>
<th>Migraine ( (n = 25) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posture (deg)</td>
<td>CV angle</td>
<td>50.3 (4.6)</td>
<td>51.1 (5.8)</td>
</tr>
<tr>
<td></td>
<td>ETH</td>
<td>13.0 (5.7)</td>
<td>15.2 (5.0)</td>
</tr>
<tr>
<td>PPTs (kg/cm²)</td>
<td>C2</td>
<td>3.2 (1.0)</td>
<td>3.3 (1.1)</td>
</tr>
<tr>
<td></td>
<td>GON</td>
<td>4.9 (1.6)</td>
<td>4.3 (1.4)</td>
</tr>
<tr>
<td></td>
<td>C2-3</td>
<td>3.6 (1.1)</td>
<td>3.4 (1.0)</td>
</tr>
<tr>
<td></td>
<td>C4 TP</td>
<td>4.5 (1.2)</td>
<td>3.9 (1.1)*</td>
</tr>
<tr>
<td>JPE</td>
<td>Flexion</td>
<td>4.1 (1.9)</td>
<td>4.3 (2.0)</td>
</tr>
<tr>
<td></td>
<td>Extension</td>
<td>5.2 (2.1)</td>
<td>5.4 (2.7)</td>
</tr>
<tr>
<td></td>
<td>(L)</td>
<td>6.1 (2.1)</td>
<td>5.6 (2.6)</td>
</tr>
<tr>
<td></td>
<td>(R) rotation</td>
<td>6.2 (2.8)</td>
<td>5.3 (2.5)</td>
</tr>
</tbody>
</table>

GON greater occipital nerve; TP transverse process.

* \( p < 0.05 \).

### Table 5

The frequency of hypomobile and painful segments and pain score in each subject group

<table>
<thead>
<tr>
<th>Level</th>
<th>Group</th>
<th>Stiff and painful segments</th>
<th>Average VAS score</th>
</tr>
</thead>
<tbody>
<tr>
<td>O/C1</td>
<td>Control</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Cervicogenic</td>
<td>38</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Migraine</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>C1/2</td>
<td>Control</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Cervicogenic</td>
<td>39</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Migraine</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>C2/3</td>
<td>Control</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Cervicogenic</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Migraine</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>C3/4</td>
<td>Control</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Cervicogenic</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Migraine</td>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>

Subjects could be assessed to have hypomobility at one or more segments. Note two joints (left and right sides) were assessed for each segment.

*Control \( (n = 50) \), cervicogenic \( (n = 54) \), migraine \( (50) \).
The frequency of muscle tightness in each group is presented in Fig. 2. The findings of bilateral muscles have been summed and results expressed as a percentage for that muscle. There was a statistically significant difference ($\chi^2$) between the incidence of tightness in the cervicogenic headache group compared to the migraine and control groups for the upper trapezius ($P = 0.003$), levator scapulae ($P = 0.001$), scalenes ($P = 0.001$) and the suboccipital extensors ($P = 0.035$) but not for the pectoral muscles. The finding of mechanosensitivity of neural tissue was rare. Positive findings (increased resistance with provocation of pain) were only determined in two of the 27 cervicogenic headache subjects (7.4%) and in no subjects in the migraine or control groups. One cervicogenic headache subject complained of reproduction of the headache with the addition of the straight leg raise test and the other complained of reproduction of the headache, neck and arm symptoms with the addition of the upper limb tension test.

Fig. 3 presents the change in normalized EMG activity in each stage of the cranio-cervical flexion test for the three subject groups. The cervicogenic headache group displayed higher normalized RMS values for signal amplitude in the SCM than the migraine or control groups at the 26, 28 and 30 mm Hg test targets, but the differences did not reach statistical significance possibly reflecting the between subject variance.

For the discriminant analysis, the averages of the left and right measurements for each test were used along with other predictors to identify which test would classify cervicogenic headache subjects from migraine with aura subjects and asymptomatic volunteers. The eigenvalue for the discriminant function was 0.462 and the only variable selected for weighting was the eigenvalue for the discriminant function was 0.462 and the only variable selected for weighting was the

discriminant analysis was therefore repeated combining the control and migraine with aura subjects into one group. With this regrouping, the classification rate was improved with 80% of cases correctly identified on the basis of the manual palpatory finding at C1/2 level and the muscle length of pectoralis minor.

4. Discussion

Clinical signs of impairment in the articular and muscle systems identified the cervicogenic headache subjects in this study from the migraine and control subjects. However, no differences were evident between the groups with respect to static posture, PPTs, mechanosensitivity of neural tissues, and measures of cervical kinaesthetic sense.

The results of this study determined that range of cervical movement was reduced in the cervicogenic headache subjects, albeit significant for flexion and extension only. This finding of reduced movement supports the current criteria for cervicogenic headache (Sjaastad et al., 1998; IHS, 2004). Furthermore, our results reflect those of Zwart (1997) who likewise identified reduced neck motion in cervicogenic headache subjects but found similar motion in migraine and non-headache control groups.

The presence of painful segmental dysfunction in the upper three cervical joints as detected with manual examination most clearly identified the cervicogenic headache subjects in this study. The upper cervical segments in both the control and migraine groups were rated as normal and non-painful for the vast majority of joints assessed. Gijsbers et al. (1999) also found that manual examination successfully identified the 38 cervicogenic headache subjects within a cohort of 105 headache subjects on the basis of painful joint dysfunction. Upper cervical joint arthropathy is regarded as a common cause of cervicogenic headache (Trevor-Jones, 1964; Bogduk and Marsland, 1986; Bovim et al., 1992; Dreyfuss et al., 1994; Lord and Bogduk, 1996) but there is no evidence of its role in the pathogenesis of migraine with aura. This is supported in this study by the lack of finding of painful segmental dysfunction in the migraine subjects, who were no different from control subjects.

There were no group differences in measures of PPTs on sites in the cervical region, except for those over the C4 transverse process where both the migraine with aura and cervicogenic headache groups had lower PPTs than the control groups. This was a curious finding given the higher pain scores in the cervicogenic headache group.

Fig. 2. Frequency (percentage) of muscle tightness in the three subject groups.
on manual examination and the findings of reduced PPTs in other studies of cervicogenic headache and migraine (Bovim, 1992).

In relation to the muscle system, the incidence of muscle tightness was significantly higher in the cervicogenic headache group (34.9% of all muscle length tests) than the migraine with aura or controls groups, where the incidence was low (16.7% and 16.3%, respectively). No one cervico-brachial muscle predominated and tightness in the pectoral muscles was not common in the cohort of this study. These findings concur with those of Treleaven et al. (1994) and Jull et al. (1999).

The cervicogenic headache group also demonstrated poorer performance in the cranio-cervical flexion test, as indicated by the higher RMS values for signal amplitude for the SCM, which were evident in the latter three stages of the test. However, these differences failed to reach significance and this possibly reflects the large variance and the patient sample size in this study. These findings concur with those of Treleaven et al. (1994) and Jull et al. (1999).

The dura mater of the upper spinal cord and posterior cranial fossa are supplied by the upper cervical nerves and thus are capable of contributing to a cervicogenic headache syndrome. However, the occurrence of positive tests for mechanosensitivity of neural structures was rare and occurred in only two subjects in the cervicogenic headache group (7.4%) in this study. No positive tests were determined in the migraine with aura or control subjects. A low incidence of mechanosensitivity of neural structures (10%) was also determined by Jull (2001) in a study of 200 cervicogenic subjects.

No between group differences were found in the static postural measurements of forward head posture (CV angle) and head inclination (ETH). This is in contrast to other studies (Watson and Trott, 1993) but parallels the findings of Treleaven et al. (1994). In common, this current study and that of Treleaven et al. (1994) tested
younger subjects, and it is possible that postural factors may only be involved in an older subject cohort, as it is known that the FHP is age related (Dalton and Coutts 1994).

No between group differences were found in cervical kinaesthetic sense (JPE). This could also be a factor of the age group studied, or could possibly relate to the extent of the cervical pathology. For example, Sterling et al. (2004) found that only whiplash subjects with higher levels of pain and disability indicative of more severe injuries demonstrated kinaesthetic deficits whereas those with lesser scores of pain and disability did not.

A discriminant function analysis was used to determine if there were physical measures, which most discriminated cervicogenic headache from the migraine and control subjects. Not unexpectedly, when considering the overall results of this study, the analysis confirmed that the factors of upper cervical joint dysfunction, principally at the C1/2 segment and pectoralis minor muscle length, were able to discriminate the cervicogenic headache group from the migraine and control subjects (as a whole) with a sensitivity of 80%. A current criterion for diagnosis of cervicogenic headache is the elimination of headache by anaesthetic blocks nerve or joint blocks (Sjaastad et al., 1998). Manual examination could be considered as a simple, conservative and inexpensive clinical alternative to anaesthetic blocks for the large population of headache sufferers to diagnose the presence of painful joint dysfunction through pain provocation. In this respect, this study adds to the evidence of other studies of the sensitivity of manual examination for this purpose (Jull et al., 1988, 1997; Gijsberts et al., 1999).

5. Conclusion

This study determined that the presence of upper cervical joint dysfunction most clearly differentiated the cervicogenic headache sufferers from those with migraine with aura and control subjects. The cervicogenic headache group also presented with restriction in cervical motion, a higher frequency of muscle tightness and a poorer (albeit non significant) performance at the higher levels of the cranio-cervical flexion. Such musculoskeletal dysfunction was not apparent in the group with migraine with aura who did not differ from the control group. These musculoskeletal criteria are in accordance with, but better define those listed by the IHS (2004). Identification of these physical impairments in the musculoskeletal system linked to clinical features will contribute to the justification and selection of treatment for cervicogenic headache. Further work is necessary to address issues of generalizability and reliability of these results.

Acknowledgements

The authors would like to acknowledge the invaluable contributions of Mrs. Robin Zito and Dr Ross Darnell (statistician) to this study.

Appendix A. Subjective questionnaire for headache subjects

Reference number:
Name:
Diagnostic group: (1) Cx/Ha (2) Migraine
Date of birth:
Date of examination:

1. PLEASE SHADE IN WHERE YOU FEEL YOUR HEAD/NECK SYMPTOMS
2. Do you suffer any of the following symptoms with your headache?

<table>
<thead>
<tr>
<th></th>
<th>NEVER</th>
<th>OCCASIONALLY</th>
<th>ALWAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Neck pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Pins and needles or numbness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c) Dizziness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d) Ringing in ears</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e) Sight disturbances (blurring/double vision)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f) Associated vomiting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g) Associated nausea</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h) Other, please specify</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Comments: ________________________________

3(i) DO YOU HAVE ANY WARNING SIGNS THAT YOU ARE ABOUT HAVE A HEADACHE EPISODE? YES NO
3(ii) HOW LONG DO THE WARNING SIGNS LAST? Hours .......... Mins. ..............
3(iii) IF YOU HAVE WARNING SIGNS PLEASE DESCRIBE THEM ________________________________________________

3(iv) IF YOU HAVE WARNING SIGNS, DO YOUR HEADACHES COMMENCE IMMEDIATELY AFTER THE WARNING SIGNS SETTLE? YES NO

4. ARE YOUR HEADACHES/NECK PAINS MADE WORSE BY ANY OF THE FOLLOWING:

a) Turning your head? .................................................................

b) Reading or watching TV? ......................................................

c) Looking up? .................................................................

d) Driving? .................................................................

e) Stress / tension? .................................................................

f) Tying back your hair? .................................................................

g) Menstruation? .................................................................

h) Certain types of food / drink? .................................................................

i) Other triggers? .................................................................

Please specify ____________________________________________

5. HOW LONG DO YOUR HEADACHES LAST?

a) 1 - 3 hours .................................................................

b) 3 - 6 hours .................................................................

c) 6 - 12 hours .................................................................

d) 12 - 24 hours .................................................................

e) Other .................................................................
6(i) ARE YOU ABLE TO DO SOMETHING TO RELIEVE YOUR SYMPTOMS?
   a) Yes ..........................................................................................................................
   b) No ...........................................................................................................................

6(ii) IF YES, WHAT DO YOU DO?
   a) Find an easing position ........................................................................................
   b) Put on a collar, or other support..........................................................................
   c) Take medication ...................................................................................................
   d) None of the above..................................................................................................  

7. HOW DO YOU CONSIDER YOUR GENERAL STATE OF HEALTH?
   a) Good .......................................................................................................................
   b) Moderate ................................................................................................................
   c) Poor ........................................................................................................................ 

8(i) ARE YOU TAKING ANY MEDICATION FOR YOUR SYMPTOMS?
   a) Yes ..........................................................................................................................
   b) No ...........................................................................................................................

8(ii) ARE YOU/HAVE YOU BEEN TAKING ANY OTHER MEDICATION?
   a) No ...........................................................................................................................
   b) Yes ..........................................................................................................................
   Please specify: ________________________________________________________________
   __________________________________________________________________________

9(i) HAVE YOU HAD ANY X-RAYS OF YOUR HEAD OR NECK TAKEN?
   a) Yes ..........................................................................................................................
   b) No ...........................................................................................................................

9(ii) IF YES, WHERE?

   __________________________________________________________________________

9(iii) WHAT WAS THE RESULT GIVEN TO YOU

   __________________________________________________________________________

10. CAN YOU RELATE YOUR HEADACHES/NECK PAINS TO HAVE STARTED WITH:

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
</table>
   a) An accident (eg, motor car, sporting, fall) ................................................  |    |
   b) Following illness..........................................................................................  |    |
   c) Following stress .........................................................................................  |    |
   d) Prolonged sessions at the computer ............................................................  |    |
   e) Following adverse events, please specify ...............................................  |    |
   f) Other ............................................................................................................  |    |
   g) Cannot relate to anything ..........................................................................  |    |
11. DID YOUR PROBLEM START:
   a) Suddenly? .................................................................
   b) Gradually? ................................................................

12. FOR HOW LONG HAVE YOU SUFFERED FROM HEADACHES?
   a) 6 months or less ......................................................
   b) 6 months to one year ................................................
   c) 1 year to 5 years ......................................................
   d) 5 years to 10 years ....................................................
   e) Longer (Specify) .......................................................  

13. HAVE YOU HAD ANY PREVIOUS TREATMENT FOR YOUR HEADACHES/
   NECK PAINS?
   a) Yes .............................................................................
   b) No ..............................................................................

14. WHAT WAS THE NATURE OF THE TREATMENT?
   a) Advice ........................................................................
   b) Medicines/tablets ......................................................
   c) Heat/ice and exercise ............................................... 
   d) Mobilization/manipulation ....................................... 
   e) Other, please specify ...............................................  

15. WHAT WAS THE OUTCOME OF PREVIOUS TREATMENT YOU RECEIVED?
   a) Improvement (state %) ................................................
   b) No difference ...........................................................
   c) Aggravation (state %) ................................................

16. OVERALL, IS YOUR CONDITION:
   a) Getting better? ...........................................................
   b) Getting worse? ...........................................................
   c) Not changing ............................................................

17. ARE YOU REGULARLY INVOLVED IN SPORT?
   a) No .............................................................................
   b) Yes .............................................................................

Please specify: ________________________________________
_____________________________________________________________________

References
