Cervical headache: an investigation of natural head posture and upper cervical flexor muscle performance

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In this study, 60 female subjects, aged between 25 and 40 years, were divided into two equal groups on the basis of absence or presence of headache. A passive accessory intervertebral mobility (PAIVM) examination was performed to confirm an upper cervical articular cause of the subjects' headache and a questionnaire was used to establish a profile of the headache population. Measurements of cranio-cervical posture and isometric strength and endurance of the upper cervical flexor muscles were compared between the two groups of subjects. The headache group was found to be significantly different from the non-headache group in respect to forward head posture (FHP) (t = -5.98, p < 0.00005), less isometric strength (t = 3.43, p < 0.001) and less endurance (t = 8.71, p < 0.0005) of the upper cervical flexors. A statistically significant relationship was also established between natural head posture and isometric endurance of the upper cervical flexor musculature which demonstrated that FHP corresponded with a low endurance capacity (c^2 = 13.2; p < 0.01). The outcome of this study highlights the need to screen for cervical etiology in patients who are suspected of suffering from common migraine. • *Cervicogenic headache, neck flexor muscle, tension headache*

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Clinical observations suggest that forward head posture (FHP) and weakness of the upper cervical flexor musculature are associated with, and co-exist in, the cervical headache patient (1, 2). An extensive search of the literature failed to reveal any research to support these observations.

Based on current knowledge, it is sometimes difficult for the clinician to differentiate between common migraine, tension-type headache, and cervical headache because of overlap of symptoms. The current study assessed the presence of relevant cervical abnormalities in a headache population and drew comparisons with a non-headache group with respect to:

- natural head posture (NHP)
- isometric strength of the upper cervical flexor musculature
- isometric endurance of the upper cervical flexor musculature
- relationship between NHP and upper cervical flexor muscle performance

Subjects

A sample of convenience comprising 60 female subjects aged between 25 and 40 years participated in the study.

The proposed study was described by a representative of the examiner to groups of women at three large institutions. Headache sufferers and non-head-ache subjects then volunteered and were given an appointment. They were assigned to two equal groups.

The headache group comprised subjects who were currently experiencing recurring headache which was of at least five years' duration, At the time of testing they had been experiencing more than one headache per month and were not receiving treatment. The non-headache group comprised subjects without cervical pain and who either did not experience headache, or, if they did, the frequency of headache was one or less per month.

Whilst the full extent of contributory determinants of head and neck posture are not yet fully known (3), the relationship between cervical posture and dysfunction of the cervical spine and temporomandibular joints, mandibular and hyoid position, dentoalveolar and craniofacial morphology and respiration has been widely researched. Conversely, there is a paucity of studies relating cervical posture to the visual, auditory and vestibular systems. However, Vig et al. (4) have suggested that the maintenance of NHP could be expected to be influenced by the physiological requirements of these systems. Therefore, to ensure that NHP was influenced as little as possible by these factors, subjects were excluded if they had experienced, or were experiencing:

- a dental prosthesis of more than four false teeth
- a history of cervical or facial fractures/trauma including cervical or temporomandibular surgery
- recurrent middle ear infections over the previous five years
- persistent respiratory difficulties over the previous five years which had necessitated absence from work, required long-term medication, or had interfered with their daily activities

- any visual impairment not corrected by glasses
- any hearing impairment requiring the use of a hearing aid
- any known bony abnormalities of the spine, for example, scoliosis
- any disease or condition of the central nervous system, for example, multiple sclerosis, meningitis
- any systemic arthritis, for example, rheumatoid arthritis

Method

Subjects were examined using the same protocol, that is, two lateral photographs of NHP were followed by isometric strength and then isometric endurance testing. A passive accessory intervertebral movement (PAIVM) examination of the upper cervical spine followed and completion of a questionnaire by the headache group completed the examination.

The headache status of each subject was not revealed until after completion of the PAIVM examination.

Natural head posture

The method used to attain NHP, 'the self-balance position', was described by Solow and Tallgren (5) and has been used by Goldstein et al. (6), Dalton (7) and Courts (8). The 'self-balance position' was achieved by the subject performing large amplitude cervical flexion and extension, gradually decreasing to rest in the most comfortably balanced position.

The tragus of the ear was clearly marked and a plastic pointer was taped to the skin overlying the spinous process of C7. On confirmation that the subject, who was seated, had achieved NHP, a lateral photograph was taken ensuring that a gravity-defined vertical (plumb line) was clearly visible.

Using the gravity-defined vertical, a horizontal line was drawn through the spinous process of C7. The angle between this and a line joining the spinous process of C7 with the tragus of the ear formed the craniovertebral (CV) angle. The CV angle was measured in degrees directly from the photograph using a plastic overlay onto which the image of a protractor and 20 closely set parallel lines were copied, and a transparent straight edge (Fig. 1).

Performance of the upper cervical flexor musculature

The equipment to assess performance of the upper cervical flexor musculature was designed and developed by Watson (9).

In brief, the equipment consisted of a plinth with a moveable head section. Subjects, who were supine, performed head-on-neck flexion against the resistance offered by a metal bar which was rigidly attached to the plinth (Fig. 2). Deflection of the bar, which was in the order of 1 cm or less, was detected by four strain gauges mounted 50 mm from the pivot point.

Caudad movement of the trunk, which increased pressure on the chin bar, was prevented by folding the subjects' arms across their chest, placing a rolled towel under their lumbar spine and resting their lower legs over a mobile stool (Fig. 2).

The examiner passively flexed the subject's head on the neck to ensure that the posterior cervical musculature was not tight whilst simultaneously demonstrating the action required for testing. Isolation of head-on-neck flexion was ensured by constant monitoring of the pressure of the subject's head on the head section of the plinth by a displacement sensor which was fixed to the frame of the plinth midway between two springs which supported the head section.

Strength testing was completed before endurance testing because it was considered that fatigue following endurance may have affected maximum values in the subsequent strength measurement. To familiarize the subjects with the action required and the equipment, each was allowed three submaximal trial contractions before testing commenced. A 30 sec rest interval was then taken prior to the actual testing. The subjects were then instructed to tuck their chin towards their throat as hard as they could in a smooth coordinated action, and when they had completed this to relax. Three maximum voluntary contractions (MCVs) were performed, each separated by a 30 sec interval.

A rest period of 30 sec was taken before endurance testing commenced. Instruction for endurance testing was the same as for strength, except that the subject was asked to maintain the chin tuck position for as long as possible.

The values for strength and endurance were calculated from the recordings of a dual channel chart recorder (Fig. 3). The highest value of three maximum voluntary contractions was taken and was measured in kiloponds (kp). Endurance, measured in seconds, was deemed to be the time taken for the subject to fatigue to 50% of the commencing MVC. Any alteration of the head pressure on the plinth was shown by deviation on the Y axis at the top of the recording (Fig. 3).

Those subjects unable to maintain an even head pressure were excluded from the study. Similarly, any subject who experienced neck pain, headache or facial pain during testing was also excluded.

PAIVM examination

In relation to cervical headache, a PAIVM examination has been shown reliably to incriminate the symptomatic joint/s (10). Headaches which are of cervical origin originate from tissues supplied by the

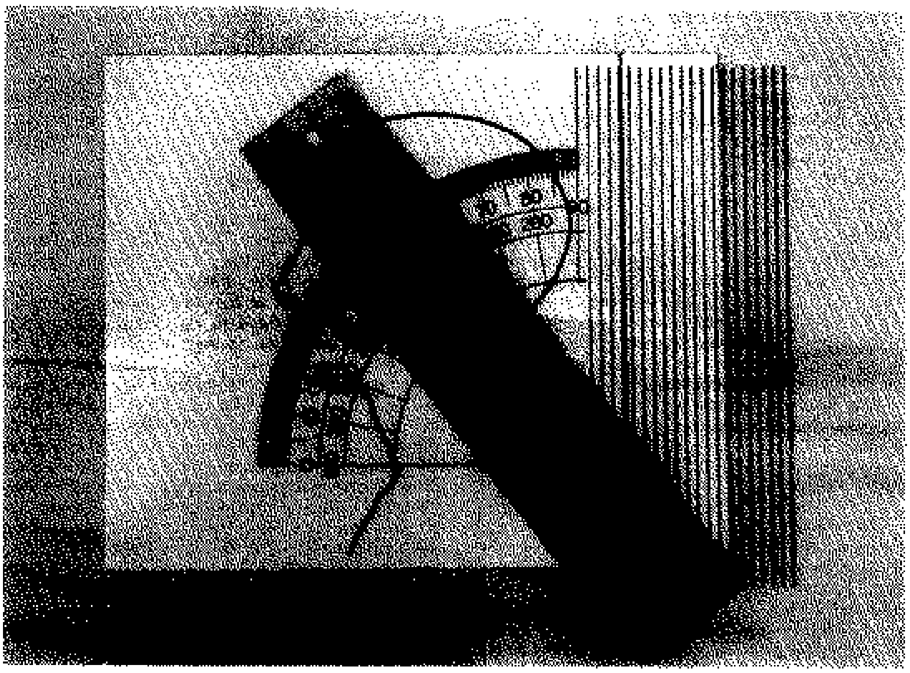

Fig. 1. The craniovertebral (CV) angle. The angle is read directly from a photograph using a protractor image and a straight edge. Note: For illustrative purposes a line diagram has been substituted for a photograph.

C_1-C_3 nerves. Bogduk (11) postulates that the trigemino-cervical nucleus provides the vehicle for referred pain to occur in the head from afferent information from the upper three cervical nerves. As the symptomatic joint/s will be located in the O-C3 complex (2), a PAIVM examination of the upper three cervical levels was performed to indicate whether the cervical spine was the possible cause of, or strongly implicated in, the subject's headache syndrome.

Each measurement was made by the examiner performing postero-anterior (PA) accessory gliding movements unilaterally on the left and right articular pillars of C1, C2 and centrally on the posterior tubercle of the C1 and spinous processes of C2 and C3. These procedures, along with differentiation between the C1-2 and C2-3 joints and transverse pressure on the tip of the transverse process of the atlas with the subject's head in ipsilateral rotation, are described in detail by Maitland (12).

Intervertebral mobility was graded on a five-point scale which ranged from hypomobile to very hyper-mobile. Grade 3 was considered normal, whilst grade 4 was classified as hypomobile; very hypomobile was graded as 5. Conversely, grade 2 indicated hypermobility and I considerably hypermobile. A symptomatic response was also recorded-no discomfort, local pain, local pain and headache, and headache only.

Questionnaire

The headache subjects then completed a questionnaire which provided information as to the description and behavior of their headache (Appendix 1). The questionnaire was designed to incorporate the features described by Edeling (13) and Jull (14), which included the area, quality, intensity, frequency and duration of symptoms, associated symptoms, history and precipitating and relieving (including response to analgesics) factors.

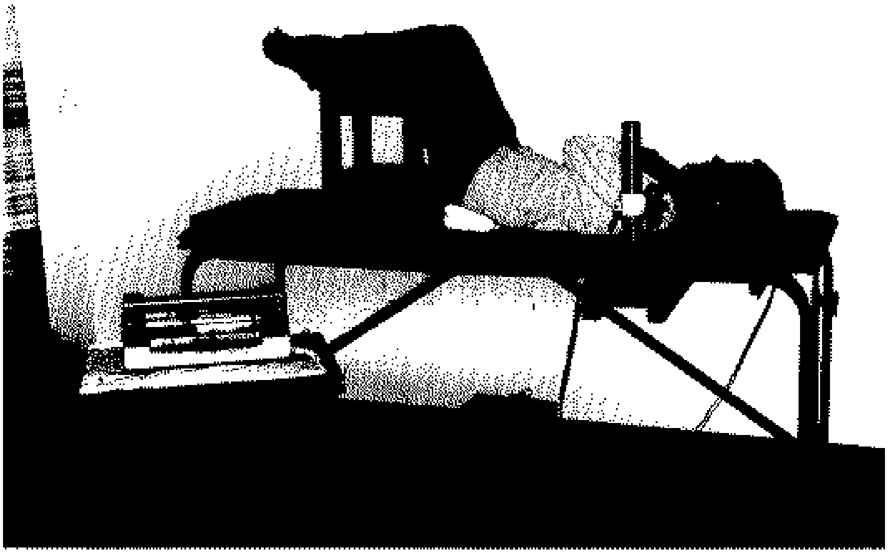

Fig. 2. The position of the subject on the plinth for testing of the upper cervical flexor musculature.

The purpose of this information was twofold. First, to exclude from the study subjects with symptoms of classical migraine and cluster headache (see question 6, Appendix 1). Second, to ensure that the headache characteristics of the subjects in this study were consistent with cervical headache as established by Edeling (13) and Jull (14) in their larger studies of 120 and 96 subjects, respectively.

Reliability

To calculate intra-examiner reliability for each section of the study 12 subjects were examined on two separate occasions, 24 h apart. The data for the CV angle were analyzed using the Pearson correlation coefficient, which revealed good agreement (r = 0.973). The Pearson correlation coefficient calculated for strength by subject on two occasions revealed good agreement (r = 0.931). An analysis of variance performed on the values of strength by subject demonstrated that the difference in values between subjects was significantly greater than any difference between the two occasions (P = 24.53, p = 0.000). Pearson correlation coefficient and analysis of variance calculations for endurance produced similar results (r = 0.931; F = 22.7, p = 0.000). The data from the PAIVM examination were analysed using Cohen's Kappa and this revealed perfect agreement in 17 of the 22 tests (K = 1.0). Of the five remaining tests the lowest Kappa score was K = 0.667, p = 0.01, which indicated good agreement (15). In view of these results it was considered that the examiner was consistent and provided reliable measurements.

Results

PAIVM examination

The subject's headache was reproduced in 12 subjects. In the remaining 18 subjects in the headache group only local joint signs were found. Unilateral headache was reported by 15 subjects and in all but two subjects, positive joint findings, that is, abnormal displacement, abnormal quality of tissue resistance and provocation of local pain, were predominately on the same side as their headache. Twelve of the 15 subjects experiencing bilateral headache demonstrated a bilateral distribution of positive joint findings.

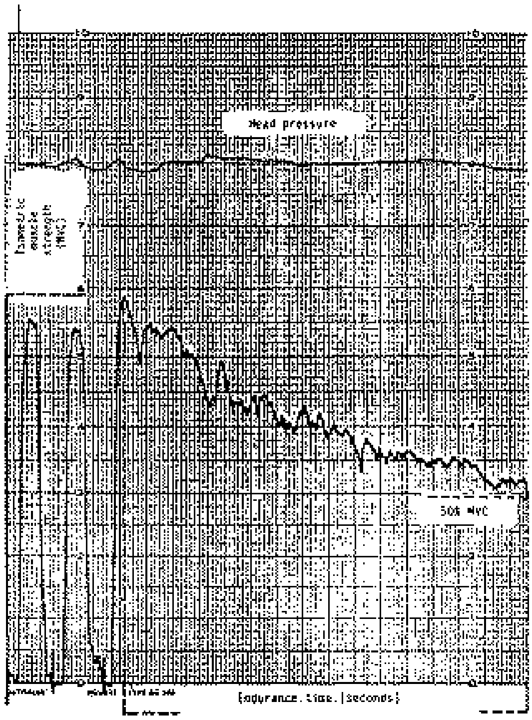

Fig. 3. Dual channel chart strip recording illustrating the muscle strength (MVC) endurance (50% MVC) and the monitoring of head pressure. Note the minimal alteration of head pressure.

Table I illustrates the frequency of positive joint findings from the headache and non-headache groups. The subjects with headache clearly had more positive joint findings.

Questionnaire

The profile of participating headache subjects closely resembled the larger studies of Edeling (13) and Jull (14).

Area of pain. Of the 30 headache subjects, 50% (15) reported experiencing predominantly unilateral headache and in no case did headache change sides. Headaches were reported in several areas of the head but the most common were frontal (73.3% *n* = 22); temporal (50% *n* = 15); occipital (29.7% *n* = 9); retro-orbital 16.6% *n* = 5. Fifty-three per cent (*n* = 16) indicated the coexistence of upper cervical pain.

Quality of pain. Subjects often complained of more than one type of pain. Twenty subjects (66.6%) reported their pain as an ache whilst 19 (63.6%)

***Table 1.* The incidence of positive joint findings in the headache (*n* = 30) and non-headache (*n* = 30) groups.**

PAIVM	Level	Non-headache (*n* = 30)	Headache (*n* = 30)
Central P/A	C1	1	8
	C2	7	17
	C3	5	15
Unilateral P/A	C1	16	30
	C2	15	26
	C1-2	1	2
	C2-3	14	24
Transverse	C1	12	21

described a throbbing/pulsating sensation, and 6 (19.8%) sharp/stabbing pain.

Intensity of pain. The subjects experienced pain levels ranging from mild through to intolerable. Twelve subjects (40%) experienced headache of moderate severity, whilst six (19.8%) considered their headache to be severe. Three of the subjects reported that the intensity of their headache varied from mild to moderately severe, mild to severe, and moderately severe to intolerable.

The remaining subjects described their headaches as mild.

Associated phenomena. Fifteen subjects (50%) reported other phenomena in addition to their headache. Nausea was the most commonly reported complaint (46.6% n = 14) of which 10% (n = 3) experienced associated vomiting. Vertigo (3 subjects), visual distubances (3 subjects) (blurred vision and photophobia), and tinnitus (1 subject) were less frequently reported associated phenomena.

Frequency and duration. The mean length of time that subjects in this study had been suffering from headache was 9.8 years, with a range of 5 to 30 years. Fifty per cent (n = 15) of subjects experienced one or more headaches per week, whilst 39.6% (n = 12) had two or more per month. Two subjects experienced daily headache and one reported a constant headache, Of the 29 subjects who had intermittent headache, the average duration of the headache was 34 h with a range of 2 h to 5 days.

Precipitating factors. Ninety per cent (n = 27) of subjects could identify one or more precipitating factors for their headache. Fifty per cent (n = 15) of subjects reported the presence of headache on waking, whilst 73.3% (n = 22) linked their headache to emotional tension. Twenty-one subjects (69.8%) were able to relate the onset of their headache to certain cervical movements or sustained flexion posture. Fatigue was also identified by 50% (n = 15) of subjects as a provocative factor.

Preceding symptoms. None of the subjects responded positively to Question 6. Twenty-two (72.6%) of the 30 subjects experienced symptoms prior to the onset of their headache. Upper neck stiffness/discomfort was reported to precede the headache by 43.3% (n = 13) of subjects, whilst 46.6% (n = 14) indicated vertigo/light headedness.

NHP/CV angle

When the mean and standard deviation values of the CV angle were tested the headache group had a smaller mean angle (44.5° ± 5.5 SD) than the non-headache group (49.1° ± 2.9 SD). A two-sample

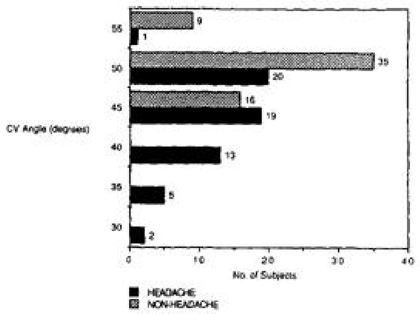

Fig. 4. The frequency of the craniovertebral (CV) angles for the headache (n = 30) and non-headache (n = 30) groups. Note that there are two scores per subject.

t-test revealed a highly significant difference between the two groups (t = -5.98; p < 0.00005). Thus, in this sample, the symptomatic group revealed a significant FHP when compared to the non-headache group. Fig. 4 illustrates the difference between the headache and non-headache groups.

Isometric strength of the upper cervical flexors

When strength values of the upper cervical flexor muscles for the two subject groups were tested the headache group had a smaller mean strength value (5.02 ± 6.88 kp) than the non-headache group (5.88 ± 1.0 kp). A two-sample t-test revealed a significant difference in muscle strength between the two groups (t = 3.43; p < 0.001). As illustrated in Fig. 5 the values for strength were lower in the

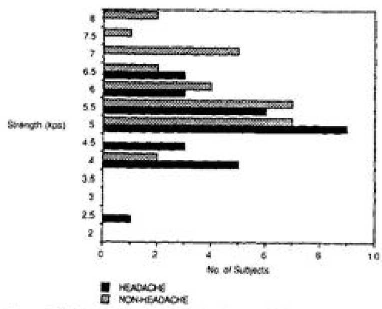

Fig. 5. The frequency of strength values of the upper cervical flexor muscles for the headache (n = 30) and non-headache (n = 30) groups. Note that values have been taken to the nearest 0.5 kp.

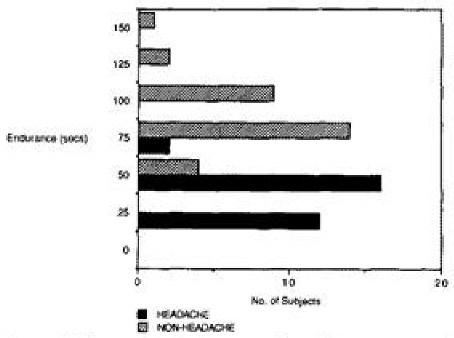

Fig. 6. The frequency of endurance values of the upper cervical flexor muscles for the headache ($n = 30$) and non-headache ($n = 30$) groups. Note that values have been taken to the nearest 25 sec.

headache group (range 2.5-6.5 kp) when compared with the non-headache group (range 3.9-8.0 kp).

Isometric endurance of the upper cervical flexors

When endurance values of the upper cervical flexors were examined it could be seen that the headache group had a much lower mean value (43.6 ± 12.9 sec) than the non-headache group (84.9 ± 22.6 sec). A two-sample *t*-test showed this difference to be statistically significant (t = 8.71; p < 0.0005). Fig. 6 illustrates the difference between the headache and non-headache groups.

Relationship between CV angle (NHP) and upper cervical flexor muscle performance

The chi square test revealed that endurance was significantly related to the CV angle (c^2= 13.7; p < 0.01), that is, lower endurance values corresponded with lower CV angle values or a FHP. No relationship was found between NHP and strength of the upper cervical flexors.

Discussion

PAIVM examination

Reproduction of headache in 12 subjects suggests the source of their headache to be cervical in origin. Of the remaining 18 subjects in the headache group, the higher incidence of positive joint findings and their correlation with the distribution of each subject's headache also suggests a headache with a cervical component.

The higher incidence of unilateral positive joint signs and greater involvement at O-C1 when compared with C2-3 and considerably less at C1-2 (Table 1) is in accordance with Jull's (14) findings in a sample of 203 patients. The 100% involvement at O-C1 in the headache group was unexpected and may reflect the small sample size.

Questionnaire

Area of pain. - Jull (14) found that the incidence of unilateral and bilateral headache was almost equal. This is borne out in the present study. The unilateral cervical headache rarely changes sides, as can occur in migraine headache (16). In this sample none of those subjects with unilateral headache reported it changing sides.

Any area of the head may be involved, but the most common areas recorded for cervical headache are frontal, retro-orbital, temporal, and occipital (14, 16-20). The results of this survey are in accordance with these reports.

Whilst an absence of upper cervical pain or neck pain does not necessarily negate a cervical cause of headache (14, 21-22) a survey of 96 headache patients found that 88% reported coexistence of occipital, suboccipital or neck pain. This finding supports those of earlier authors (23-29) and is further supported by the results of this sample.

Quality of pain.-An ache was the most commonly reported type of pain in this survey and compares favourably with Jull's (14) finding (74%), and is also in accordance with other authors (19, 20, 28).

A surprisingly large number of subjects (19, 63%) in this sample described throbbing/pulsating pain when compared with 7% of patients in the survey by Jull (14). This type of pain, along with a sharp stabbing pain described by 19.8% of subjects is reported to be uncharacteristic of cervical headache and more typical of migraine without aura (20, 30, 31). However, this finding, along with those of Edeling (13), who reported that 27.5% of the 120 patients in her survey experienced throbbing or sharp pain, suggest that these types of presentations are not uncommon in the headache sufferers with demonstrated cervical abnormality.

The high incidence of throbbing/pulsating pain is the only major discrepancy between our results and those of Edeling (13) and Jull (14). This discrepancy may have arisen from the fact that our subjects were permitted to list more than one description of their headache if it was applicable. It is unclear if this option was available to patients in previous surveys. Of the 30 subjects in this study 66.6% (n = 20) used more than one description. Ten of those subjects described aching when their headaches were mild which progressed to throbbing/pulsating if their headache became more severe.

Intensity of pain.-The intensity of the pain reported by subjects in our study compares favourably with Jull's survey (14), where 73 and 20% respectively reported moderately severe or severe headache. Edeling (13) noted that 36% of her patients surveyed experienced disabling pain. In our study the intensity of headache within some subjects ranged from mild to disabling, which contrasts with migraine in which the headache is more often moderate to severe (13).

Associated phenomena.-Jull, in her survey of 96 patients (14), reported that 44 experienced other phenomena with their headache. Nausea, dizziness and visual disturbances were the most common accompanying phenomena. From Edeling's sample of 120 patients (13), 40 reported nausea (of those 8 had associated vomiting), 27 experienced vertigo and 65 had visual disturbances. The visual disturbances reported included blurred vision, photophobia, spots and flashing lights. In all three surveys (9, 13, 14) up to half of the subjects experienced associated phenomena, including nausea, vomiting, vertigo and visual disturbances, indicating that these features may not be unique to migraine headache.

Frequency and duration of headache.-The unrecognized and untreated cervical headache usually follows a protracted course (14, 18, 22). Sixty five per cent of patients surveyed by Jull (14) had a history of headache ranging from 2 to 20 years. The subjects in the present study were required to have a history of headache for at least 5 years and had experienced their headache for a mean of 9.8 years with a range of 5 to 30 years.

Cervical headaches are not confined to bouts or attacks, but fluctuate according to circumstances (2, 13, 16, 17, 19, 29). This relative constancy of pain is reflected in the results of the present survey. Although subjects in this study had to have at least two headaches per month, 18 (59.4%) of the 30 subjects had more frequent headaches. Fifty per cent (15) of subjects reported experiencing one or more headaches per week, 6.6% (2) experienced daily headache and one subject's headache was constant. This contrasts with Jull's (14) study where 61.4% of patients reported daily headache and 28.1% two or three headaches per week. However, at the time of examination, the subjects in this study were not seeking treatment for their headache, as was the case in Jull's (14) survey. This suggests that the subject population in this study was less severely afflicted by their headache. Whilst this is a reasonable assumption, it is interesting to note that 90% (n = 27) of subjects in the current study relied on medication (comprising simple analgesics and non-steroidal anti-inflammatories), and of those, 19.8% (n = 6) reported total relief, 66.6% (n = 20) partial relief and one subject no relief at all.

Precipitating factors.- The results of Jull's (14) survey revealed that 58% of patients awoke with their headache. In the current study 50% (15) of the subjects reported headache on waking. This feature has been reported with respect to cervical headache by other authors (22, 23, 28, 32).

According to Edeling (13) and Jull (4), a common precipitating factor is that of emotional tension, to which 45 and 32.2% of patients respectively linked the onset of their headache. In our study tension was implicated in 73.3% (n = 22) of subjects. From the literature it appears that many factors are common to both cervical and tension headache. Because dysfunction of the upper cervical spine frequently co-exists in the tension headache sufferer (33) it has been suggested that either dysfunction of the cervical spine is a trigger mechanism for excessive muscle contraction or conversely the excessive muscle contraction acts on the dysfunction to cause headache (21, 33). Edeling (17) believes that "tension headache" arises primarily from pressure exerted on pre-existing painful hypomobile joints. She cites two possible reasons. First, not all people in stressful situations suffer from headache, and, second, if the headache ceases after (successful) treatment of painful upper cervical joints then emotional stress was unlikely to be the major cause of the symptoms.

Martin (34), after reviewing the literature on tension headache, concluded that the inconsistency of results reported by different authors showed that there was no simple direct relationship between contraction of scalp muscles and headache. This view is supported by Bogduk (11). Indeed, studies by Martin and Matthews (35) and Anderson and Franks (36) showed no significant difference in the amplitude of electromyographic recordings from forehead and neck muscles in patients with tension headache than in a normal controlled group. Considerable doubt then exists as to the causative role of excessive muscle contraction in tension headache (37). Therefore, there is a real possibility that tension headache is an unrecognized cervical headache, having been a convenient rather than inquiring diagnosis for chronic headache.

Authorities agree that cervical headache is commonly precipitated or aggravated by sustained neck posturing or neck movements (14, 16, 21, 22, 28, 31, 38). This is borne out in the present study, where 69.8% (n = 21) of subjects related the onset to this cause. This is in accordance with the survey by Jull (14) in which 51.0% of patients associated their headache with sustained neck flexion or neck movements. Almost a third of Edeling's (13) patients related their headache to neck movement or posture. The number of subjects in the present study reporting these features is considerably higher than the previous studies, and is even stronger support that they are common precipitating factors.

In summary, the presentation of the headaches in this study might support a diagnosis of tension headache or common migraine. The presence of relevant upper cervical intersegmental abnormalities in our subjects, however, strongly supports a cervical etiology.

CV angle/NHP

The mean CV angle of 49.1° in the non-headache group is the same (49°) as recorded by Dalton (7) in her study of 52 asymptomatic subjects of similar age (20-44 years) (Table 2). Although the sample size of both studies is small, the results demonstrate that the non-headache group of our study can be regarded as having a normal age-related value for its NHP and that the headache group presented a significantly different posture. The headache group in our study had a higher incidence of dysfunction of the upper cervical joints than the non-headache group. This is particularly important when assessing postural changes because the articular capsules of the cervical spine are highly innervated by mechanoreceptors which contribute significantly to postural and kinesthetic sensation (39, 40). McCouch et al. (41) demonstrated that the joint mechanoreceptors of the upper cervical spine are the origin of the tonic neck reflex (TNR). Trauma, even minor, influences the cervical proprioceptors, with the resultant abnormal afferent proprioceptive information affecting the TNR, which

Table 2. **Natural head posture (NHP). A comparison of results with previous studies.**

Author	NHP angle (degrees)	SD
Asymptomatic samples		
Goldstein et al. 1984 (6)		
(females *n* = 7, males *n* = 5, mean age 27.5 years)	49.9	3.8
Dalton 1987 (7)		
(females, 20-40 years, *n* = 25)	49.5	4.0
(females, 35-44 years, *n* = 27)	48.6	4.6
Watson 1990 (9)		
(females, 25-40 years, *n* = 30 mean age 30 years)	49. 1	2.9
Cureton 1941 (59)		
(males, *n* = 644, ages unknown)	50.0	-
Courts 1958 (8)		
(males, 20-34 years, *n* = 24)	50.6	3.5
(males, 35-44 years, *n* = 25)	48.9	4.1
Braun and Amundsen 1989 (60)		
(males, *n* = 20)	52.0	5.8
Headache sample		
Watson 1990 (9)		
(females, 25-40 years, *n* = 30 mean age 31 years)	44.3	5.5

subsequently alters the head-on-neck movement and position.

The centre of gravity relative to the head lies anterior to the transverse axis of sagittal motion for the head, and the resultant flexion moment is countered by the posterior cervical musculature. Whilst subjects with a history of trauma were excluded from this study, the painless, insidious nature of repetitive minor trauma in the form of abusive postural positions and abnormal movement patterns, for example, habitual flexed postures of the head and neck, may affect changes in the length-tension relationships of the cervical musculature (43). This forward positioning magnifies the effect of gravity, increasing the flexion moment of the head. The resultant hyperactivity or shortening of the posterior cervical musculature places the occiput in extension relative to the upper cervical spine, tipping the face upwards. To maintain the horizontal position of the otic (vestibular) and bipupilar planes, the individual subconsciously flexes the lower cervical spine (relative to the thoracic spine), thus adopting a forward head posture. This conceivably results in joint dysfunction which in turn leads to abnormal afferent information affecting the tonic neck reflex and encouraging the gradual adoption of a forward head posture.

Isometric performance of the upper cervical flexors

A FHP and concomitant weakness of the upper cervical flexors has been commonly observed in the cervical headache patient (1, 2). Our study confirms this clinical observation with respect to isometric endurance. Isometric strength, however, was not related to natural head posture (CV angle). This is not surprising, because the upper cervical flexors have a predominantly stabilizing role providing a holding mechanism to maintain balance and stability for the head (44). Whilst the upper cervical flexors also have a mobility function (44), that is, to initiate and perform bursts of activity, the mobility function (strength) of the upper cervical flexors probably does not play a major role in the maintenance of natural head posture.

Human skeletal muscle fibres have been classified according to their characteristics. Type I or slow twitch fibres are resistant to fatigue, and their contraction rate is slow (46, 47). Type II, or fast-twitch, fibres can be subdivided into IIa, IIb and IIc fibres. The type IIb fibres fatigue easily but contract quickly, whilst the IIa fibres are more resistant to fatigue than IIb (but less resistant than Type I fibres) and also exhibit a rapid contraction rate. Less is known of the IIc fibres, but they appear to be an intermediate form of fast-twitch fibre and usually make up only a small percentage of total fibre populations (46-48).

The upper cervical flexors are posture stabilizing and as such may have a higher proportion of Type I fibres compared to phasic or mobility musculature (49). The proportions of Type I fibres varies considerably between individuals (50, 51*).* Possibly subjects in our headache group had a lower proportion of Type I fibres. This would explain the difference in the mean endurance values. By extrapolation this leads to the possibility of an increased proportion of Type II fibres. But this would provide more strength for the headache group, contrary to our results.

Whilst most evidence suggests that fibre type predominance is genetically determined (48, 52), it may also be influenced by environmental factors (52, 53). The reduction of both isometric strength and endurance in our headache group could be due to an habitually forward head posture which, by increasing the flexion moment of the head, is likely to increase tonic activity in the suboccipital muscles with a corresponding decrease in activity of the upper cervical flexors. Experimentally, a chronic reduction in muscle activity leads to a decrease in area and number of Type I fibres and a corresponding increase in number of Type IIa fibres without change in total fibre number, that is, conversion of Type I fibres to IIa fibres (54-56). These findings, coupled with the possibility of a lower proportion of Type I fibres, could account for the considerable difference in endurance between the groups, whilst the histochemical examination findings of Templeton et al. (56), which revealed atrophy of not only Type I but also IIa fibres, may explain the less striking difference with respect to strength.

In summation, our study highlights the need to screen for cervical cause in patients who are suspected of suffering from migraine without aura and tension-type headache. Furthermore, our results confirm the clinical observations in that cervical headache sufferers: (i) exhibit forward head posture; (ii) demonstrate weakness of the upper cervical flexor musculature; (iii) lack endurance of the upper cervical flexor musculature; and (iv) present with a forward head posture and concomitant lack of isometric endurance of the upper cervical flexor musculature.

Whether forward head posture in cervical headache individuals is causative of, or perpetuating, their headache, can only be verified by ongoing research. In the meantime, clinicians should be aware of the relationship between cervical headache and poor craniocervical posture. Postural correction and re-education should be an integral part of both prevention and management of patients with cervical headache.

The direct relationship of endurance and forward head posture also confirms the need for specificity in terms of rehabilitation exercises. These should be endurance-based because endurance training improves the efficiency of Type I fibres and converts Type IIb fibres into IIa fibres (57, 58), the latter being more resistant to fatigue.

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Appendix 1

Headache questionnaire

Name:

ID:

1. Do you (please underline)
   - have headache on two or more days/month?
   - have headache on one or more days/week?
   - have a daily headache but intermittent?
   - have a constant headache?

2. Is your headache (please underline)
   - mild?
   - greater than mild but tolerable?
   - moderately severe?
   - severe?
   - intolerable?

3. How would you describe your headache (e.g. sharp, dull ache, throbbing/pulsating, bursting, squeezing/tight, heaviness, shooting, stabbing, other . . .)?

   ____

   ____

4. Are you aware of any factors that *bring on* your headache (e.g. neck bending, fatigue, tension, lifting/housework, neck movement/pain, premenstrually, other . . .)? Y/N

   ____

   ____

5. Are you aware of any factors that *aggravate* your headache? If yes, please elaborate Y/N

   ____

   ____

6. Are your headaches *preceded* by any sensation/awareness that indicates a headache is imminent? If yes, please elaborate (e.g. visual disturbances [specify], nausea, vomiting, upper neck stiffness/discomfort, dizziness, ringing in the ears, light-headedness, watering of the eyes, blocked/running nostrils, involvement of lips/tongue, pins and needles, numbness, weakness, speech disturbances, other . . .) Y/N

   ____

   ____

7. Are your headaches *accompanied* by any other sensations? If yes, please elaborate. Y/N

   ____

   ____

8. How long does your headache usually last? .... hours / .... days

9. Do you usually take medication for your headache? Y/N

10. How long have you been experiencing your headache? .... years

11. Do you usually wake with your headache? Y/N

12. On the diagrams provided please indicate

(i) where you feel your headache
(ii) the worst area if any, and, if the area changes with an increase in severity, where?
(iii) where it starts, and
(iv) where it spreads/transfers to

13. If your headache is one-sided or predominantly one-sided, is it always on the same side? Y/N

Thank you for your assistance.

Dean Watson