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Original article

The relationship between head posture and severity and disability of patients with neck pain

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Abstract

Study Design: A cross-sectional correlation study.
Objectives: To investigate the relationship between head posture with pain and disability in patients with neck pain.
Method: Sixty-two subjects with neck pain and 52 normal subjects were recruited by convenience sampling. The forward head posture was measured via the craniovertebral (CV) angle by using the Head Posture Spinal Curvature Instrument (HPSCI). The Chinese version of Northwick Park Neck Pain Questionnaire (NPQ) and Numeric Pain Rating Scale (NPRS) were used to assess neck pain disability and severity. The difference in CV angles between the two groups and Pearson's correlation coefficient between the CV angle, NPQ and NPRS were determined.
Results: There was a significant difference in the CV angle between subjects with and without neck pain. CV angle was negatively correlated with NPQ ($r_p = -0.3101$, $p = 0.015$) and NPRS ($r_p = -0.329, p = 0.009$). It was also negatively correlated with age ($r_p = -0.380, p = 0.002$). When age was taken into account, the CV angle was negatively correlated with NPQ ($r_p = -0.3101$, $p = 0.015$) but showed no significant correlation with NPRS ($r_p = -0.1848, p = 0.154$).
Conclusion: The CV angle in subjects with neck pain is significantly smaller than that in normal subjects. There is moderate negative correlation between CV angle and neck disability. Patients with small CV angle have a greater forward head posture, and the greater the forward head posture, the greater the disability.

Keywords: Correlation; Craniovertebral angle; Neck disability

1. Introduction

Proper posture is believed to be the state of musculoskeletal balance that involves a minimal amount of stress and strain on the body. Although correct posture is desired, many people do not exhibit good posture (Haughie et al., 1995). An ideal posture is considered to exist when the external auditory meatus is aligned with the vertical postural line. The vertical posture line, as seen in a side view, passes slightly in front of the ankle joint and the centre of the knee joint, slightly behind the centre of the hip joint and through the shoulder joint and the external auditory meatus (Haughie et al., 1995). Forward head posture is one of the common types of poor head posture seen in patients with neck disorders (Haughie et al., 1995; Hickey et al., 2000; Good et al., 2001; Chiu et al., 2002).

Forward head posture means that the head is in an anterior position in relation to the theoretical plumb line, which is perpendicular to a horizontal line through the centre of gravity of the body. Therapists rate the severity of the anterior positioning of the head as minimal, moderate or maximal without any objective or numeric values. A decision regarding normality or otherwise is then based on clinicians' experience and

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perception of what constitutes a normal or ‘‘ideal’’ posture, and is therefore considered to be a potential source of error (Griegel-Morris et al., 1992).

One objective method of assessing head posture is through measuring the craniovertebral (CV) angle (Watson, 1994). It is the angle between a horizontal line through the spinous process of C7 and a line from spinous process of C7 through the tragus of the ear forming the CV angle (Fig. 1). Neutral position and resting head posture are synonymous with ‘‘natural head posture’’ (Hickey et al., 2000). It is attained by asking the subject to perform large amplitude cervical flexion and extension gradually decreasing to rest in the most comfortably balanced position (Watson, 1994). The CV angle appears to be a representative measurement of a combination of an anterior or posterior position of the lower cervical spine and the associated upper cervical flexion or extension. It is imperative that the instrument and method chosen to assess head posture clinically are reliable, objective, easy to use and produce immediate results when assessing a patients’ condition as well as measuring the progress of the patient after therapeutic intervention (Wilmarth and Hilliard, 2002).

There are many instruments to assess head posture, including the Rocabado Posture Gauge, the Cervical Range of Motion (CROM) Instrument, the plumb line and photographic imaging. However, they all have disadvantages such as a complicated procedure, an expensive cost and being inconvenient to use clinically. The Rocabado posture gauge cannot be used to measure the CV angle. It measures the horizontal distance from the tangent of the most posterior thoracic spinous process to the most anterior cervical spinous process (Willford et al., 1996). The plumb line method is simple but is limited by the subjective nature of determining forward head posture (Wilmarth and Hilliard, 2002). Therapists rate the degree of anterior translation of the head as minimal, moderate or maximal without objective and numeric values though the inter-tester reliability is moderate (ICC = 0.738) (Wilmarth and Hilliard, 2002). The CROM instrument with an extension arm for head posture measurement is cumbersome (Garrette et al., 1993). Photographic imaging although accurate is time-consuming and does not allow immediate feedback of results (Wilmarth and Hilliard, 2002).

An instrument, the Head Posture Spinal Curvature Instrument (HPSCI), designed by Wilmarth, was developed to measure both the head posture and the cervical curvature (Wilmarth and Hilliard, 2002). This HPSCI was designed to eliminate the cumbersome use of multiple instruments to provide a more efficient assessment tool with immediate feedback in order to facilitate measurement in a clinical setting. The HPSCI is a non-invasive, inexpensive measurement method which has been demonstrated to produce consistent intra-rater results (ICC > 0.9) across days and trials (Wilmarth and Hilliard, 2002).

There were no previous published studies that had identified an association between forward head posture and the level of neck pain severity and disability. Griegel-Morris et al. (1992) identified an increased incidence of cervical pain, inter-scapular pain and headache with forward head posture; however, they did not establish a relationship between the severity of neck pain and the degree of postural abnormalities. Willford et al. (1996) found that there was no significant difference in the forward head posture between groups of subjects with different levels of neck pain, although they did find that subjects wearing multifocal lenses had a greater degree of forward head posture when compared with non-multifocal lens wearers. However, the sample size was small and the validity of the pain assessment tool was questionable in their study. Szeto et al. (2002) showed that there were trends for increased head tilt and neck flexion postures in the symptomatic subjects presenting with neck and shoulder discomfort when compared to the asymptomatic subjects. However, the study by Szeto et al. did not evaluate the relationship between head posture and the degree of disability caused by neck pain. Moreover, the subjects in their study were limited to female clerical staff.

From our clinical experience, we hypothesize that there is a relationship between CV angle and pain and

Fig. 1. The craniovertebral (CV) angle.

the disability level in patients with neck pain. Thus, the objectives of this study are to determine:

1. if there is any difference in the CV angle between subjects with and without neck pain;
2. if there is any relationship between head posture as measured by CV angle with neck pain and the disability level in patients with neck pain.

The significance of this study may give clinicians further objective information to evaluate the severity and disability of neck pain by measuring the CV angle using the HPSCI.

2. Materials and methods

2.1. Subjects

There were two groups of subjects. The non-neck pain (control) group consisted of 52 subjects (mean age 42.33, SD $\pm$ 11.18) and the neck pain group consisted of 62 subjects (mean age 39.92, SD $\pm$ 10.80). Both groups were recruited from a physiotherapy out-patient department by convenience sampling. Subjects in the non-neck pain group were patients with other problems referred for physiotherapy treatment such as knee pain, sprained ankle, tennis elbow, etc. They had not suffered from neck pain in the past three years. Subjects in the neck pain group were diagnosed to have neck pain with or without referred pain, numbness or paraesthesia over the upper limbs and were referred for physiotherapy by a physician. Subjects were excluded if they had experienced, or were experiencing, one or more of the following: a history of cervical fracture or trauma, cervical surgery, idiopathic scoliosis, bone cancer, spasmodic torticollis or neurologic motion disorder, disease of the central nervous system, persistent respiratory difficulties over the past five years, any hearing impairment requiring the use of a hearing aid, temporomandibular surgery or dysfunction and any visual impairment not corrected by glasses. Written consent was obtained from all subjects. This study was approved by the Human Research Ethical Committee of the Hong Kong Polytechnic University.

3. Procedure

3.1. Head posture measurement (CV angle)

For the head posture measurement, subjects from both groups were assessed in their first physiotherapy session before any treatment was given. Their diagnoses were known to the principle investigator and they were recruited according to the inclusion criteria. The subjects were asked to give consent and they were asked not to tell the assessor about their diagnoses. The measurements were taken by an experienced physiotherapist who was blinded to the grouping of the subjects.

During the assessment, the subject was required to stand in a relaxed posture. The assessor first located the spinous process of C7 by asking the subject to flex and extend the neck. The C7 spinous process is more prominent, whereas the C6 spinous process is absent in palpation when the neck is extended. The C7 spinous process was then marked by a small flag to ensure the correct location and consistency of the bony landmark. The subject was then instructed to flex and extend his or her head three times and then rest the head in a comfortable neutral position (Watson, 1994). The assessor performed the assessment in a left sagittal view. The measurement (CV angle) was taken with the HPSCI. The assessor aligned the axis of the instrument with the C7 spinous process in the left sagittal view. The instrument was placed adjacent to the shoulder. Then, the movable arm of the instrument was aligned with the tragus of the ear and the stationary arm was aligned perpendicularly to the floor. The alignment with the floor was confirmed with the line level that was attached to the stationary arm. Once it was levelled, a measurement (the angle between the movable and stationary arms) to the nearest degree was made and then recorded (Fig. 2). If the indicator fell between two whole numbers, the smaller degree would be recorded in order to be consistent. A total of three measurements were made. A 2-min rest was given to the subject between each measurement. The mean value was evaluated (Wilmarth and Hilliard, 2002).

3.2. Neck pain disability and severity

After the three measurements, subjects with neck pain were required to fill in the Chinese version of Northwick Park Neck Pain Questionnaire (NPQ) (Chiu et al., 2001) and Numeric Pain Rating Scale (NPRS). It was considered unlikely that the CV angle measurement protocol would affect intensity of pain symptoms.

The NPQ has been found to be reliable and valid for patients with neck pain (Chiu et al., 2001); it consists of nine five-part questions that assess the subject's symptoms, from which a score is obtained. Subjects were required to answer all the questions except question 9 on driving, which was omitted if the patient did not drive a car when in good health. The scores to the questions were summed and converted to a percentage score, as recommended by Leak et al. (1994). The higher the percentage, the greater the disability and vice versa. The NPRS is a numeric scale to measure the intensity of pain (Jensen et al., 1986; Cole et al., 1994). The scale consists of 11 points from 0 to 10 with 0 being "no pain" and 10 being "pain as worst as it could be".

3.3. Data management and analysis

Intra-class correlation coefficient (ICC) was used to determine the intra-rater reliability of using the HPSCI. The minimal level of detectable change (MDC) was calculated according to the formula: standard error of measurement (SEM) $\times$ z-score at the two-sided 95% confidence intervals ($z = 1.96$) $\times \sqrt{2}$. Independent sample t-tests were used to determine if there were any differences in demographic characteristics and CV angle between the control and neck pain groups. Pearson's correlation coefficient was used to investigate the relationship between the CV angle, neck pain disability and severity. SPSS 10.0 for Windows was used for statistical analysis.

Fig. 2. Measuring the CV angle by using the Head Posture Spinal Curvature Instrument.

4. Results

A total of 62 subjects (22 males and 40 females) and 52 subjects (16 males and 36 females) were recruited in the neck pain group and non-neck pain (control) group, respectively. The demographic characteristics of these subjects are shown in Table 1. The distribution of male and female subjects in both groups was comparable. Results demonstrated that there was no significant difference in age between the two groups ($p = 0.916$). However, CV angle of the neck pain group (mean 49.93, SD $\pm$ 6.08) was significantly smaller ($p < 0.000$) than that in the control group (mean 55.02, SD $\pm$ 2.86).

The ICC of using the HPSCI with all the subjects (in both groups) was 0.98. The SEM was 1.696 and the MDC was 3.61°.

Pearson product–moment correlation coefficients between the CV angle, age, neck disability score (NPQ), NPRS and history of neck pain are shown in Table 2. Results demonstrated that CV angle was negatively correlated with NPQ ($r_p = -0.395, p = 0.002, R^2 = 15.6\%$) and NPRS ($r_p = -0.329, p = 0.009, R^2 = 10.8\%$). That is, the greater the CV angle, the lower the NPQ and NPRS scores and vice versa. It was also negatively correlated with age ($r_p = -0.380, p = 0.002, R^2 = 14.4\%$). That is, the older the subject, the smaller the CV angle and vice versa.

When correlation evaluation was adjusted for age, the CV angle was negatively correlated with NPQ ($r_p = -0.3101, p = 0.015$) but showed no significant correlation with NPRS ($r_p = -0.1848, p = 0.154$) (Table 3).

No relationship was found between CV angle and the duration of neck pain ($r_p = 0.002, p = 0.988$). A positive correlation was found between NPQ and NPRS ($r_p = 0.649, p \leqslant 0.000$). That is, the higher the NPQ, the higher the NPRS and vice versa. Age was positively correlated with NPRS ($r_p = 0.470, p \leqslant 0.000$) and NPQ

Table 1
Demographic characteristics of the subjects

	Neck pain group	Control group	*p* value of between group difference
	Mean ± standard deviation	Mean ± standard deviation	
Age (years)	39.92 ± 10.80	42.33 ± 11.18	0.916
Northwick Park Neck Pain Questionnaire score (%)	31.90 ± 15.41	Not applicable	Not applicable
Numeric Pain Rating Scale	3.87 ± 1.82	Not applicable	Not applicable
Craniovertebral angle (degree)	49.93 ± 6.08	55.02 ± 2.86	<0.000
Duration of neck pain (years)	2.61 ± 2.64	Not applicable	Not applicable

Table 2
Pearson's correlation between CV angle, age, NPQ, NPRS and history of neck pain

	CV angle	Duration of neck pain	NPRS	NPQ	Age
CV angle	1.000	0.002 $p = 0.988$	-0.329^{**} $p = 0.009$ $R^2 = 10.8\%$	-0.395^{**} $p = 0.002$ $R^2 = 15.6\%$	-0.380^{**} $p = 0.002$ $R^2 = 14.4\%$
Duration of neck pain	0.002 $p = 0.988$	1.000	−0.023 $p = 0.858$	−0.110 $p = 0.396$	0.073 $p = 0.574$
NPRS	-0.329^{**} $p = 0.009$	−0.023 $p = 0.858$	1.000	0.649^{**} $p \leqslant 0.000$	0.470^{**} $p \leqslant 0.000$
NPQ	-0.395^{**} $p = 0.002$	−0.110 $p = 0.396$	0.649^{**} $p \leqslant 0.000$	1.000	0.324^{*} $p = 0.010$
Age	-0.380^{**} $p = 0.002$	0.084 $p = 0.517$	$0.4\text{–}0.380^{**}$ $p = 0.002$	0.324^{*} $p = 0.010$	1.000

CV angle: craniovertebral angle; NPQ: Northwick Park Neck Pain Questionnaire; NPRS: Numerical Pain Rating Scale; R^2: coefficient of determination.
*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table 3
Pearson's correlation between CV angle, NPQ and NPRS (adjusted for age)

	CV angle	NPRS	NPQ
CV angle	1.000	−0.1848 $p = 0.54$	-0.3101^{*} $p = 0.015$
NPRS	−0.1848 $p = 0.54$	1.000	0.5952^{*} $p \leqslant 0.000$
NPQ	-0.3101^{*} $p = 0.015$	0.5952^{*} $p \leqslant 0.000$	1.000

CV angle: craniovertebral angle; NPQ: Northwick Park Neck Pain Questionnaire; NPRS: Numerical Pain Rating Scale.
*Correlation is significant at the 0.05 level (2-tailed).

($r_p = 0.324, p \leqslant 0.000$). That is, the older the subject, the higher the NPRS and NPQ and vice versa.

5. Discussion

The intra-rater reliability (ICC) of using HPSCI to measure CV angle was ICC = 0.98 in this study, which was consistent with the previous finding by Wilmarth and Hilliard (2002) (ICC$\geqq$0.9). The SEM was 1.696 and MDC was 3.61°. This indicated that a given clinician could reliably monitor head posture through the CV angle using HPSCI. Further study on the inter-rater reliability of the HSPCI should be performed as this would give greater flexibility for different therapists or medical professionals to follow patients' progress. The MDC is the lowest change that can confidently be considered as exceeding measurement error and noise.

Results of the present study showed that the CV angle in neck pain subjects was significantly smaller than that in normal subjects. We consider that this is clinically significant as the difference (5°) is 38.8% bigger than the MDC (3.61). Thus, in this sample, subjects with neck pain revealed a significant forward head posture when compared to the subjects without neck pain. Johnson (1998) suggested that prolonged forward head posture might increase loading to the non-contractile structures and abnormal stress on the posterior cervical structures and cause myofascial pain. Further study is required to find out whether this 5° difference in forward head posture could lead to a significant increase in stress on the posterior cervical region in subjects with neck pain.

The results also showed that there were moderate degrees of relationships between NPQ and CV angle ($r = -0.395$) and between NPRS and CV angle ($r = -0.329$) (Portney and Watkins, 2000). CV angle was negatively correlated with NPQ and NPRS. This was consistent with our hypothesis. The smaller the CV angle (that is, the more forward head posture), the higher the NPQ and NPRS scores and vice versa. However, no causal relationship could be established in this correlation study.

The correlation between CV angle and NPQ and NPRS were only moderate at best, suggesting that forward head posture is only one of the factors relating to neck pain and disabilities. The coefficient of determination (R^2) might reveal that about 10–15% of the level of pain and disability could be attributed to neck posture (if it were a causative relationship). There are a number of other factors, for example, osteoarthritis changes, repetitive strain, overuse syndromes and psychological factors that can contribute to the level of neck pain and disabilities (Borenstein et al., 1996). Further studies are required to elucidate this.

When correlation evaluation was adjusted for age, CV angle was not significantly correlated with NPRS, indicating that age is a confounding factor in this relationship. Moreover, pain intensity is only one of the dimensions addressed in the disability of neck pain. Chiu et al. (2005) also reported a weak correlation between intensity of pain and physical impairments, which included an active range of motion and isometric neck muscle strength in patients with chronic neck pain. There was still a moderate degree of relationship between CV angle and NPQ even when age was taken into account. This may give support to the fact that disability assessment is multi-dimensional and can provide a more complete picture of the presenting clinical problem.

Clinically, the measurement of CV angle by HPSCI can provide us with further objective information to monitor patients' conditions. We can measure patients' CV angle objectively and attempt to correlate this with patients' pain level and disability. Measures of the CV angle can also be used to document changes in cervical posture due to various interventions, such as exercise programs or postural education.

The finding that the NPQ and NPRS were positively correlated ($r_p = 0.649$) is consistent with a previous study (Hermann and Reese, 2001). Hermann and Reese reported that physical impairments (which included cervical spine range of motion and cervical muscle force), pain intensity, disability and functional limitation were positively correlated in patients with cervical spine disorder. As pain intensity is one of the dimensions measured in NPQ, a positive correlation would be expected.

Age was also negatively correlated with CV angle. That is, the older the subject, the smaller the CV angle. This result is consistent with the findings of a study by Dalton and Coutts (1994) who demonstrated that there was a progressive decline in the CV angle of natural head posture with increasing age. However, they did not provide any reason for this progressive change. Also, age was positively correlated with NPQ and NPRS. That is, the older the subject, the more disability and pain they suffered. A recent study also demonstrated that the prevalence of spinal pain (neck and back pain) with disability continues to rise into old age (Webb et al., 2003). In contrast, Cote et al. (1998) reported that the prevalence of low-intensity and low-disability neck pain decreases with age. A longitudinal study may better assess the relationship between age, posture and neck pain (Griegel-Morris et al., 1992).

Hanten et al. (2000) suggested that clinical assessment of patients with neck pain should focus on cervical mobility rather than resting head posture. They found that the resting head posture was not significantly different between patients and the normal population. However, results of the present study revealed a significantly different forward head posture in patients with neck pain when compared to the subjects without neck pain. Our findings also demonstrated a moderate correlation between head posture and disability in patients with neck pain. Therefore, we suggest that clinicians should be aware of the relationship between forward head posture and neck pain. Postural correction and re-education should be considered as an integral part of prevention and management of patients with neck pain.

6. Limitations

The major weakness of correlational research is its inability to establish cause-and-effect relationships. However, in view of the lack of documented evidence that exists concerning these common outcome measures, it is essential to demonstrate how these variables are related in patients with chronic neck pain.

As the three measurements were made on one occasion with only a short interval between repeated measures, assessor recall bias was likely to be high, possibly inflating the level of reliability found (ICC 0.98). There was potential error in attempting to choose which way to read the scale when the indicator fell between two whole numbers (Garrette et al., 1993); we tried to overcome this by recording the smaller degree in order to be consistent. The measurement can be more accurate if an electronic HPSCI with high sensitivity is developed.

Furthermore, we did not measure the sagittal plane position of either the cervical, thoracic or lumbar spine. This was another limitation to our study because the CV angle depends on the relative position of the entire spine (Hermann and Reese, 2001). We tried to minimize this error by standardizing the measurement in standing position. Accurate measurement of complete head and neck posture requires a cephalometric radiographic analysis which was not available for this study. Patients with a certain diagnostic label, for example, whiplash and radiculopathy, might have different postural responses. Future investigation in patients with different diagnosis may give us information about the CV angle and disability level with different pathologies. Further study is also required to elucidate the responsiveness of CV angle as measured by the HPSCI in patients with neck pain before this can be recommended as a valid and reliable outcome measuring tool.

7. Conclusion

Results demonstrate that there is a high degree of test–retest reliability in measuring the CV angle by using the Head Posture Spinal Curvature Instrument (HPSCI). The CV angle in subjects with neck pain is significantly smaller than that in normal subjects. The CV angle is negatively correlated with the disability of patients with neck pain. The smaller the CV angle (that is, the more forward head posture), the higher the NPRS score will be and vice versa. We recommend that CV angle as measured by the HPSCI can provide clinicians with further objective information on the disability and severity of patients with neck pain.

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