An investigation of poor cervical resting posture

Karen Grimmer

In an attempt to measure cervical resting posture, a device was developed to quantify the excursion of anatomical points on the upper and lower cervical spine. Measurements were taken from 427 randomly chosen subjects who had never sustained an injury to the neck or back. Excursion measurements were in good agreement over a month interval. Poor cervical resting posture was described by dividing the excursion angle data at each anatomical point into quintiles, and designating the first and fifth quintiles as extreme. Subjects whose upper and lower aspects of the cervical spine excursed by extremely small angles, and subjects whose upper and lower aspects of the cervical spine excursed by extremely large angles, were considered to have poor posture. These postures were markedly different. The study highlighted the need for further research into influences on habitual cervical resting posture.

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K Grimmer PhD, MMedSc, BPhty, LMusA is a Research Fellow at the School of Physiotherapy, University of South Australia.

Correspondence: Dr Karen Grimmer, School of Physiotherapy, University of South Australia, North Terrace, Adelaide, South Australia 5000.

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A function of the cervical spine is to counterbalance the head against the force of gravity (Janda 1988, Kendall et al 1952, Wägenhausen 1971). Erect human posture is often assessed in the sagittal plane using a vertical reference line, as in this view the body's response to gravitational forces can be observed (Wägenhausen 1971). The most commonly cited vertical reference line, that of Kendall et al (1952), is a compromise between the actual gravitational line, reported by Hall et al (1986), and the plumb line which was used originally by Braune and Fischer (1889). The human spine aligned against a vertical reference in the sagittal plane forms three curves, the posteriorly concave aspects of which are described as the cervical and lumbar lordoses. These spinal curves are a compensatory arrangement of spinal segments that support the body with minimal stress and energy expenditure (Basmajian 1979, Penning 1988, Sahrmann 1987).

Poor head posture is considered to be inefficient, increasing the antigravity load on cervical structures, instigating abnormal and compensatory activity by them, and resulting in pain (Edmeads 1988, Janda 1988, Jensen et al 1993, Trott 1988). In research settings, there are several sophisticated methods that can provide objective and reliable measurements of cervical resting posture. The range of intervertebral joint movement has been measured by X-ray techniques (Smidt et al 1984, Van Mameren et al 1990) and by computer-assisted anatomical positioning (Gervais and Marino 1983). An early method of measuring spinal angles from photographs (Loebl 1967) was revised and described by Braun and Amundson (1989), and has been employed by Raine and Twomey (1994), Refshauge et al (1994) and Watson and Trott (1993) in recent Australian studies of head-on-neck posture.

In clinical settings, time, expense and/or the need for immediate information limit the use of these methods. There are no standard and reliable methods available to measure posture in a clinical setting. Several recently reported methods of measuring cervical resting posture in a clinical setting are variations on the method of Kendall et al (1952), where the position of the head is described with respect to a vertical reference line or a grid (Ayub et al 1984, Bryan et al 1989, Passero et al 1985, Rheault et al 1989). However attractive from the point of view of time, cost and space efficiency, the subjectivity of this approach limits its usefulness both for taking repeated measures from an individual, and for describing the range of cervical resting posture in the population.

There is also no standard method of defining poor head posture in a clinical setting, where poor resting head postures are usually identified by visual inspection. They are commonly described as forward head posture. This term appears to be non-specific, as it has been employed to describe different poor resting head postures. One of these is a resting head held well in front of the line of gravity (Braun 1991, Passero et al 1985, Raine and Twomey 1994). This posture, illustrated by Trott (1988, p. 237), involves a flattened cervical lordosis.

The second resting head posture

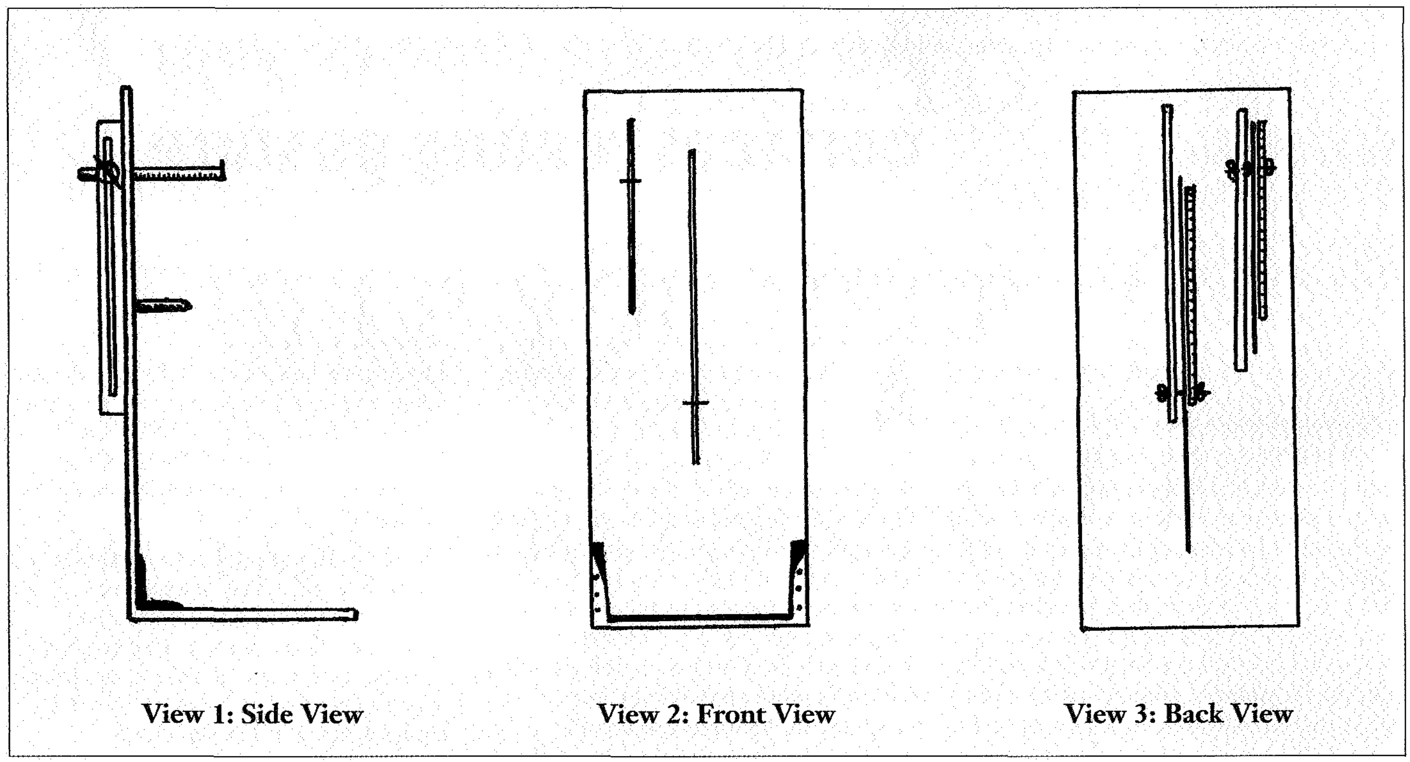

Figure 1.
The plan of the Linear Excursion Measuring Device.

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commonly described as forward head posture is one in which the chin leads and the head is angled slightly upwards, tilted caudally within, or slightly anterior to, the line of gravity (deVries 1966, Hanten et al 1991). Saunders (1982) describes this posture as "a sagging forward of the head and neck with the face tipped upward" (p. 20-21). This posture implicates C5 in an increased translatory movement on C6 because of the accentuated cervical lordosis (White and Panjabi 1990).

Evidence to specifically associate particular cervical resting postures with pain has been provided largely by single case studies or anecdotal reports, in which correction of perceived poor posture by realigning the position of the head with respect to the gravitational line (Kendall et al 1952) effects a decrease in headache and/or neck pain (Ayub et al 1984, Bibby and Preston 1981, Jull 1986, Rocobardo 1983, Trott 1988). Accordingly, correction of all perceived poor posture to approximate the gravitational line should be questioned. Kendall et al (1952) claimed never to have examined an individual with posture perfectly aligned with the vertical reference line. Moreover, Penning (1978) provided radiological evidence of wide variation in cervical spine posture in the sagittal plane in subjects who had never sustained an injury to the cervical spine. There have been no studies describing the resting head posture most closely associated with pain, and there has been little investigation of the causal mechanisms underlying cervical resting posture. In addition, there is little to indicate why individuals assume one particular resting posture, or why certain individuals suffer pain associated with particular resting head postures.

In an attempt to describe the resting head posture in a clinical setting in a reproducible and objective way, a new method of measuring cervical resting posture has been developed. It is based on the measurement described by Hanten et al (1991) who contended that "stating that someone has forward head posture based solely on resting head posture provides no information about the mobility in the excursion range, which may be more valuable" (p. 880).

Cervical resting posture is described in this paper as the angular excursion of two points on the cervical spine, traced as the head assumes its habitual resting posture from a corrected vertical starting position. This paper reports on a randomised cross-sectional study of individuals who had never sustained an injury to the neck or back. It describes the range of excursion angles traced by two points on the cervical spine in the never-injured population. Two hypotheses were tested, ie that:

1. no subject had resting posture perfectly aligned with the gravitational line; and

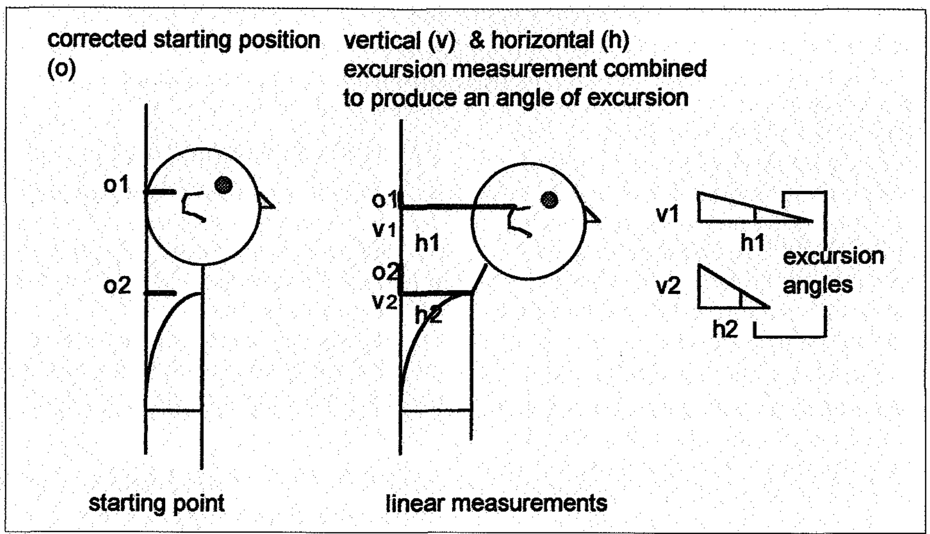

Figure 2.
The concept of linear excursion measurements and cervical excursion angles.

2. subjects with both excursion angles occurring in either of the two extremes of the population range, had 'poor' habitual cervical resting posture.

Method

Measurement of cervical excursion angles

Cervical resting posture was measured as cervical excursion angles using the Linear Excursion Measurement Device (LEMD) described by Grimmer (1993 and 1996) and illustrated in Figure 1. The LEMD measured the horizontal and vertical excursion traced by anatomical points on the upper and lower aspects of the cervical spine when the head moved from a standard starting position into its usual resting position. The device consisted of a vertical backboard attached at right angles to a horizontal board seat. Two vertical slots were cut, one into the centre of the backboard, and one 15cm to the right of this slot. A frame fitted parallel to each slot on the rear of the backboard accommodated a sliding T-square bracket. A casing mounted onto this bracket allowed a calibrated steel ruler to run horizontally through the vertical slot. Each casing had two screws: one to lock the T-square bracket onto the frame, and the other to lock the horizontal ruler into position within the casing. A millimetre ruler with a sliding central pointer was placed parallel to each vertical slot on the rear of the backboard.

The superior-most tip of the helix of the ear was chosen as the reference point for upper cervical spine movement because it was clearly visible, it moved in direct relation to the skull and it could be indelibly marked for re-measurement. This point was closely aligned with the vertical reference line as it passed through the head and cervical spine of a subject standing with ideal plumb alignment as described by Kendall et al (1952).

The spinous process of C7 was chosen as the reference point for lower cervical spine movement because it could be located by sight and palpation. It was a choice consistent with the method of measuring cervical posture using the cranio-vertebral angle from photographs (Braun and Amundsen 1989).

The LEMD was positioned on an adjustable plinth which allowed each subject to sit with thighs, knees and ankles at 90 degrees. Subjects' forearms rested comfortably on their thighs and the anatomical reference points were marked in this sitting position.

A wall chart was hung in front of the subjects and subjects were asked to spot any letter level with their eyes. Subjects then maximally retracted their chins, pressing the back of the head and scapulae onto the vertical backboard. This maximal chin retraction position has been described by Braun and Amundson (1989) and McKenzie (1990). The horizontal sliding rulers were positioned level with the anatomical reference points, and the position of the T-square brackets, through which the horizontal rulers ran, was marked on the vertical ruler. While a large range of chin retraction mobility was observed among the study subjects, positioning head and shoulder blades on the backboard standardised the starting position for all subjects and became the reference for resting posture measurements (corrected starting position O in Figure 2). Subjects then assumed their usual cervical resting posture using the Natural Head Posture technique (Solow and Tallgren 1971). This required three decreasing amplitude flexion/extension movements of the head on the neck. During this procedure, subjects maintained contact between their scapulae and the backboard, and spotted the selected letter during each head sweep. The usual resting posture of the head was then measured by sliding the T-squares down and again fixing the horizontal rulers level with the marked anatomical points. Instructions for eye contact during the three flexion/extension sweeps of the head were considered to be an important element of the protocol, since these standardised the horizontal placement of the head during assumption of habitual resting posture (Hanten et al 1991, Solow and Tallgren 1971). Tonic coupling has been observed between horizontal eye position and dorsal muscle activity in both humans and animals (Andre-

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Deshays et al 1991).

A chest strap, as advocated by Braun and Amundson (1989), to obtain cervical resting posture measurements was not employed with this device. There was concern that a chest strap might disadvantage the true excursion of the spinous process of C7 by unduly constraining the usual relaxation of the lower cervical and upper thoracic spine. Mid-thoracic stability was confirmed by continued contact between the scapulae and the vertical backboard during all movements. It was found that all subjects achieved sufficient shoulder relaxation after the initial head movement, to allow the head to lie anterior to the vertical backboard at the full arc of initial extension. The concept of excursion measurements is illustrated in Figure 2. From the linear measurements, angles of excursion for each anatomical point were computed using the formula:

$$\text{degrees } (\theta) = \tan^{-1} \frac{\text{vertical distance}}{\text{horizontal distance}}$$

Small angles of excursion were produced by small vertical movements and large horizontal movements of the chosen anatomical point. Conversely, larger angles of excursion were obtained as the vertical movement increased and the horizontal movement decreased.

Subjects and selection

The source of subjects was the electoral rolls of two adjacent municipalities in Tasmania, Australia: the Huon and the Esperance municipalities. Subject selection was by random numbers, proceeding backwards from the end of one electoral roll, and downwards from the beginning of the other. In the event that the chosen individual could not be contacted by telephone or letter, the next person on the electoral roll was contacted.

Individuals were excluded from the study if they recalled sustaining a specific neck or back injury. They were also excluded if they were taking medication for classic migraine headache, if they were regularly taking anti-inflammatory medication for degenerative joint conditions, if they were taking analgaesics or if a woman was pregnant or breast feeding. The exclusion criteria were applied with the aim of identifying subjects without previous spinal injury and who had potentially similar influences on their cervical resting posture.

A sample of 450 individuals were approached to participate in the study. There was no information regarding the prevalence of poor posture in the never-injured population, and therefore this sample size was an estimate only of the required number for adequate description of the population range of excursion angles. There were nine refusals and 14 exclusions: five for previous neck or back injury, three for pregnancy or breast feeding, four for regularly taking non steroidal anti-inflammatory drugs (NSAIDs) and/or analgaesics and two for taking regular medication for migraine headaches. Measurements of cervical excursion were then taken from 427 subjects.

Measurements

The data for men and women were tested separately in an attempt to identify and describe gender effects on excursion.

Reproducibility of measurements

The first 100 of the 427 subjects were recalled one month after the first set of measurements for a second set, and 93 complied. The two sets of measurements were compared to determine the reproducibility of the excursion of the chosen points on the cervical spine. Correlation coefficients were reported as an expression of the stability of the measure (Nunnally 1972). Intraclass correlations ($ICC_{(1,3)}$) were calculated from the output of analysis of variance procedures under a general linear model, in which account was taken of random subject effects. Root mean square error (RMSE) statistics were reported as measures of the variability between scores and *t* tests for correlated means were employed to assess systematic influences on the second test.

Strength of association

An estimate was made of the gender-specific strength of association between the two excursion angles, using data from all 427 subjects. The relationship between the data was initially investigated by scattergraphs, and a model appropriate to the shape of the observed relationship was then fitted to the data.

Extreme excursion angles

Extreme excursion angles were identified from the frequency distribution of the excursion angle data from all 427 subjects. Where data were normally distributed, extreme excursion angles would be identified as those falling beyond two standard deviations from the mean. Where data were non-normally distributed, the data would be divided into quintiles and the first and fifth quintiles identified as extreme (Cramer 1991).

An attempt was made in this study to describe a series of resting head positions that were representative of a defined stratum of the excursion angle range. Investigation was confined to those subjects with similar angular excursion of the upper and lower cervical spine. This focus was taken because little is known regarding the manner in which posture develops, and why an individual assumes a particular resting head position. When comparing the ideal (most efficient) resting head posture with the vertical reference line used in the linear excursion measuring device (the backboard), the upper and lower aspects of the cervical spine would be similarly positioned in the sagittal plane. Significantly, Penning (1978) reported wide variability in resting head postures of subjects who had not sustained an injury to the cervical spine. Thus, differences in the habitual resting position of the upper and lower aspects of the cervical spine with respect to the gravitational line may well exist among subjects. Reasons for such differences may include individual

Table 1.
Frequency distribution statistics for excursion angles.

frequency distribution statistics	helix excursion angles		C7 excursion angles	
	men	women	men	women
range (degrees)	1 - 18	1 - 17	1 - 25	1 - 25
skewness	0.64	1.18	0.79	0.88
kurtosis	-0.001	1.31	0.61	0.68
Shapiro Wilk statistic	0.89*	0.94*	0.91*	0.94*
mean	5.42	6.08	7.70	8.45
(SD) (degrees)	(3.45)	(3.32)	(4.52)	(4.72)
median (degrees)	5	6	7	7.5
25th percentile (degrees)	3	4	5	5
75th percentile (degrees)	7	8	11	11

* $p < 0.05$

genetic composition, body build, the performance of cervical and thoracic muscles, occupational demands, cultural and environmental factors, nutrition and emotional influences (Janda 1988, Penning 1988, Sahrman 1987). The point of effect, and the nature of action of causal agents of cervical resting posture, requires rigorous investigation. In the absence of such information, for the purpose of this study, large individual differences in the angular excursion of the upper and lower aspect of the cervical spine were proposed as resulting from abnormal causal influences on posture. A proxy control for such influences was exerted in the sample data by focusing attention only on those subjects with similar amounts of angular excursion at the upper and lower aspects of the cervical spine. It was believed that this subset of subjects would provide clear descriptions of the change in the shape of the cervical lordosis, when it was influenced by similar increases in angular excursion at the upper and lower aspects of the cervical spine.

If the angular excursion of both the upper and lower cervical spine were extremely small, or extremely large, subjects were recalled and photographed in their usual resting posture. Photographs were also taken of subjects with both excursion angles falling in the same data division in the more central aspects of the frequency distributions. The photographs were compared with each other, and with descriptions in the literature of forward head posture, to inform a clearer description of poor head posture than is currently available.

Results

1. Reproducibility of cervical excursion angles measured one month apart

At the spinous process of C7, a significant percentage of the variation in the first excursion angle measurement (for women, $R^2 = 0.84$ and for men, $R^2 = 0.69$) was explained by the second measurement. There was moderately high agreement (Richman et al 1980) between test and retest measurements ($ICC_{(1,3)}$ (lower 95 per cent CL) for women 0.91 (0.81) and for men 0.83 (0.74)). The RMSE values were low (1.25 for women and 1.78 for men), an indication of the low variability between the measurements. There were no significant differences between test and re-test means. For women, the mean (SD) of Test 1 was 8.74 (4.37) degrees and the mean (SD) difference between the tests was 0.34 (0.28) degrees, while for men, the mean (SD) of Test 1 was 7.89 (4.38) degrees and the mean (SD) difference was 0.38 (0.34) degrees.

For the superior-most tip of the helix of the ear, 80 per cent variation in the initial measurement was explained by the second measurement ($R^2 = 0.80$) for both women and men. There was moderately high agreement (Richman et al 1980) between test and retest measurements ($ICC_{(1,3)}$ (lower 95 per cent CL) for women 0.87 (0.74) and for men 0.89 (0.83)). The RMSE values were again low (1.39 for both women and men). There were no significant differences between test and retest means. For women, the mean (SD) of Test 1 was 4.92 (3.39) degrees and the mean (SD) difference was -0.36 (0.05) degrees. For men, the mean (SD) on Test 1 was 6.07 (4.05) degrees and the mean (SD) difference was 0.09 (0.04) degrees.

2. The frequency distribution of the excursion angles

The frequency distribution of the excursion angle data was significantly left skewed for both anatomical points, for both men and women. Statistics describing the frequency distribution of the excursion angle data are provided in Table 1. There was evidence supporting the null hypothesis that *no subject had resting posture perfectly aligned with the gravitational line*. Had any individual's cervical resting posture been aligned with the gravitational line, the lowest value in the excursion angle range would have been 0 degrees (indicating no linear excursion movement from the starting position). However, the lowest value was 1 degree, where the anatomical point moved through a large distance horizontally, but a small distance vertically.

Table 2.
Division of the helix and C7 excursion angle data into five parts.

Data division	helix angles	percentile	*n*	C7 angles	percentile	*n*
1	1.0 - 2.5	17.3	74	1.0 - 4.0	22.7	97
2	2.6 - 4.0	40.3	98	4.1 - 6.0	42.4	84
3	4.1 - 5.9	54.4	67	6.1 - 8.0	59.7	74
4	6.0 - 8.4	80.3	109	8.1 - 11.4	78.2	79
5	8.5 - 18.0	100	79	11.5 - 25.0	100	93

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3. The strength of association between the excursion angle data

On visual evidence from scatter plots, a linear regression model was appropriate to examine the relationship between the two excursion angles. However, a linear regression model requires a normal distribution of the dependent variable. Accordingly, the angular excursion of the spinous process of C7 was selected as the dependent variable for the model, as an approximation to the normal distribution was obtained by squaring the C7 excursion angle data for both men and women. Support for the normalcy of the distribution was provided by Shapiro-Wilk statistics that were not significantly different from one (0.973, $p = 0.06$ for women and 0.978, $p = 0.05$ for men). The linear regression model in which the square of the C7 variable was the dependent variable was appropriate to the data, since a horizontal plot of the residuals was observed for both men and women.

The linear regression model provided evidence of a weak association between excursion angles in the sample data. It was found that 0.28 per cent of the variation in the (squared) C7 excursion angles was explained by the helix excursion angles for women ($F = 0.59$, $p > 0.05$), while 9.8 per cent was explained for men ($F = 23.24$, $p < 0.05$). It appeared that for both men and women, other factors such as body mass and muscle performance were required as explanatory terms in the model, to more fully describe the nature of the relationship between the excursion angles. The weak association between the excursion angles provided clear evidence of the variability in cervical resting posture in the study sample.

4. Extreme excursion angles

The non-normal distribution of the excursion angles at the superior-most tip of the helix of the ear and the spinous process of C7 directed the identification of subjects with extreme excursion angles by the method of dividing the data into quintiles. The first and last categories in each excursion angle frequency distribution were designated as extreme.

The excursion angle data were divided similarly for men and women at each anatomical point, because the frequency distributions were similar. The nature of both sets of excursion angle data precluded division at exactly 20 per cent intervals. Divisions were therefore made as close as possible to the 20 per cent cut points to ensure similar numbers of subjects in each division. The points of division in the data are reported in Table 2.

Extremely small excursion angles

Thirteen male and two female subjects had C7 and helix excursion angles that each fell in the first quintile. These subjects had considerably more horizontal than vertical excursion movement. Their resting head position was well forward of the vertical reference line and supported by a protracted cervical spine. This posture is illustrated in Figure 3 by a subject with helix excursion of one degree, and C7 excursion of 2.5 degrees. It is similar to that described as forward head posture by Braun (1991), Passero et al (1985) and Raine and Twomey (1994).

Excursion angles in the second, third and fourth data divisions

Five male subjects and one female subject had C7 and helix excursion angles that each fell in the second quintile. Thirteen male and 12 female subjects had excursion angles that each fell in the third quintile, and 11 male and 11 female subjects had excursion angles that each fell in the fourth quintile. As the excursion angles increased, so the resting heads were held progressively closer to the vertical axis, with decreasing horizontal and increasing vertical excursion. Moreover, the cervical lordosis appeared to increase with increasing excursion angles.

The postures described by subjects with both excursion angles in the more central tendencies of the data (the second, third and fourth quintiles) are illustrated in Figure 4. The subject

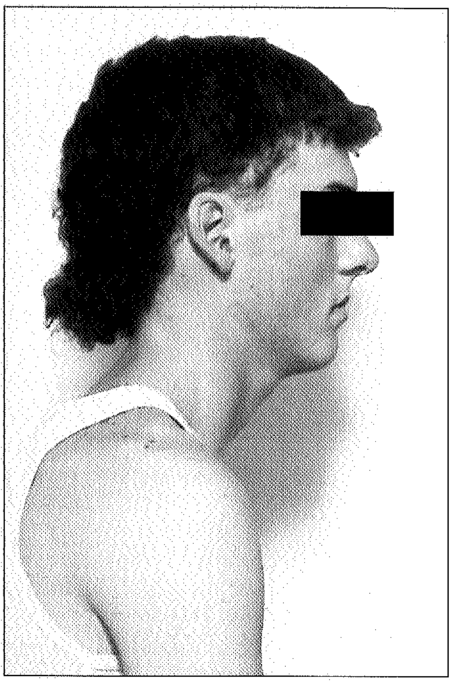

Figure 3.
Habitual cervical resting posture associated with excursion angles in the first data division.

with cervical excursion angles in the second quintile had helix excursion of 3.5 degrees and C7 excursion of 5 degrees (Figure 4i). The subject with cervical excursion angles in the third quintile had helix excursion of 5.1 degrees and C7 excursion of 7.1 degrees (Figure 4ii), and the subject with cervical excursion angles in the fourth quintile had helix excursion of 7.5 degrees and C7 excursion of 9 degrees (Figure 4iii). The second of the resting postures in this figure (Figure 4ii), that is, the posture associated with both excursion angles in the third quintile, was identified as the population norm, as it represented the central tendency in the data.

Extremely large excursion angles

There were 15 male and 15 female subjects whose excursion angles both fell in the fifth quintile. Their cervical resting posture was characterised by a leading chin and an occiput that was caudally rotated within the gravitational line. The head was supported on the neck by a markedly curved cervical lordosis. This posture is illustrated in Figure 5 by a subject with helix excursion of 14 degrees and C7 excursion of 19 degrees. This posture is similar to that described as forward head posture by deVries (1966), Hanten et al (1991) and Saunders (1982), where the chin leads, and the head is angled slightly upwards, with the occiput tilted caudally within, or slightly anterior to, the line of gravity.

Overall, 98 subjects (57 men and 41 women) had excursion angles that were both in the same data division. This represented less than one quarter of the study sample (21.9 per cent) and provided evidence of the wide variability in cervical resting posture in the study sample. There were significant differences overall in the proportion of men and women with both excursion angles in one of the five data divisions ($F = 6.57, p < 0.05$). The percentages of men and women of the total number of subjects with both excursion angles in same data division, are illustrated in Figure 6. Differences in proportions of men and women are most noticeable in data divisions one and two.

A comparison of the series of illustrated resting head postures (those associated with excursion angles in the same data division) suggested that increasing excursion angles were associated with increasing extension of the middle/lower aspects of the cervical spine. The movement of the upper cervical spine was not readily discernible in the photographs.

The cervical resting postures associated with two extremely small, or two extremely large, excursion angles are similar to those that have been described as forward head postures in the literature and which also have been referred to as poor. Therefore, there was evidence for the hypothesis that *extreme excursion of both the superior-most tip of the helix of the ear and the spinous process of C7 both describe poor cervical resting postures.* Additionally, when the population mean was the reference, poor cervical resting posture took at least two forms.

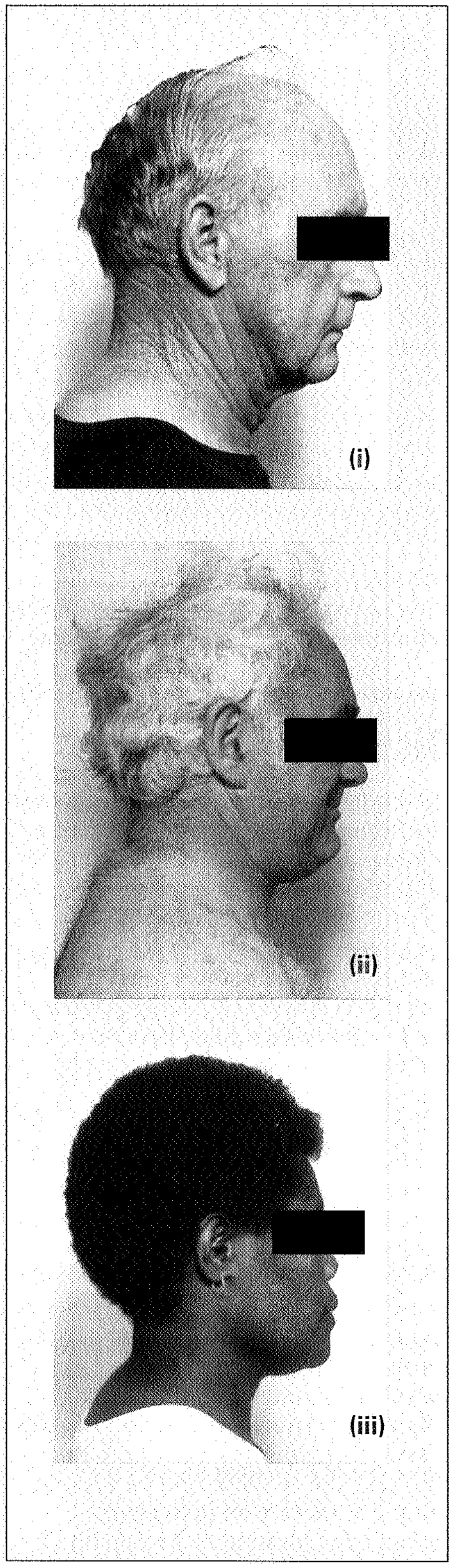

Figure 4.
Habitual cervical resting posture associated with excursion angles in the second, third or fourth data divisions.

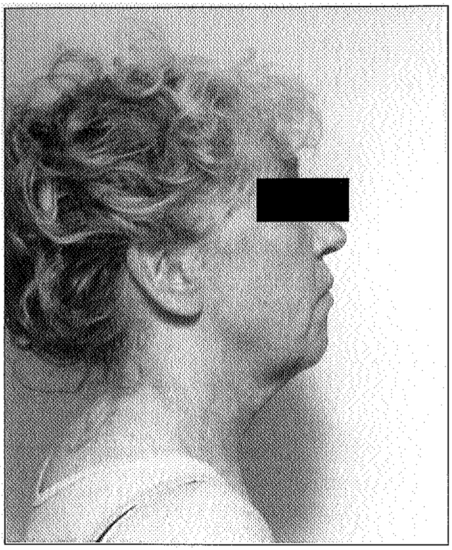

Figure 5.
Habitual cervical resting posture associated excursion angles in the fifth data division.

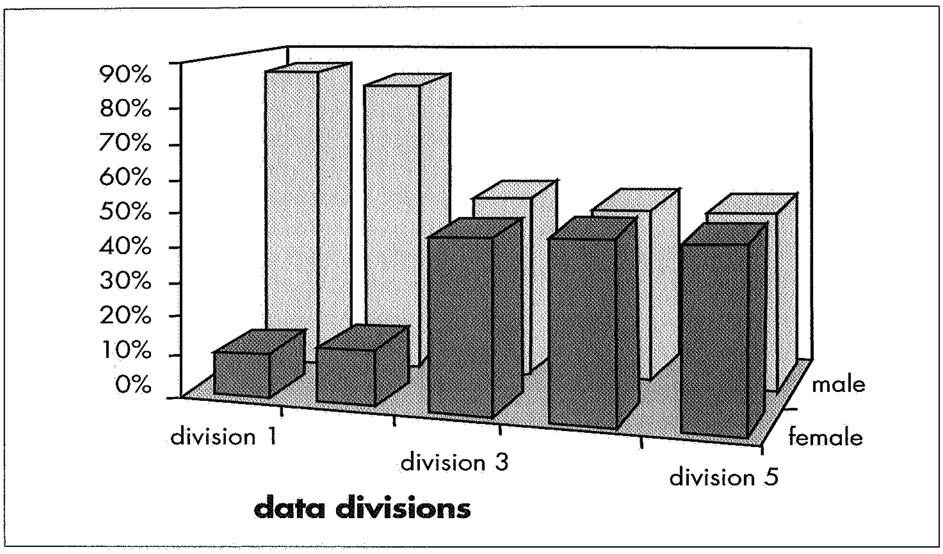

Figure 6.
The proportion of men and women with excursion angles in the same data division.

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Discussion

Accurate measurement and appropriate description of cervical resting posture is important to physiotherapists in a clinical setting. Physiotherapists commonly assess resting posture by visual inspection and provide instructions to patients regarding correction of cervical resting posture in an effort to reduce pain. However, currently there are few tools to assist them in accurate measurement or description of poor posture.

The LEMD was developed to objectively measure cervical resting posture in a clinical setting. It was manufactured at a low cost and was time and space efficient. Moreover, it provided immediate and reproducible measurements of the excursion of two points on the cervical spine, an advantage in a clinical setting. Information gathered from the LEMD is useful from the perspective of the therapist, the referrer and the patient, because it enables an individual's resting head position to be described with respect to the range of resting head positions found in the never-injured population. The LEMD facilitated standard assessment, and provided a method by which immediate objective feedback could be provided on the results of intervention.

This study provided the first reported evidence about the extent to which measurements of an individual's upper and lower cervical excursion vary over an interval of one month. The finding that the measurements provided by the LEMD were in good agreement, despite being a month apart, corroborates reports by recent studies of consistency in the cervico-vertebral angle (Raine and Twomey 1994, Refshauge et al 1994). The LEMD protocol required visual orientation by spotting the letter on the wall chart between flexion/extension movements of the head. This was believed to assist consistent horizontal placement of the head (Hanten et al 1991). However, the visual cueing may have constrained some subjects from adopting their usual head-on-neck posture, particularly if their usual gaze orientation was downwards. Error in measurement in this instance would be anticipated, particularly of the angular excursion of the superior-most tip of the helix of the ear of these subjects. Further study into the extent of the influence exerted by the requirement of a horizontal gaze on the habitual placement of the head is indicated.

An investigation of the data failed to identify convincing evidence of an association between C7 and helix excursion angles. In assuming habitual resting head posture, similarly sized movements of the upper and lower aspects of the cervical spine occurred in less than one quarter of this sample of never-injured subjects. Measurement error may have partly contributed to this finding. Furthermore, this study did not add to knowledge regarding influences on habitual cervical resting posture. The variability in the excursion angles in the sample data suggested that investigation of factors causally implicated with habitual resting posture is essential in order to develop a clearer understanding of the nature of the association between the excursion angles.

This study provided evidence of two different poor resting postures when a defined population norm was used as a comparison. However, it is acknowledged that it provides an incomplete picture of poor cervical resting posture, because it examined only those subjects with similar angular excursion of the upper and lower aspects of the cervical spine. Undertaking this manner of investigation was justified by the desire to control the sample data for abnormal causal influences on postural mechanisms. This approach may well be flawed and requires further consideration. Examination of postures associated with differential excursion angles at the upper and lower aspects of the cervical spine is required, particularly in subjects with one extremely small and one extremely large excursion angle.

The posture defined and illustrated in this study as the population norm requires more consideration. For instance, its usefulness as a tool for clinical comparative purposes needs to be tested further. Moreover, before poor cervical resting posture can be fully described with respect to a defined population norm, important influences on cervical resting posture require identification and their causal role in cervical posture requires clarification. Such investigations will assist understanding of why individual resting postures are assumed.

The differences in proportions of men and women with excursion angles both in the same data division suggest that gender-specific mechanisms underlie the development of habitual resting head posture. For instance, the head posture associated with the first and second data divisions describes a head held well forward of the gravitational line. Men may be more likely to assume this habitual head position because they are believed, on the whole, to have stronger neck muscles and larger neck bulk than women. The factors influencing resting head posture require further enquiry regarding gender-specific influences on them. Nevertheless, there were small numbers of subjects in whom both excursion angles fell in the first and the second data division. This study needs to be repeated to test whether the observed gender differences were in fact chance events.

Further avenues for study identified in this work include the usefulness in a clinical setting of the measure of excursion and the head postures most closely associated with pain.

Conclusion

Physiotherapists commonly assess cervical resting posture and correct perceived poor posture on the grounds that it is associated with pain. There is no evidence yet to suggest that one cervical resting posture is more closely associated with pain than any other. This study employed a reliable, inexpensive and time-efficient method of objectively measuring cervical resting posture in a clinical setting. This study proposes that the measurement of the angular excursion of two points in the cervical spine provides a useful method of measuring cervical resting posture in a clinical setting, and of describing poor resting postures with respect to the population norm. No subject had cervical resting posture aligned perfectly with the vertical reference line, and there was considerable variability in the study sample in the excursion of the upper and lower cervical spine. Subjects with two extremely small or two extremely large excursion angles had different resting head postures, both of which have been described as poor in the literature. Differences in the number of men and women with particular resting head postures suggested the need for examination of gender-specific influences on habitual cervical resting posture. The variability in cervical excursion angles in the sample data also indicated the need for a clearer understanding of influences on cervical posture.

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