The association between the static posture of the cervical spine and cervicogenic headache

Peter Keith Farmer

B. App. Science (Physio)

Thesis submitted for the degree of

Master of Philosophy (Physiotherapy)

The University of Newcastle, Australia
**Declarations**

I hereby certify that the work embodied in this thesis is the result of original research and has not been submitted for a higher degree to any other University or institution.

Signed
Acknowledgements

The author would like to acknowledge the assistance provided by the following people, who helped make the completion of this project possible:

Professor Darren Rivett, Discipline of Physiotherapy, The University of Newcastle, who as principal supervisor was a knowledgeable and valuable advisor and mentor.

Dr Susanne Snodgrass, Senior Lecturer, Discipline of Physiotherapy, The University of Newcastle, who as co-supervisor provided encouragement, constructive advice and feedback throughout the project which was much appreciated.

Anthony Buxton, Senior Lecturer, Discipline of Medical Radiation Science, The University of Newcastle, who spent many hours performing the radiographic examinations and radiographic measurements for each participant.

John Tessier, Lecturer, Discipline of Medical Radiation Sciences, The University of Newcastle, who performed the radiographic measurements for determining the reliability of the measurement methods.

Lucy Thomas, Lecturer, Discipline of Physiotherapy, The University of Newcastle, who assisted with the postural palpation assessment of each participant.
Sue Reid, Lecturer, Discipline of Physiotherapy and Discipline of Anatomy, The University of Newcastle, who assisted with the postural palpation assessment of each participant.

Associate Professor Helen Warren-Forward, Discipline of Medical Radiation Science, The University of Newcastle, who determined the radiation dosage risk for the radiation procedures.

Kim Colyvas and Nic Croce, Statistical Consultants, Discipline of Mathematics and Physical Sciences, The University of Newcastle, who provided statistical advice.

All of the participants who volunteered their valuable time to make this study possible.
Table of Contents

Declarations ........................................................................................................................ i
Acknowledgements ........................................................................................................... ii
Table of Contents ............................................................................................................. iv
List of Tables ................................................................................................................... vii
List of Figures ................................................................................................................. viii
Abbreviations and list of terms ....................................................................................... ix
Abstract x

Chapter 1 Introduction ................................................................................................... 1
  1.1 Background ............................................................................................................... 1
  1.2 Aims .......................................................................................................................... 4
  1.3 Hypotheses ................................................................................................................ 5
  1.4 Null Hypotheses ........................................................................................................ 5
  1.5 Structure of the thesis................................................................................................ 6

Chapter 2 Literature Review ......................................................................................... 7
  2.1 Overview ................................................................................................................... 7
  2.2 Headache diagnosis ................................................................................................. 9
    2.2.1 Theorised mechanisms of tension type headaches........................................... 11
    2.2.2 Theorised mechanisms of migraine ................................................................. 12
    2.2.3 Theorised mechanisms of CEH ....................................................................... 12
  2.3 Aetiology of Cervicogenic headache ...................................................................... 13
    2.3.1 Articular system ............................................................................................... 15
    2.3.2 Dura mater ....................................................................................................... 20
    2.3.3 Neural system ................................................................................................... 20
    2.3.4 The muscular system ........................................................................................ 22
    2.3.5 Summary of CEH aetiology ............................................................................. 22
    2.4 Cervicogenic headache (CEH) diagnosis ............................................................. 24
      2.4.1 International Headache Society diagnostic criteria .......................................... 25
      2.4.2 Cervicogenic Headache International Study Group (CHISG) diagnostic criteria ................................................................................................................................... 26
    2.5 CEH diagnosis: Using diagnostic blocks or clinical signs? ................................. 28
      2.5.1 Using diagnostic blocks for CEH diagnosis .................................................... 28
      2.5.2 Using clinical signs for CEH diagnosis ........................................................... 30
    2.6 Evidence that a combination of clinical signs may be needed in CEH diagnosis .. 31
    2.7 Posture .................................................................................................................. 33
    2.8 Why investigate posture? ....................................................................................... 36
    2.9 Abnormal posture and different headache types ................................................... 38
      2.9.1 Postural assessment in headache ...................................................................... 38
      2.9.2 Postural assessment in headache: sagittal plane ............................................ 39
    2.10 Postural assessment in headache: horizontal plane ............................................. 52
      2.10.1 Measuring C1 horizontal plane posture ......................................................... 53
      2.10.2 Measuring C2 horizontal plane posture ........................................................ 53
      2.10.3 Factors complicating C2 horizontal plane assessment ................................. 55
List of Tables

Table 4.1 The age and gender characteristics of the participants in the cervicogenic headache (CEH) and control groups. .......................................................... 117
Table 4.2 Number of CEH participants reporting reproduction of their familiar headache with palpation at each cervical level .................................................. 119
Table 4.3 The age and gender of the participants with CEH separated into sub-groups based on the distribution of their reported headache reproduced by palpation. ........ 120
Table 4.4 Kappa scores and standard error for the agreement between physiotherapy examiners for each of the spinal postural variables assessed with postural palpation. 121
Table 4.5 Intraclass correlation coefficients (ICC) (2,1) and 95% confidence intervals (CI) of the cervical spinal postural variables measured on radiographs .................... 123
Table 4.6 Descriptive statistics, normality tests and comparisons of radiographic postural variables between participants in the cervicogenic headache (CEH) and control groups. .......................................................... 125
Table 4.7 Pearson’s correlation between the radiographic measures of cervical spinal posture for the whole sample and for the CEH group. ................................. 126
Table 4.8 Associations between the radiological measurements of the cervical spinal postural variables and the likelihood of experiencing CEH. .................... 127
Table 4.9 Characteristics of the CEH, control and headache distribution sub-groups. 129
Table 5.1 Comparison of general cervical lordosis (C2-C7 Cobb angle) measurements (degrees) between the present study and Harrison et al. (2004). ......................... 135
List of Figures

Figure 2. 1 Illustration of the convergence of inputs from the trigeminal nerve with the inputs from the cervical region (muscle, joints and skin) onto the second-order neurones in the trigeminocervical nucleus (Goadsby & Bartsch, 2008). ................................................. 10
Figure 2. 2 Illustrates the proposed ‘ideal’ static posture in the sagittal plane with the line of gravity aligned with the atlanto-occipital junction (AOJ), cervicothoracic junction (CTJ), thoracolumbar junction (TLJ) and lumbosacral junction (LSJ) (Boyle et al., 2002). ........................................................................................................................................... 34
Figure 2. 3 Illustration of the craniovertebral angle measurement method. The craniovertebral angle is the angle between the horizontal line passing through C7 and a line extending from the tragus of the ear to the tip of the C7 spinous process (Fernandez-de-Las-Penas, Cuadrado, & Pareja, 2007). ........................................................................................................... 41
Figure 2. 4 Illustration of the upper cervical lordosis radiographic measurement method. The acute angle between the two lines is measured in degrees to indicate the upper cervical lordosis (Johnson, 1998). ................................................................................................................... 49
Figure 2. 5 Illustration of the C2-7 Cobb angle radiographic measurement of general cervical lordosis. The acute angle between the two perpendiculars is measured in degrees to indicate the general cervical lordosis (D.E. Harrison et al., 2000). .............................................................. 50
Figure 2. 6 Illustration of the posterior tangent method for radiographically measuring the cervical lordosis. The C2-C7 posterior tangent is the acute angle between two lines: one line connecting the posterior-superior point on C2 and the posterior-inferior point on C2, and the second line connecting the posterior-superior point on C7 and the posterior-inferior point on C7 (D. E. Harrison et al., 2000). .................................................................................................................. 51
Figure 2. 7 Represents a typical C2 vertebra viewed in the horizontal plane. .................................................................................................................. 54
Figure 2. 8 Represents a deviation of the C2 spinous process to the left with C2 viewed in the horizontal plane................................................................. 56
Figure 2. 9 Represents a rotation of the C2 vertebra to the right with C2 viewed in the horizontal plane................................................................................................. 57
Figure 2. 10 Represents an asymmetrical bifid C2 spinous process with the right tip being more prominent, viewed in the horizontal plane. .................................................................................... 58
Figure 2. 11 Demonstrates the technique for measuring C2 spinous process deviation from the midline using an AP X-ray (the distance in millimetres between the lines indicates the deviation of the C2 spinous process from the midline) (Gradl et al., 2005). 64
Figure 2. 12 Demonstrates the distances measured in the odontoid lateral mass interspace technique (Iannacone et al., 1990). ...................................................................................................................... 65
Figure 3. 1 Flow chart demonstrating the sequencing of the recruitment process for potential participants and the assessments performed on participants. ...................................................................................... 86
Figure 3. 2 Example of upper cervical lordosis measurement on a radiograph. .................................................................................................................. 107
Figure 3. 3 Example of a general cervical lordosis measurement (Cobb C2-C7 measurement) on a radiograph................................................................................................. 109
Figure 3. 4 Example of a C2 spinous process deviation measurement on a radiograph. 111
Abbreviations and list of terms

C2    Axis (second cervical vertebra)
CEH   Cervicogenic headache
CI    Confidence intervals
DevL  Deviated left
DevR  Deviated right
GCL   General cervical lordosis
ICC   Intraclass correlation coefficient
RotL  Rotated left
RotR  Rotated right
SPD   Spinous process deviation
UCL   Upper cervical lordosis
Abstract

Research previously investigating cervical posture reports an association between cervical spinal posture and tension type headaches and migraines but no association between cervicogenic headache (CEH) and cervical spinal posture. These reports lead to the competing conclusions that there is either no association between CEH and abnormal posture or that the methods used to assess posture in the previous studies did not isolate the specific postural variables that are associated with CEH.

The present study used a single blind, age and gender matched, comparative measurement design to evaluate the differences in cervical spinal posture, measured on cervical radiographs, between asymptomatic participants (control group) and participants who had cervicogenic headache (CEH). There were two main objectives of the present study. The first was to determine if radiographic assessment can identify differences in sagittal plane posture and C2 spinous process alignment in the horizontal plane in individuals with CEH compared to controls. The second was to determine whether physiotherapist examiners could determine the presenting posture of the cervical spine using a palpation assessment.

The association between CEH and measures of cervical spinal posture using cervical radiographs were studied in 30 CEH participants and 30 age and gender matched control participants. The cervical spine postural variables assessed were general cervical lordosis (GCL), upper cervical lordosis (UCL) and C2 spinous process alignment. Differences between postural variables between the two groups were determined using paired t-tests
(matching participants by age and gender) or the non-parametric equivalent where appropriate. Logistic regression determined the postural variables which increased the likelihood of experiencing CEH. The same postural variables of these same participants were also assessed by two experienced physiotherapy examiners using palpation. Kappa was used to determine reliability of physiotherapist palpation assessment.

The results of the present study did not identify any postural variables that could differentiate the CEH from the control participants using radiographs (GCL $p = 0.06$, UCL $p = 0.10$, C2 deviation $p = 0.77$). The logistic regression analysis did, however, demonstrate that there was a statistically significant association between increased general cervical lordosis, as measured on radiographs, and an increased likelihood of experiencing CEH ($p = 0.042$). This association was not found for UCL ($p = 0.09$) or C2 deviation ($p = 0.74$). The present study also found that experienced physiotherapy examiners were unreliable at determining the postural presentation of the cervical spine (Kappa GCL = 0.15, UCL = 0.19, C2 = 0.04, 95% CI GCL = -0.07 - 0.37, UCL = -0.02 - 0.42, C2 = -0.10 - 0.18).

These results suggest that GCL may be an important clinical characteristic to identify in the assessment or management of CEH. However, physiotherapist palpation alone is not recommended to assess GCL, as therapists were unreliable in this study. These results suggest that increased GCL increases the likelihood of experiencing CEH. Therefore, future assessment and management strategies for this condition should consider including assessment of cervical lordosis.