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Relationships among head posture, pain intensity, disability and deep cervical flexor muscle performance in subjects with postural neck pain



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المخلص

أهداف البحث: يتبنى محترفو تقنية المعلومات؛ العاملون بأجهزة الحاسب الآلي، تدريجياً قوام ثني الرأس للأمام، ونتيجة لذلك فإن هؤلاء المهنيين معرضون للعديد من الاضطرابات العنقية. هدفت هذه الدراسة إلى الكشف عن العلاقة بين شدة الألم والإعاقة ووضع الرقبة وأداء عضلات الثني الأمامي العميقة عند المرضى الذين يعانون من ألم الرقبة الناتج عن سوء القوام.

طرق البحث: أجريت دراسة مقطعية على 84 من محترفي تكنولوجيا المعلومات، الذين تم تشخيصهم بألم في الرقبة ناتج عن سوء القوام. تم اختيار المشاركين بأسلوب الاختيار العشوائي. واستخدم مقياس النظير البصري المرني، واستبانة "نورثويك بارك" لآلام الرقبة، وأداة انثناء العمود الفقري المعدلة لوضعية الرأس، ووحدة الارتجاج الحيوي للضغط المثبت لقياس كل من شدة الآلام الرقبية، والعجز في الرقبة، ووضع الرقبة، وأداء عضلات الثني الأمامي العميقة العميقة على التوالي.

النتائج: كشف معامل ارتباط بيرسون علاقة إيجابية قوية بشكل كبير بين مقياس النظير البصري المرني واستبانة نورثويك بارك لآلام الرقبة. ووجد أن الزاوية بين الرأس والعمود الفقري لها علاقة سلبية كبيرة مع مقياس النظير البصري المرني وعلاقة سلبية ضعيفة مع استبانة نورثويك بارك لآلام الرقبة.

الاستنتاجات: خلصت هذه الدراسة إلى أنه كلما صغرت الزاوية بين الرأس والعمود الفقري كلما زادت شدة آلام ومقدار عجز الرقبة. وعلاوة على ذلك، فإنه لا توجد علاقة ذات قيمة بين الزاوية بين الرأس والعمود الفقري وبين أداء عضلات الثني الأمامي العميقة، مما يشير إلى أن إعادة تأهيل الرأس من

خلال تمارين تصحيح القوام لن تعيد تصحيح الإعاقات العضلية في عضلات الثني الأمامي العميقة. بالإضافة إلى ذلك، فإن برنامج تدريبي مناسب يستهدف عضلات الثني الأمامي العميقة فقط لتحسين قدرتها على التحمل هو أمر مطلوب.

الكلمات المفتاحية: قوام الرأس؛ ألم الرقبة الناتج عن سوء القوام؛ الإعاقة؛ أداء عضلات الثني الأمامي العميقة؛ الزاوية بين الرأس والعمود الفقري

Abstract

Objectives: Information Technology (IT) professionals working with computers gradually develop forward head posture and, as a result, these professionals are susceptible to several neck disorders. This study intended to reveal the relationships between pain intensity, disability, head posture and deep cervical flexor (DCF) muscle performance in patients with postural neck pain.

Methods: A cross-sectional study was conducted on 84 IT professionals who were diagnosed with postural neck pain. The participants were recruited with a random sampling approach. A Visual Analogue Scale (VAS), the Northwick Park Neck Pain Questionnaire (NPQ), the Modified Head Posture Spinal Curvature Instrument (MHPSI), and the Stabilizer Pressure Biofeedback Unit were used to measure neck pain intensity, neck disability, head posture, and DCF muscle performance, respectively.

Results: The Pearson correlation coefficient revealed a significantly strong positive relationship between the VAS and the NPQ ($r = 0.734$). The cranio-vertebral (CV) angle was found to have a significantly negative correlation with the VAS ($r = -0.536$) and a weak negative correlation with the NPQ ($r = -0.389$).

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Conclusion: This study concluded that a smaller CV angle corresponded to greater neck pain intensity and disability. Furthermore, there is no significant relationship between CV angle and DCF muscle performance, indicating that head posture re-education through postural correction exercises would not completely correct the motor control deficits in DCF muscles. In addition, a suitable exercise regimen that exclusively targets the deep cervical flexor muscle to improve its endurance is warranted.

Keywords: Craniovertebral angle; Disability deep cervical flexors muscle performance; Head posture; Postural neck pain

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Introduction

Posture is one of the most frequently cited risk factors for musculoskeletal disorders.¹ Proper posture is considered a state of musculoskeletal balance that involves a minimal amount of stress or strain to the body.^{2–4} Deviation from normal alignment (i.e., postural abnormality) suggests the presence of imbalance and abnormal strain on the musculoskeletal system.⁵ Alignment is considered ‘poor’ when the head is held forward in relation to the trunk, which is referred to as ‘forward head’, ‘poke chin’ and, ‘rounded shoulders’.^{6,7} Forward head posture is one of the common types of poor head posture seen in patients with neck disorders.^{8,9} and is commonly described as an anterior position of the head in relation to the vertical line of the body’s centre of gravity.^{10,11} Anatomically, the upper cervical spine is in flexion and the lower cervical spine is in extension, but forward head posture causes extension of the head and the upper cervical spine (C1–C3), accompanied by flexion of the lower cervical spine (C4–C7) so that the cervical curvature is increased, a condition called hyper-lordosis.^{12,13} This altered positioning magnifies the effect of gravity, thereby increasing the flexion moment of the head, which may cause changes in the length-tension relationships of the anterior, posterior and lateral cervical musculature.^{14,15} Forward head posture is considered a cervical musculoskeletal variation that is associated with shortening of the posterior neck extensor muscles and weakening of the anterior neck flexor muscles.¹⁶ If one maintains this poor head posture for a long period of time, the length-tension relationship of the cervical musculature can become altered. As a result, there is shortening of the posterior cervical muscles and weakening of the anterior cervical flexor muscles, increasing the loading to non-contractile structures and creating abnormal stress on posterior cervical structures, which leads to myofascial pain.^{17,18} Additionally, in 2006, Fernández-de-las-Peñas et al.¹⁹ found that most of the trigger points in forward

head position were in the upper trapezius, temporalis, sternocleidomastoid and the sub-occipital muscles.

Computer operators involved in visual display terminal (VDT) gradually develop forward head posture as a compensatory posture due to either poor work habits or ergonomically poor work station arrangements.²⁰ Consequently, they are more frequently prone to neck pain disorders.^{21,22} In 2013, Sabeen et al.²³ confirmed that severe neck pain was found in people who spend more than 5 h a day on a computer. This postural neck pain is usually associated with sustained static loading of the cervical spine and shoulder girdle during occupational or leisure activities.²⁴ Therefore, three specific impairments are noted in these postural neck pain patients, including altered head posture, pain and its subsequent disability, and impaired deep cervical flexor muscle performance.²⁵ To effectively manage these impairments, it is essential to understand the relationship between these postural deviations, the severity of neck pain, and corresponding disabilities.

Few studies have been conducted to understand the relationship between postural deviations, the severity of neck pain, and subsequent disabilities.^{3,26} In 2010, Lau et al.²⁷ established a relationship among the sagittal postures of the thoracic and cervical spines, the presence of neck pain, neck pain severity and disability. A previous study indicated that neck pain in working positions was related to incorrect postures of the head and the cervical and thoracic spine.²⁸ Contrary to these findings, a more recent study found no association between craniocervical posture and disability variables, except for small differences in the measurements of craniocervical posture between asymptomatic subjects and patients with chronic cervico-craniofacial pain.²⁹ In the literature, very few studies have addressed the relationship among deep cervical flexor muscle performance, head posture, neck pain intensity and disability. Unlike previous studies, the present study is unique in that it intends to establish a relationship among variables such as head posture, pain intensity, disability and DCF muscle performance in the most vulnerable group of IT professionals who are frequently prone to postural neck pain disorders. Furthermore, the present study utilizes the MHPSCI to measure head posture, in which a therapist can objectively fix the pivot exactly over the C7 spinous process to improve the clinical accuracy of measuring the CV angle.

Materials and Methods

Study design

A cross-sectional study design was adopted to study the relationship among variables such as pain intensity, disability, head posture and deep cervical flexor muscle performance in subjects with postural neck pain.

Subjects

Subjects between the ages of 20 and 40 years working both day and night shifts at a selected Information Technology

(IT) industry were the focus of this study. Among them, eighty-four subjects (N = 84) diagnosed with postural neck pain were recruited based on the criteria suggested by Subbarayalu in 2016.¹⁷ The criteria are (i) Neck pain that predominantly becomes worse due to the adaptation of poor posture during daily activities and is reduced by postural correction³⁰; (ii) Restricted flexion of the upper cervical spine (9° or less) with no pain related to a limitation of cervico-thoracic mobility³¹; (iii) Symptoms lasting for approximately more than three months, including subjects who have experienced neck pain at least once a week over the past three months³⁰; (iv) Mild (from 1 to 4 VAS scores) to moderate (from 4 to 6 VAS scores) neck pain intensity³²; and (v) No history of any medical, surgical or physiotherapy treatment for neck pain. In addition, all subjects were examined by a physician to exclude any structural bony abnormalities and degenerative disorders around the cervical spine, including assessments of cervico-thoracic mobility, upper cervical flexion range of motion, myotome and dermatome examinations, and the presence of trigger points in the cervical musculature. Subjects with a history of cervical fracture, trauma or degenerating disease of the cervical spine were excluded. This study was approved by the human ethical committee of 'KGISL Information Systems Private Limited' and all the subjects signed written consent forms before participating in the study.

Procedure

Based on a literature review, discussions with experts, and the feasibility criteria of the study, appropriate tools were chosen to measure the variables to be explored in this study (Table 1).

Neck pain intensity & disability

A Visual Analogue scale (VAS), which is a reliable and valid tool for patients with neck pain, was used to measure the severity of neck pain.^{33,34} The subjects were asked to report their perception of pain by selecting a point along on a line from zero to 10 that best describes their current pain status. Likewise, the Northwick Park Neck Pain Questionnaire (NPQ) was adopted to measure neck pain

and its consequent disability. It is relatively simple to use and provides an objective measure to monitor symptoms over time.³⁵ The NPQ consists of 9 five-part questions and measures parameters such as (i) neck pain intensity; (ii) neck pain and sleeping; (iii) pins and needles or numbness in the arms at night; (iv) the duration of symptoms; (v) carrying items; (vi) reading and watching television; (vii) working and/or housework chores; (viii) social activities; (ix) driving; and (x) a comparison of the current state with the last time that the questionnaire was completed. The response for each question varied from '0' to '4', where '0' indicated no disability and '4' indicated maximum disability. The final score was calculated by summing all scores and was presented in the form of a percentage from 0% to 100% depending on the number of questions answered by the subjects. A higher the percentage corresponded to greater disability. The questionnaire was designed to determine how neck pain affected a subject's ability to manage his or her daily life. The questionnaire had good short-term repeatability and internal consistency.³⁶

Head posture

A noninvasive instrument named "Modified Head Posture Spinal Curvature Instrument" (MHPSCI) was used to objectively measure head posture based on the guidelines given by Subbarayalu in 2016.¹⁷ The MHPSCI is a reliable and valid tool for measuring the craniovertebral (CV) angle in subjects with or without postural neck pain.¹⁷ To achieve uniformity in the measurement of habitual head posture among the subjects, a simulated computer workstation was arranged according to the guidelines given by Hoyle et al., in 2011³⁷ for low postural stress conditions. The subjects were asked to sit relaxed in the simulated computer workstation. The position of the head was standardized by asking the subjects to flex and extend their head three times and then rest it in a comfortable neutral position to view the monitor directly in front of them exactly as they would throughout the day.³⁸ A total of three measurements were taken with a 2-min interval between each measurement and the mean value was calculated.³⁹

Deep cervical flexor muscle performance

Deep cervical flexor (DCF) muscle performance was measured using a Stabilizer pressure biofeedback unit that consisted of a pressure gauge (a combined gauge and inflation bulb) connected to a three-layered pressure cell. A screw at the base of the pressure gauge could be tightened by the operator to inflate the three chambers of the pressure cell until it moulded between the body part and the supporting surface. Upon completion of the test, the air was released by loosening the screw. The reading in the pressure gauge was displayed in millimetres of mercury ranging from 0 mmHg to 200 mmHg along with a needle indicator that displayed the actual pressure held by each subject.

The subjects were positioned in the crook lying position over an uninflated three-layered pressure cell placed behind the neck. After positioning the subject, the pressure cell was inflated to a stable baseline pressure of 20 mmHg, which is a

Table 1: Tools used to measure impairments from postural neck pain.

S. No.	Variables	Measurement tools to be used
1	Intensity of neck pain	Visual Analogue Scale [VAS]
2	Neck pain disability	Northwick Park Neck Pain Questionnaire [NPQ]
3	Head posture (expressed in cranio-vertebral angle)	Modified Head Posture Spinal Curvature Instrument (MHPSCI)
4	Deep cervical flexor muscle performance (expressed in Performance index)	Stabilizer Pressure Biofeedback Unit. (Chattanooga Stabilizer Group Inc., Hixson, TN),

standard pressure sufficient to fill the space between the testing surface and the neck without pushing the neck into a lordosis. In this position, the subject was instructed to perform a gentle and slow head nodding action (as if saying “yes”). While performing the test, the pressure gauge was held in front of the subject for self-monitoring of the pressure changes that occurred with slight cervical lordosis flattening, thus facilitating the contraction of deep cervical flexor muscles. At the same time, the motion of the head and the muscle activity in the superficial flexors were analysed by observation or palpation. The device provided feedback and direction to the subjects to perform the required five stages of the test. The baseline assessment was documented as the pressure level that the subject could hold steadily for 10 s with minimal superficial muscle activity and in the absence of any compensatory strategies. During the initial performance of the test, performance was scored by the pressure level that the subjects were able to achieve (activation score) and hold for 10 s in 10 repetitions (holding capacity). A performance index (PI) was calculated based on the number of times that the subject could hold the achieved pressure level for 10 s.⁴⁰ The performance index (PI) was calculated by multiplying the target pressure achieved (activation score) by the number of successful repetitions.

Statistical analysis

A Pearson correlation coefficient was applied to study the relationship between variables such as VAS scores, NPQ scores, CV angle and the deep cervical flexor (DCF) muscle performance index among the subjects. The correlation coefficient is placed in five categories,⁴¹ including (i) 0.00 to 0.19 [“very weak”], (ii) 0.20 to 0.39 [“weak”], (iii) 0.40 to 0.59 [“moderate”], (iv) 0.60 to 0.79 [“strong”] and (v) 0.80 to 1.0 [“very strong”]. The analysis was performed using the Statistical Package for Social Sciences (SPSS) version 19.0 for Windows and $p < 0.01$ was considered statistically significant.

Results

Demographic characteristics of the subjects

Among the subjects who underwent the measurements, 68% were male ($N = 57$) and 32% were female ($N = 27$). All subjects with postural neck pain reported having ‘mild’ to

‘moderate’ neck pain intensity and the average pain intensity was 4.89 on the VAS. Likewise, the mean disability score was 19.01 from NPQ scores. The average CV angle was 41° for males and 42° for females who participated in this study. The average deep cervical flexor muscle performance index of all the subjects in this study was 5.28.

Relationship between the variables

Through the correlation matrix, the CV angle has a significant moderate negative correlation with the VAS ($r = -0.536$, $p = 0.000$) and a significant weak negative correlation with the NPQ ($r = -0.389$, $p = 0.000$). The results indicated that a smaller CV angle corresponded to higher neck pain intensity and greater disability in the subjects. Furthermore, a very weak positive correlation ($r = 0.121$, $p = 0.275$) was found between CV angle and DCF muscle performance. However, it is not statistically significant ($p > 0.01$) (Table 2).

Moreover, a significant strong positive correlation was found between the VAS and the NPQ ($r = 0.734$, $p = 0.000$). That is, higher VAS scores corresponded to higher NPQ scores. DCF muscle performance showed a very weak negative correlation with the VAS ($r = -0.020$, $p = 0.858$) and a weak negative correlation with the NPQ ($r = -0.213$, $p = 0.051$). From these results, it can be concluded that lower neck pain intensity and disability correspond to a higher performance index in craniocervical flexion tests. Even though DCF muscle performance was negatively correlated with VAS and NPQ scores, this relationship was not statistically significant ($p > 0.01$) (Table 2).

Discussion

This research study intended to reveal the relationship between pain intensity, disability, head posture and DCF performance in subjects with postural neck pain. This relationship between forward head posture, neck pain intensity, disability and DCF muscle performance in IT professionals has not been previously considered. This study utilized a non-invasive, reliable and valid instrument, the MHPSCI, invented by Subbarayalu in 2016¹⁷, to measure head posture (CV angle) and evaluated the relationship between neck symptoms, CV angle and DCF muscle performance. The results of the correlation analysis demonstrated that VAS and NPQ scores are strongly positively correlated

Table 2: Pearson correlations between crani-vertebral angle, the Visual Analogue Scale, Northwick Park Neck Pain Questionnaire scores and the deep cervical flexor muscle performance index in postural neck pain subjects.

Variables	Craniovertebral Angle	Visual Analogue Scale	Northwick Park Neck Pain Questionnaire	Deep Cervical Flexor Muscle Performance Index
Craniovertebral Angle	1	-0.536** ($p = 0.000$)	-0.389** ($p = 0.000$)	0.121 ($p = 0.275$)
Visual Analogue Scale	-0.536** ($p = 0.000$)	1	0.734** ($p = 0.000$)	-0.020 ($p = 0.858$)
Northwick Park Neck Pain Questionnaire	-0.389** ($p = 0.000$)	0.734** ($p = 0.000$)	1	-0.213 ($p = 0.051$)
Deep Cervical Flexor Muscle Performance Index	0.121 ($p = 0.275$)	-0.020 ($p = 0.858$)	-0.213 ($p = 0.051$)	1

**Significant at 0.01.

($r = 0.734$; $p < 0.01$, significant). This finding was consistent with the results of previous studies that focused on neck pain.^{3,42–44} Since pain intensity is one of the dimensions measured in the NPQ, a positive correlation would be expected. Furthermore, the results also showed that CV angle has a moderate negative correlation with neck pain intensity ($r = -0.536$; $p < 0.01$, significant) and a weak negative correlation with disability ($r = -0.389$; $p < 0.01$, significant), indicating that a smaller CV angle corresponds to greater neck pain intensity and disability and vice versa. This finding is consistent with previous studies.^{3,43,45} These findings support the assumption that improving head posture could eventually reduce neck pain and disability in subjects with postural neck pain. The correlation between CV angle and DCF muscle performance in the entire sample was very weak and positive ($r = 0.121$; $p > 0.01$, non-significant). This finding is consistent with earlier studies that indicated a very weak correlation between head posture and DCF muscle performance.²⁶ Forward head posture puts the DCF muscle in a lengthened position, creating a mechanical disadvantage and contributing to decreased muscle performance. Given this association between forward head posture and DCF muscle performance, merely retraining head posture through postural correction exercises would not completely correct the motor control deficits in the deep cervical flexor (DCF) muscles. However, more specific training of the craniocervical flexor muscles can effectively increase the activation of the DCF muscles and improve the ability to maintain upright posture of the cervical spine during prolonged sitting.^{46–52}

In addition, DCF muscle performance has a very weak negative correlation with the VAS ($r = -0.020$; $p > 0.01$, non-significant) and a weak negative correlation with the NPQ ($r = -0.213$; $p > 0.01$, non-significant), indicating that lower neck pain and disability correspond to greater performance in the craniocervical flexor test and vice versa. Several studies have also observed a relationship among pain, strength, and endurance of the flexor muscles in subjects with neck pain.^{25,30,53,54} Previous studies also validated these findings as the activities of the DCF muscles are impaired in persons with neck pain.^{55,56} Therefore, retraining the DCF muscles can decrease neck pain symptoms and increase the activation of the DCF muscles during the performance of the cranio-cervical flexion test. Deep cervical flexor muscle training may improve the capacity of the cervical spine to sustain an upright posture.⁴⁹

Conclusion

This study established relationships among pain intensity, disability, head posture, and DCF muscle performance in subjects with postural neck pain. The relationships established in this study are as follows: (i) a significant strong positive relationship between neck pain intensity and disability; (ii) a significant moderate negative correlation between CV angle and neck pain intensity; (iii) a significant weak negative correlation between CV angle and disability; (iv) a non-significant, very weak negative correlation between DCF muscle performance and neck pain intensity; and (v) a non-significant weak negative correlation between DCF

muscle performance and disability. A non-significant, very weak positive correlation was observed between CV angle and DCF muscle performance in subjects with postural neck pain. The results of this study contribute to the literature on postural neck pain management in two ways: (i) First, it is essential to adjust poor head posture through appropriate therapeutic interventions; and (ii) In addition to the routine application of pain-relieving modalities, a suitable exercise regimen that exclusively targets the deep cervical flexor muscle to improve its endurance is warranted.

Conflicts of interest

The authors have no conflicts of interest to declare.

Authors' contribution

AVS conceived and designed the study, conducted research, set the objectives, designed the methodology, conducted the research, collected and organized data, and prepared the initial draft of the paper. MAA has collected the literature, assists in writing, checked and finalized the manuscript draft. AVS & MAA have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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