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Impact of Cranio-vertebral Angle on Risk of Falling in Patients with Chronic Cervical Radiculopathy

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Abstract:

Purpose: This study aimed to explore the impact of craniovertebral angle (CVA) changes on the risk of falling in CR patients.

Subjects and methods: Fifty patients with CR of both genders took part in this study. These patients were assigned into two groups; the study group (G I) comprised 25 patients with FHP (CVA=less than 49°) and the control group (G II) comprised 25 patients without FHP (CVA ≥ 55°). Assessment of falling risk was conducted utilizing the Berg Balance Scale (BBS), whereas fear of falling was measured with the Fall Efficacy Scale-International (FES-I).

Results: Significant statistical differences were recorded between the groups in the mean scores of BBS and FES-I, as the study group exhibited a significantly decreased mean BBS score and a significantly increased mean FES-I score compared to controls. The CVA was significantly positively correlated with mean scores of BBS while significantly negatively correlated with mean scores of FES-I.

Conclusion: Patients with CR and FHP have higher fear of falling and risk of falling compared with patients without FHP, and there is a strong positive relationship between FHP and both the risk and fear of falling in CR patients.

Key words: Cervical Radiculopathy , Cranio-vertebral angle , risk of falling.

1. Introduction:

Cervical radiculopathy **(CR)** describes a set of symptoms resulting from compressed or irritated nerve roots in the cervical spine. The most frequent symptoms in patients are unilateral neck-arm pain, motor impairments (as diminished strength and reflex responses), and sensory alterations (as a gain or reduction in sensory perception) (1). These symptoms arise from either degenerative stimulation or mechanical pressure on the cervical nerve root. This can occur due to conditions such as herniation of the cervical intervertebral disc, changes in the articular facet and uncinate joints, including hyperplasia and hypertrophy, a decrease in intervertebral disc height, and hypertrophy of the ligamentum flavum, among other factors (2).

Cervical radiculopathy caused by cervical spondylosis **(CS)** is the most common type. It occurs between 50 and 60 percent of all cases (3), with an estimated 83.2 per 100,000 people living with CR on an annual basis(4).

Forward head posture (FHP) represents a predominant postural abnormality (5). It is defined as a decrease in lower cervical lordosis with posterior curvature in the upper thoracic region, and it affects 66% of the population. It increases loading on the neck extensor musculature and related connective structures. Due to daily living activities in the modern lifestyle as using laptops and tablets with poor posture for a prolonged time, FHP occurs (6).

Forward head posture is determined by a CVA value below 49°(7). It affects the afferent

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information received from the neck, so it impacts the pathways and mechanisms associated with the consolidation and storage of short-term memory, cerebellar activity and subsequent sensorimotor integration (SMI), performance accuracy, and upper limb performance (8). FHP impairs the cervical nerve roots, affecting proprioception, thus leading to cervicogenic dizziness and a high risk of falling (9). Information from afferent receptors in peripheral muscles, capsules, ligaments, and joints contributes to optimal neuromuscular control over movement and enhances joint stability (10).

The risk of falling is multifactorial. Environmental, pharmacological, demographic, behavioral, and intrinsic factors interact to cause falls. Functional disabilities, previous instances of falling, advanced age, environmental hazards, muscular weakness, vision impairments, vestibular system dysfunction, cognition reduction, illness, and certain drugs that induce dizziness, vertigo, and walking difficulties constitute the primary risk factors for falling (11).

Numerous research studies have looked into the relationship between contributing factors and falling, however, no research has studied the relationship between CVA and the risk of falling. So, this study was performed to examine how variations in the cranio-vertebral angle (CVA) affect fall risk among CR patients.

2. Materials and Methods:

Study design:

This research, a case-control study, received approval from the ethical committee of the Faculty of Physical Therapy at Cairo University, with registration number (P.T.REC/012/004743). It was also registered in the ClinicalTrials.gov (NCT06220799).

Participants:

Fifty patients with CR from both genders joined this study following their consent. CR was diagnosed in participants through detailed clinical assessments by a neurologist and imaging of the cervical region via Magnetic Resonance. Recruitment of participants took place at the outpatient clinic of the Faculty of Physical Therapy, Cairo University, Egypt. Patients were assigned into two equal groups; the study group comprised 25 patients with FHP (CVA < 49°) and the control group comprised 25 patients without FHP (CVA ≥ 55°).

Sample size:

For this study, each group required roughly 25 participants. The sample size was computed by applying G*POWER statistical software (version 3.1), targeting 80% power, a 0.05 alpha level, and a 0.73 effect size.

Inclusion criteria were: Fifty patients (from both genders) with chronic CR(degenerative type), age ranged from 35 to 50 years, and CR duration was over half a year. Exclusion criteria were: Patients with cervical myelopathy, acute CR, diabetic neuropathy, previous cervical surgery, cervical trauma, deformities in the cervical spine, patients with rheumatoid arthritis, tumors and infection involving the cervical spine, a history of neuromuscular disorders and patients with any inner ear problems or vestibular disorders as BPPV .

Instruments:

Cranio-vertebral angle was assessed by capturing a side-view image of the patient's cervical region. It was measured by the Kinovea software program. Assessment of falling risk was conducted utilizing the Berg Balance Scale (BBS) (12), whereas fear of falling was measured with the Fall Efficacy Scale-International (FES-I) (13).

Assessment procedures:

All patients provided their signatures on a consent form after being fully informed about the study's objectives, methodology, advantages, confidentiality, and data handling. All patients were subjected to the following evaluation:

1. Assessment of craniovertebral angle by the Kinovea software program:

The camera was placed on a non-movable base, held steady without tilting or rotating, with the base adjusted to the patient's shoulder height. For the standardization of head and neck postures, patients were positioned using a self-balanced technique. Patients flexed and extended their head and neck fully to get into this posture, then gradually decreased the range of motion until reaching a point of stillness, maintaining a natural head and neck positioning. Plastic markers were secured just above the C7 spinous process on the skin, and the ear's tragus received a similar marking. Then a picture was captured from the side view of the patient's cervical region. The Kinovea software was started, and the image was uploaded. The toolbar icon for angles was used to create the first horizontal line that goes through the marker directly above the C7 spinous process in order to initially establish the angle. The second was then created by clicking, holding, and linking the ear's tragus mark to the marker above the C7 spinous process on the image with a line. A larger FHP was indicated by a smaller CVA. A CVA less than 49 degrees indicates a forward head position.

2. Assessment of falling risk by the Berg Balance Scale (BBS):

The 14 tasks of the BBS were well explained to the patient. Each item is graded on a 0–4 scale, with 0 reflecting non-completion of the task and 4 revealing the greatest possible score, with each grade having specific criteria to meet. High fall risk is linked to scoring between 0 and 20, moderate fall

risk to scoring from 21 to 40, and minimal fall risk to scoring from 41 to 56 (14).

3. Assessment of fear of falling by the Fall Efficacy Scale-International (FES-I):

The FES-I has 16 items that were scored using the following responses to indicate "how concerned the patient is about the possibility of falling": no concern, slightly concerned, fairly concerned, and extremely concerned. The FES-I total score varies from 16 to 64 and is determined by adding all the individual scores. FES-I can be finished in 3–4 minutes. The cut-off points are set at 16 to 19 for low, 20 to 27 for moderate, and 28 to 64 for high levels of concern (15).

Data analysis and statistical design:

The patients' demographic and collected data were subjected to descriptive statistical analyses, such as means, standard deviations, and frequencies. Comparisons between the two groups were made utilizing an unpaired t-test. The Pearson Correlation Coefficient was conducted to explore if CVA was correlated with both BBS and FES-I scores. All statistical tests applied a significance criterion of ($p > 0.05$).

3. Results:

Patients' demographic and clinical characteristics:

Comparison of the general characteristics of patients between both groups indicated insignificant differences in mean age, weight, height, or body mass index (BMI) ($p>0.05$). However, a significantly longer illness duration characterized the study group versus the control group ($p= 0,000$). The study group comprised 21 women and 4 men, whereas the control group comprised 22 women and 3 men ($p > 0.05$). The study group included 17 patients (68%) with left-sided symptoms and 8 patients (32%) with symptoms on the right side, while, in the control group, 13 patients (52%) had left-sided symptoms and 12 patients (48%) had right-sided symptoms ($p > 0.05$), **Table 1.**

Comparison between study and control groups:

Between the groups, significant statistical differences in mean scores of BBS and FES-I were recorded ($p < 0.05$), **Table 2.**

Correlation between CVA and (BBS) and (FES-I):

A statistically significant strong positive correlation was identified between CVA and BBS scores ($r= 0.947$, $p= 0.000$). Conversely, a significant very strong negative correlation was identified between CVA and FES-I scores ($r= -0.889$, $p=0.000$), **Table 3.**

Table (1):Patients' demographic and clinical characteristics for both groups.

Variables	Study Group n=25	Control Group n=25	p-value
	Mean± SD	Mean ± SD	
Mean age (years)	42.44 ± 5.28	42.60 ± 5.69	0.918
Mean weight (kg)	76.72 ± 10.60	78.08 ± 6.93	0.594
Mean height (cm)	166.08 ± 9.656	168.28 ± 7.289	0.368
Mean BMI (kg/m²)	27.62 ± 2.72	27.616 ± 2.58	0.996
Mean duration (month)	13.32 ± 2.91	9.28 ± 1.768	0.000**
Affected Side			
RT	8 (32%)	12 (48%)	0.156
LT	17 (68%)	13 (52%)	
Sex			
Women	21 (84%)	22 (88%)	0.687
Men	4 (16%)	3 (12%)	

SD: Standard deviation, ** highly significant, BMI: body mass index, Rt: right, LT: left.

Table (2): Comparison of mean BBS and FES-I scores between both groups.

Variables	Study Group	Control Group	Between groups comparison (P value)
	mean ± SD	mean ± SD	
Mean BBS score	32.36 ± 4.932	54.28 ± 2.301	0.0001**
Mean FES-I score	43.72 ± 9.838	19.36 ± 2.596	0.000**

SD: Standard deviation, ** highly significant, BBS: Berg balance scale, FES-I: Falls Efficacy Scale-International

Table (3): correlation between CVA and other outcome measures

	Craniovertebral angle (CVA)	
	Pearson Correlation	Sig. (2-tailed)
BBS score	0.947	0.000**
FES-I score	-0.889	0.000**

**** highly significant, BBS: Berg balance scale, FES-I: Falls Efficacy Scale-International**

4. Discussion:

This study aimed to identify the influence of CVA alterations on fall risk in chronic CR patients. Results from this study showed that the study group (patients with FHP) exhibited a statistically significant higher fear and risk of falling when contrasted with the control group (patients with no FHP). These results agreed with Sedaghati et al. (2018) (16), who noticed that FHP was associated with an increased fear of falling when comparing the pre- and post-evaluation of individuals participating in a postural realignment program. They also found a notable inverse relationship between CVA and fear of falling. Moreover, Brown (2017) (17) demonstrated a positive correlation between poor posture (FHP and thoracic kyphosis) and fall history, fear of falling, and fall risk.

This study's findings demonstrated that the CVA was strongly positively correlated with falling risk (BBS scores), and strongly negatively correlated with the fear of falling (FES-I scores). This indicates that patients with FHP and lower degrees of CVA have lower balance and a higher risk of falling. Our findings came in agreement with Bhat et al. (2024)(18), who found a direct correlation between cranio-vertebral angle and balance. Moreover, van der Jagt-Willems et al. (2015) (19) noted that FHP was correlated with elevated fall rates. They explained that this postural deviation causes forward shifting of the center of mass, resulting in forward falls.

Kang et al. (2012) (20) also identified that FHP was linked to decreased balance control in prolonged computer users compared with the control group. Additionally, their computerized posturography data revealed an anterior shift in the participants' center of gravity (COG), observed under both static and dynamic test settings. Furthermore, Karajgi et al. (2015) (21) proved that young adults with FHP exhibited increased movement velocity of the COG and atypical endpoint excursions in the forward direction within the limits of stability compared to the control group.

In contradistinction, Lee (2016) (22)found that FHP was not significantly correlated with dynamic balance control when evaluating the diagnostic modes of a body-tilt training and measuring system in participants with FHP versus those without. Silva et al. (2013) (23) also reported a non-significant difference in postural control between young healthy adults with FHP and young healthy adults without FHP. The discrepancy may be attributed to the characteristics of the population, as the current study was applied to CR patients, not healthy individuals.

5. Conclusion:

Patients with lower CVA are more likely to fall and feel more fearful of falling compared to patients without FHP. Treatment plans for those patients must take this into account to enhance their quality of life.

Ethical approval:

This research received approval from the ethical committee of the Faculty of Physical Therapy at Cairo University, with registration number (P.T.REC/012/004743). It was also registered in the ClinicalTrials.gov (NCT06220799).

Conflict of interests:

No conflicts of interest exist.

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