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ASSOCIATION BETWEEN THORACIC KYPHOSIS, HEAD POSTURE AND CERVICAL RANGE OF MOTION IN ADULTS WITH AND WITHOUT CERVICAL SPINE DYSFUNCTION

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ABSTRACT

Background: Excessive Thoracic Kyphosis (TK) and Forward Head Posture(FHP) become more apparent in aging adults from the accumulation of remodeling in response to habitual postures. Faulty posture of the shoulders, neck, and particularly the head may contribute to the onset and perpetuation of cervical pain dysfunction syndrome. Current literature suggests that an association exists between the head posture, thoracic kyphosis and cervical range of motion in individuals with cervical spine dysfunction. Since age as well as cervical spine dysfunction may affect the above parameters, the objective of our research was to study the association between these in adults with and without cervical spine dysfunction.

Methods: 50 adults with CSD and 50 adults without CSD were assessed for TK, FHP and Cervical range of motion (CROM) by flexicurve method Kipnotic Index (KI), measuring crano-vertebral angle(CVA) using a lateral-view photograph(digitized) of the subject and using Universal Goniometer respectively.

Results: In both groups, there was increased KI (TK), lesser CVA i.e. FHP and reduced CROM when compared to normative values, however there was no statistical difference in KI and CVA between the two groups ($p=0.53,0.75$). Cervical extension and rotation ranges were significantly reduced in CSD adults ($p=0.00,0.00,0.00$). Correlation between CVA and CROM, KI and CROM and KI and CVA was not significant in adults with as well as without CSD ($p=0.16-0.51,0.05-0.35,p=0.08-0.69,0.19-0.52,p=0.13,0.94$ respectively).

Conclusion: Correlation between FHP and CROM,TK and CROM, FHP and TK in adults with and without CSD was not significant.

Keywords: FHP, KI, CROM, CSD, CVA, Flexicurve, Photographic method

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INTRODUCTION

Cervical spine dysfunction (CSD) is highly prevalent in the universal populace and is a cause of neck discomfort. Pain, restricted range of cervical motion, tenderness on the cervical spine or muscles, crepitus and cranio-cervical posture changes are the presenting signs and symptoms [1]. Faulty posture of the shoulders, neck, and particularly the head may contribute to the onset and perpetuation of cervical pain dysfunction syndrome [2]. Forward head posture is common type of poor head posture seen in patients with neck disorders. It indicates that the head is anteriorly placed when related to a plumbline, passing perpendicular to a horizontal line through the centre of gravity of the body [3]. Few researchers have observed that individuals with head, neck, and shoulder pain usually have a smaller Cranio Vertebral angle indicative of a Forward Head Posture (FHP), than asymptomatic subjects [3-5]. The degree of FHP reported by Dalton [6], Raine [7] and colleagues for pain-free individuals over the age of 55 years was higher than that reported by Braun [8] for patients with neck pain with an average age of 38 years. This highlights the relevance of controlling for age when comparing forward head posture between individuals with and without neck pain [3].

Dysfunctions and activity limitations associated with postural impairments are not an inevitable part of ageing; however excessive thoracic Kyphosis (hyperkyphosis) and FHP become more apparent in aging adults from the accumulation of remodeling in response to habitual postures [9]. Hyperkyphosis, a significant health risk, is a commonly observed postural dysfunction in elders, and increasing thoracic kyphosis angle has been related to increasing mobility restrictions in them [10]. FHP and hyperkyphosis are closely related mechanically and functionally, although FHP can exist in older adults separate from hyper kyphosis.

Cervical spine dysfunction is a very common musculoskeletal condition in working age population and a leading cause of disability [11]. Pain can cause postural changes and also reduce ROM which can lead to decreased mobility in one or more vertebrae.

Quek J [10] in her study, concluded that the association between thoracic kyphosis and cervical ROM, specifically general cervical rotations and flexion, was mediated by FHP. John Krauss [12] observed association between upper thoracic spine (T1-T4 motion segments) manipulation and significantly increased range of cervical rotation. Lau et al(2011) [13], in a randomized controlled study, concluded that FHP and cervical flexion ROM improved, following thoracic spine manipulation.

In view of the above literature, it may be hypothesized that, there is an association between head posture, thoracic kyphosis and cervical ROM in individuals with cervical spine dysfunction. Since age as well as cervical spine dysfunction may affect head and thoracic spine posture as well as cervical ROM, the objective of our research was to study the association between these parameters in adults with and without cervical spine dysfunction.

METHODS

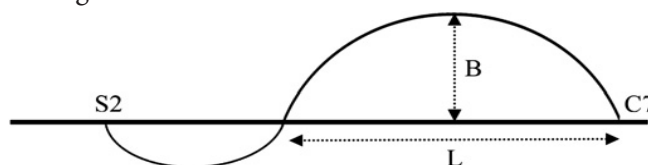
Approval was granted by the institutional ethics committee before commencement of the study. Adults aged 45 to 80 years with and without CSD, attending the physiotherapy OPD of K. J. Somaiya Hospital between August 2013 to September 2014 were included. The adults with CSD complained of cervical pain, with or without referred pain and parasthesias. Individuals suffering from trauma, tumour, fracture or infection of spine and lower limb, cervical spine instability, surgeries, spondylolisthesis or canal stenosis, moderate to severe structural scoliosis, vertigo, dizziness, neuromuscular disorders, vestibular diseases and impairment of vision, uncorrected by prescriptive lenses were excluded.

PROCEDURE

125 adults with and without CSD were screened, of which 100 subjects participated in the study (n=100), Group A: 50 adults with CSD and Group B: 50 adults without CSD. All participants signed a consent form after explanation of the study procedure and benefits in language best understood. Following this, thoracic kyphosis, head posture and active cervical range of motion was assessed.

Thoracic Kyphosis (TK) [10]:

TK was measured using the flexicurve method. Subjects were asked to stand in relaxed standing position while the flexicurve was placed over the thoracic and lumbar spinous processes. The flexicurve ends were aligned to the spinous processes of C7 and S2 and the shape of the flexicurve was conformed to the curvature of the spine. The flexicurve was then carefully placed on a graph paper and the curve was traced onto the paper. A ruler with 1/10th cm markings was used to measure the length and width of each segment.



Calculation of Kyphosis Index(KI) was performed as:

$\frac{\text{Thoracic width (B)}}{\text{Horizontal length(L)}} \times 100$.

High reliability values for KI(ICC: 0.88 and more)was found in previous studies.



Picture 1: Measurement of Thoracic kyphosis using flexicurve

Head posture [10]

A digitized, lateral-view photograph of the individual in his/her usual standing attitude was used to assess the head posture. Tragus of the subject's ear was marked, and a black pointer was adhered to the skin overlying the C7 vertebra. Subject was then asked to stand comfortably with arms by the side of the body and to visually focus on a point on the wall directly ahead of them. At a distance of 60 cm [14] from the left side of the subjects face, a camera was positioned on a tripod and height adjusted to include the subject's head from the top to the base of the clavicle [15]. Circular spirit level was placed at the base of the camera to ensure that the camera was perpendicular to the horizontal and minimize image distortion. On the photograph, angle (a) between the horizontal line passing through C7 and a line extending from the tragus of the ear to C7 was measured (CVA). FHP is indicated by lesser CVA. Test – retest reliability was good in previous studies (ICC: 0.88 – 0.96) [7]



Picture2: Measurement of CVA using photographic method (digitized)

Active Cervical Range of Motion (CROM) [16]

CROM was measured using Universal Goniometer (UG) in relaxed sitting posture [17].

STATISTICAL ANALYSIS

MS-Excel-2007 was used to enter the data which was analyzed using SPSS-20 software.

Data was found to be normally distributed using Kolmogorov Smirnov test. Descriptive analysis for numerical data consists of mean with standard deviation (SD) for various parameters. Frequencies for categorical data are expressed in percentage. Pearson's product-moment coefficient correlation was used to study association between the parameters. Unpaired t test was used for comparison of parameters between the groups. P value less than 0.05 was considered to be statistically significant.

RESULTS

Table 1: Mean and SD of variables in adults with and without CSD

Variables	CSD adults (mean ±SD)	Non CSD adults (mean ±SD)	t	p
No.of subjects	50	50		
% males	32%	30%		
% females	68%	70%		
Age	53.68± 7.9	54.42 ± 8.4	-0.455	0.650
Height	154.1± 23.2	155.3± 6	1.635	0.105
Weight	66.36± 17.5	61.88± 10.4	1.318	0.191
CVA	46.62± 7.1	46.4± 4.2	-0.313	0.755
KI	13.78± 5.52	12.72± 2.7	0.627	0.532
Flexion	41.36± 8.3	44.72± 6.47	-1.893	0.061
Extension	49.34± 6.5	52.8± 6.2	-2.737	0.007 (significant)
Rt Lat Flex	33.5± 8.5	33.86± 7.7	0.379	0.705
Lt Lat Flex	33.5± 7.2	34.42± 7.4	-0.631	0.529
Rt Rotation	69.4± 8.6	77.12± 7.4	-4.815	0.000 (significant)
Lt Rotation	70.8± 6.3	77.4± 7.016	-4.965	0.000 (significant)

Table 1: In both groups, there was increased KI (TK), lesser CVA i.e. FHP and reduced CROM when compared to normative values, however there was no statistical difference in KI and CVA between the two groups. Cervical extension and rotation ranges were significantly reduced in CSD adults.

Table 2: Correlation of parameters in CSD adults

Variables	r ²	p value
CVA- KI	0.045	0.139
CVA- Flexion	0.09	0.512
CVA- Extension	0.04	0.164
CVA- Rt Lat Flexion	0.025	0.270
CVA- Lt Lat Flexion	0.01	0.495
CVA- Rt Rotation	0.027	0.257
CVA- Lt Rotation	0.024	0.287
KI- Flexion	0.003	0.690
KI- Extension	0.004	0.645
KI- Rt Lat Flexion	0.04	0.166
KI- Lt Lat Flexion	0.060	0.085
KI- Rt Rotation	0.034	0.200
KI- Lt Rotation	0.022	0.305

Tables 2: Correlation between CVA and CROM, KI and CROM and KI and CVA was not significant in adults with CSD.

Table 3: Correlation of parameters in non CSD adults

Variables	r ²	p value
CVA- KI	0.00	0.946
CVA- Flexion	0.031	0.220
CVA- Extension	0.018	0.355
CVA- Rt Lat Flexion	0.066	0.071
CVA- Lt Lat Flexion	0.077	0.051
CVA-Rt Rotation	0.054	0.102
CVA- Lt Rotation	0.067	0.070
KI- Flexion	0.028	0.26
KI- Extension	0.009	0.521
KI- Rt Lat Flexion	0.031	0.220
KI- Lt Lat Flexion	0.035	0.194
KI-Rt Rotation	0.015	0.399
KI- Lt Rotation	0.018	0.353

Tables 3: Correlation between CVA and CROM, KI and CROM and KI and CVA was not significant in adults without CSD.

DISCUSSION

In present study,

More number of females (68%) presented with neck pain in CSD group as compared to males.

Similar findings were reported in a IKCO cohort study by Akbar Alipour(2008) [18], who observed that neck shoulder pain was experienced by women more than men and that women also displayed symptoms more commonly at all ages. The factor, he thought responsible was that, women were often employed in more hand intensive tasks which due to their anthropometrical parameters (eg. body size, strength) could disadvantage them in work systems where such differences were not accounted for.

In both groups, there was increased KI(TK), lesser CVA i.e. FHP and reduced CROM when compared to normative values.

In a study conducted by James W Youdas (1992) [19], he concluded that each of the five cervical AROMs of extension, bilateral lateral flexion and rotations had a significant association with age and gender.

In asymptomatic females, Dvorak et al [20] observed significant reduction in all cervical ranges of motion from age group 30–39 years to age group 40–49 years.

Matti Nykanen et al (2007) [21] conducted a study on 179 female office workers aged 25–53 years with chronic neck pain and reported that range of cervical axial rotation decreased significantly, while range of other cervical motions also reduced, in older females with degenerative changes. They stated that attempted rotation may have led to pain in a degenerated cervical spine, resulting in a reflex muscular contraction that limited the ROM.

Anabela G. Silva (2009) [3], in her study investigated the presence of forward head posture for older participants with and without neck pain. She argued that FHP may be related to changes in the mechanisms involved in the maintenance of head posture with age.

Sally Raine, Lance T. Twomey (1997) [7] observed a signif-

icant association between cranio vertebral angle and age, which revealed that the head of elder individuals tended to be placed more forward.

In their study, Serkan Erkan et al (2010) [22] concluded that age and upper, lower and whole thoracic kyphosis was not related in individuals with loss of cervical lordosis (group 1) as well as with physiological cervical lordosis (group 2). However, they also found that in individuals older than 50 years in group 2, the lower and whole thoracic kyphosis was significantly increased.

Takahashi and Atsumi (1955) [23] stated that the flexi-curve thoracic index was negatively correlated with height and positively with age. They credited this to lifelong postural and occupational habits of individuals.

Gerald T. Fon(1980) [24] postulated the possibility of poor posture and aging of soft tissues with resultant loss of muscle tone leading to increased thoracic kyphosis in older females.

Significant reduction was noted in ranges of extension and rotations in Group A(CSD adults).

Similar finding was reported by Lan Yuen Guo (2012) [25] who concluded that the cervical ROM of extension and right rotation in primary planes was significantly reduced in patients with mechanical neck disorders(MND) compared to the control group in his study.

In a cross-sectional study conducted on 102 subjects with neck pain and 33 healthy controls by Kim Dunleavy and Allon Goldberg (2013) [26], they reported that both rotation and extension ranges were often limited in individuals with cervical dysfunction.

FHP and kyphotic upper thoracic region have compensatory hyperextension of the cervical spine and head. This can compress the facet joints, affecting the biomechanics of the head/neck [15] and therefore the cervical range of motion. This may also lead to shortening of suboccipital muscles and stretch weakness of anterior neck muscles. Abnormally large compression force on the articular facets due to the altered and sustained pull of the shortened muscles may lead to pain [27] causing still further reduction in cervical mobility in adults with CSD.

There was poor negative correlation between KI and CVA in both groups, which was not significant.

In a study by Raine and Twomey [7]in 1997 with 160 asymptomatic subjects(17-83yrs), Sagittal C7-tragus, sagittal head tilt, and sagittal shoulder- C7 angle were not found to be related to the upper or lower thoracic spine curvature. This contradicted the idea that forward head posture is related to forward positioned shoulders or exaggerated thoracic spine curvature.

June Quek (2013) [10] found thoracic kyphosis and FHP to be significantly correlated in subjects with cervical spine dysfunction. However our results (insignificant correlation) contradict that obtained in above study for the CSD adults. Methodologic and analytical differences as well as younger mean age of participants could be the reason for the contrary results.

In adults with CSD, bilateral rotations were poorly pos-

itively correlated and all other ranges were poorly negatively correlated with CVA (not significant). All ranges in adults without CSD were poorly positively correlated with CVA but not significant.

AnaI. De-la-Llave-Rincon (2009) [15] demonstrated greater FHP and reduced cervical range of motion in patients with moderate Carpal Tunnel Syndrome when compared to healthy individuals. FHP correlated negatively with cervical range of motion but though the correlations were statistically significant, they were low to moderate (0.25-0.45).

June Quek (2013) [10] in her study on older adults (mean age: 66±4.98) with CSD observed an association between greater FHP and larger deficits in cervical rotation and flexion ROM along with non significant association between upper cervical rotation ROM and FHP.

The non significant correlations between CVA and cervical ROM for both groups in our study could be attributed to the fact that the mean age of the participants was less (mean age: 53.68±7.9 & 54.42±8.4) as compared to the participants of the above study. The intensity of pain and disability due to cervical dysfunction was also not taken into consideration while including the participants in the study.

In the present study, both groups demonstrated smaller CVA i.e increased FHP as well as reduced ROM when compared to normative values [19]. Though no significant correlation was established between forward head posture and cervical range of motion, it was seen that there was a significant reduction in the ranges of cervical extension and rotations in CSD adults. This suggests that FHP may be associated with increasing age and not only with cervical spine dysfunction while the reduced ranges observed in CSD adults may be related to the cervical dysfunction.

In CSD group, only flexion and rotations showed poor negative correlation with KI (not significant) while positive correlation was found with all ranges in adults without CSD, though not significant.

In June Quek's (2013) [10] study, their chief finding was the indirect effects of FHP on the relation between exaggerated thoracic kyphosis and reduced cervical ROM. They stated that increase in thoracic kyphotic curvature may cause trunk mass to shift anteriorly due to altered loading of the thoracic spine. This results in a FHP, with increased compressive loading in the cervical spine leading to decreased cervical ROM.

Results of this study are in contrast with that of the above, for CSD older adults. However it was interesting to note that the adults without CSD also depicted non significant association. Exaggerated thoracic kyphosis in both the groups could be due to the effects of aging and may not contribute to the cervical spine dysfunction. Further research may be conducted to study the association between the variables in young adults as well as the geriatric population, in individuals with and without Cervical spine dysfunction.

LIMITATIONS

Small sample size, inclusion of varied cervical dysfunction

cases eg cervical spondylosis, mechanical neck pain, prolapsed cervical intervertebral disc, etc and not controlling for chronicity of dysfunction/ symptoms were the limitations of the study.

CONCLUSION

Correlation between FHP and CROM, TK and CROM, FHP and TK in adults with and without CSD was not significant.

KEY POINTS

Findings: There was no significant correlation between Forward head posture, Thoracic Kyphosis and CROM in adults with and without Cervical spine dysfunction.

Implication: Forward head posture, increased thoracic kyphosis and reduced cervical range of motion may result from increasing age and is not necessarily associated with cervical spine dysfunction alone. Clinicians should be aware of the association between forward head posture, thoracic kyphosis and cervical mobility with CSD and age.

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