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Effect of Stabilization Exercises on Craniovertebral Angle and Cervical Range of Motion among Visual Display Users with Forward Head Posture

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ABSTRACT

INTRODUCTION. VDT (video display terminal or visual display terminal) is used, especially in ergonomic studies, for the computer display. When using a VDT, static posture raises muscle tension, which causes a variety of neuromuscular symptoms, most frequently in the upper body, including discomfort, numbness, loss of function, and other symptoms. The advent of the technological revolution has rendered modern computing and communication tools indispensable for both professional and recreational purposes. The companies have extended its market reach by introducing their computing products, specifically Video Display Terminals (VDTs), beyond the confines of traditional business settings to include personal laptops used in residential spaces such as bedrooms.

AIM. The study aimed to compare the effects of stabilization exercises vs traditional exercise on cervical range of motion and the Craniovertebral angle in VDT users with a forward head posture.

MATERIALS AND METHODS. Comparative study design with 26 participants, comprising both genders with forward head posture between the ages of 20 and 35. Following selection, subjects were randomly divided into two groups: Group A, which received stabilization exercises, consist of 12 subjects; Group B, with 14 subjects; the main outcome measures were cervical range of motion and Craniovertebral angle.

RESULTS. Group A shows statistically substantial improvement in all the outcomes. Group B also shows statistically significant improvement in selected cervical range of motion; however, the group did not improve the Craniovertebral angle and cervical rotations substantially.

CONCLUSION. The results of the current study showed that stabilizing exercises are superior to conventional training in reducing the craniovertebral angle and increasing cervical range of motion in visual display terminal users with a forward head posture.

KEYWORDS: visual display terminal users, forward head posture, swiss ball, stabilization exercise.

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Влияние стабилизирующих упражнений на краниовертебральный угол и диапазон движения шейного отдела позвоночника у пользователей визуальных дисплеев с положением головы вперед

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РЕЗЮМЕ

ВВЕДЕНИЕ. ВДТ (видеодисплейный терминал или визуальный дисплейный терминал) используется, особенно в эргономических исследованиях для отображения информации на экране компьютера. При использовании ВДТ статическая поза вызывает напряжение мышц, что приводит к различным нервно-мышечным симптомам, чаще всего в верхней части тела, включая дискомфорт, онемение, потерю функции и другие симптомы. Наступление технологической революции сделало современные компьютерные и коммуникационные средства незаменимыми как для профессиональных, так и для развлекательных целей. Компании расширили сферу своего влияния на рынок, выведя свои вычислительные продукты, в частности ВДТ, за рамки традиционной деловой среды и распространив их на персональные ноутбуки, используемые в жилых помещениях, например, в спальнях.

ЦЕЛЬ. Сравнить влияние стабилизирующих упражнений и традиционных упражнений на диапазон движения шейного отдела позвоночника и краниовертебральный угол у пользователей ВДТ с наклоном головы вперед.

МАТЕРИАЛЫ И МЕТОДЫ. В сравнительном исследовании приняли участие 26 человек обоих полов с прямой позой головы в возрасте от 20 до 35 лет. После отбора испытуемые были случайным образом разделены на две группы: Группа А, получавшая стабилизирующие упражнения, состояла из 12 человек; Группа В — из 14 человек; основными показателями были диапазон движения шейного отдела позвоночника и краниовертебральный угол.

РЕЗУЛЬТАТЫ. Группа А показала статистически значимое улучшение по всем показателям. Группа В также показала статистически значимое улучшение в выбранном диапазоне движения шейного отдела; однако группа не улучшила краниовертебральный угол и ротацию шейного отдела.

ЗАКЛЮЧЕНИЕ. Результаты данного исследования показали, что стабилизирующие упражнения превосходят обычные тренировки в уменьшении краниовертебрального угла и увеличении диапазона движения шейного отдела позвоночника у пользователей визуальных терминалов с положением головы вперед.

КЛЮЧЕВЫЕ СЛОВА: пользователи терминалов с визуальным дисплеем, положение головы вперед, швейцарский мяч, стабилизирующие упражнения.

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INTRODUCTION

In technologically advanced eras, computer users have grown to be the most important group for keeping up with time and progress. To enable and speed up data flow and information, banks, government agencies, corporate organizations, autonomous institutions, and nearly every organization are becoming computerized. Modern computing and communication tools are now necessary for both work and play due to the arrival of the technology revolution. They have expanded their presence with their computing devices VDT from the fixed desktop of an office environment to a user's laptop in the bedroom [1–2].

Conferring to National Statistical Office reports that as more individuals own computers and have access to larger internet networks, the amount of time per week that each individual spends using a computer has substantially increased, rising from 5.9 hours in 1997 to 14.6 hours in 2003. Additionally, 56.2 % of computer users log on for 10 hours or more per week. Computers boost productivity and effectiveness at work, but prolonged use can cause VDT syndrome, which can cause headaches, visual disturbances, musculoskeletal pain, and other symptoms. Of these concerns, musculoskeletal issues are the most prevalent [3–6].

The characteristics of the task determine the effects on head and neck posture. VDT work typically entails staying in a fixed position for an extended period. Szeto et al. [7] discovered that during VDT work, People tend to hunch their heads forward more often, which is comparable to a protracted portion of the cervical spine where the lower cervical vertebrae are flexed in a forward glide and the upper cervical vertebrae are extended [8]. This forward head posture involves an excessive anterior part of the head regarding the theoretical plumb line perpendicular to the body's center of gravity.

Although the link between forward head posture and neck pain has not been established, a tool for developing neck pain from habitual postures has been demonstrated [9] According to research on the effects of sustained forces, a single stance should not be held for more than 60 minutes. McGill and Brown have demonstrated that 20 minutes of persistent stress can cause soft tissue creep, with recovery requiring up to 40 minutes [10].

The normal cervical lordosis is a curve in the cervical spine, which houses the neck vertebrae. This curve is perfectly standard

and even desirable because it aids in the stabilization of the head and spine. The cervical lordosis in a healthy spine resembles an extensive C, with the C pointing towards the back of the neck. The load affects cervical postural changes. Prolonged static postures are more common, and both non-neutral and neutral neck postures have been linked to cervical discomfort [11].

The studies found that subjects with head, neck, and shoulder discomfort are more likely to have a smaller craniovertebral angle, which indicates a forward head posture, than asymptomatic subjects. Neck posture is significantly associated with musculoskeletal neck disorders in occupational settings [12]. FHP and rounded shoulders are both characterized by head and shoulder protrusion in the sagittal plane. These changes in the cervical region may lead to musculoskeletal discomfort, such as "upper crossed syndrome," as a result of keeping a bad head position for an extended period of time (upper cervical extension and flexion of the lower cervical spine). Additionally, neck and shoulder pain are prominent complaints among FHP patients [13].

The CV angle is the angle formed by a horizontal line passing through C7 and a line extending from the tragus of the ear to C7, which is significantly reduced in subjects with FHP [14] CV angle, has an average range of 42–54. The CV angle is a reliable way to assess forward head posture (ICC-0.95) [15]. Restoring normal neck flexion and extension range of motion should be the aim of treatment for poor cervical posture. Enhancing cervical mobility to manage CV angle assisted in lowering the FHP for neck stabilization [16].

Workers in VDU now place proper posture of the cervical spine in relation to the shoulders. There isn't much that defines stance based on measurements, and a few other postural detriments have been linked with quantitative measures; furthermore, working for lengthy periods of time causes atypical postures due to the stress that builds up during the workday.

Previously, different ergonomic measures were discussed in computer users, and the role of stabilizing exercises has become vital in daily life to avoid future illness development and improve quality of life further to it age specific protocols can be developed.

AIM

Hence the aim of the training is intended to find out the effect of stabilization exercises on craniovertebral angle and cervical range of motion among Visual display users with forward head posture.

MATERIALS AND METHODS

Participants

The data is collected from Kritiprakashan pvt LTD and Cognizant technology solutions Bangalore with forward head posture with total sample size of 26 by simple random sampling technique. Randomization — Allocation concealment mechanism:

$$n = \frac{(Z_{1-\alpha/2}+Z_{1-\beta})^2 \times S^2 \times 2}{d^2}$$

The group is transcribed on paper and preserved in a solid closed envelope using the sequentially numbered, solid, closed envelope (SNOSE) technique. A serial number is inscribed on the label of the envelope, subsequently attaining the subjects consent; the researcher opens the sealed envelope and designates the therapy group as necessary.

Inclusion criteria

1. Neck pain for more than three months.
2. Desktop or laptop usage for more than 2 hours/day.
3. Both male and female subjects.
4. Age group: 19–35 years.
5. Subjects with forward head posture.

Exclusion criteria

1. Patients with cervical discal pathology (Radiographic evaluation was done to evaluate for degenerative pathology to rule out osteophytes).
2. Infectious pathology in or around the spinal column.
3. Previous history of cervical surgery.
4. Patients with temporomandibular joint disturbances.
5. Patients with vestibular imbalance.

The study has been approved by the ethical committee vide of Padmashree Institute of Physiotherapy, Ref: PIP/EC/15-10/03-18 dated 15.03.2018. The subjects were divided into two groups.

Out of 26 subjects 12 were in Group A received stabilization exercises and 14 were in Group B who received isometric exercises. The back ground variables of age and gender are homogenous in both the groups with mean and SD of age and frequency and percentage of the gender (Table 1).

Table 1. Description of Background Variables

Sl. No	Variables	Group A (n = 12)	Group B (n = 14)	p-value
		Mean ± SD	Mean ± SD	
1	Age	29.00 ± 2.32	29.00 ± 3.43	p = 1.00
2	Gender	9 (75.0)/3 (25.0)	8 (57.1)/6 (42.9)	p = 0.340

Note: Not significant ($p > 0.05$).

Group A (n = 12) (Experimental Group): This group performed stabilization exercises on the Swiss ball. Stabilization exercises performed strengthening of deep cervical neck flexors and scapular retractors.

Exercises for strengthening neck flexors

The subjects lay supine with head up and chin tuck both the hands are placed on abdomen [17]. For strengthening of scapular retractors: the subjects were positioned prone with shoulders at 90°–120° abduction, then extended their spine by externally rotating their arms while maintaining the chin-tuck.

The subjects performed these exercises twice a week for four weeks, with ten repetitions and 10 seconds hold in the first two weeks and 15 seconds hold in the following two weeks [18].

Group B (n = 14): 10–15 repetitions of isometric exercises were carried out while lying on the back with the chin resting against a towel roll under the neck for 10 seconds at a time, with 15-second pauses in between holds. Then, in the seated position, isometric workouts were carried out with maximum effort by resisting cervical flexion, extension, lateral flexion, and rotation with one's own hand for the same number of repetitions and duration as in the supine position.

Table 2. Comparison of Pre Intervention outcome variables

Sl. No	Variables	Group A (*n* = 12)	Group B (*n* = 14)	*p*-value
		Mean ± SD	Mean ± SD	
1	CV angle	56.50 ± 3.89	58.14 ± 3.65	*p* = 0.279
2	Flexion	26.75 ± 5.27	27.21 ± 3.63	*p* = 0.795
3	Extension	34.75 ± 7.96	30.93 ± 3.56	*p* = 0.118
4	Flexion LT side	38.75 ± 7.99	36.50 ± 7.73	*p* = 0.473
5	Flexion RT side	43.08 ± 8.78	42.57 ± 8.34	*p* = 0.880
6	Left Rotation	53.42 ± 15.5	51.21 ± 13.4	*p* = 0.703
7	Right Rotation	63.25 ± 6.93	61.71 ± 8.54	*p* = 0.623

Note: *Not significant (p > 0.05).*

The stabilization exercise group has performed two sets of exercise and the isometric group has performed only one set of exercises hence there is a variation in the frequency of sessions in the groups.

Outcome Measures

Universal Goniometer for the assessment of cervical ROM [19] Cervical X-Rays for the evaluation of CV angle [20–23].

A body marker is used to identify the ear tragus and the spinous process of C7. Draw a horizontal line that intersects C7 and forms a right angle with the vertical. Two lateral pictures of the person in a relaxed seated position without back support are taken in order to estimate the craniovertebral angle

Statistical Analysis

The data was carefully elicited on the outcome measures, and demographic characteristics of the forward head posture subjects were evaluated by SPSS software (version 20.0). The level of significance was set at 5 % (i.e., α = 0.05). The frequency and percentage analysis described the demographic data of the subjects. Baseline variables and primary variables have been computed using Mean and standard deviation.

The significant difference between pre- and post-test results was examined using the paired t-test. The significant difference between the experimental and control groups was examined using an unpaired t-test.

The significance of the difference in gender proportion across groups was examined using the chi-square test. The Shapiro-Wilk test is used to determine whether the data for quantitative outcomes are normal. The graphs and tables were created using MS-Excel and MS-Word.

RESULTS

The outcome measures of CV angle and cervical range of motion (Flexion, Extension, Left side Flexion, Rt side flexion, left and right rotation were compared and given in the above table before the intervention the mean and SD of outcome measures pre interventionally more or less similar individually in both the groups. The Unpaired t test was shown to be non-significant for all the variables (Table 2).

Table 3 presents the pre and posttest comparison of the outcome measures individually for Group A and Group B the CV angle, and cervical range of motion Flexion, Extension, left side flexion and Right side flexion were found to be significant in both the groups but the outcome measures of left rotation and right rotation were found to be statistically significant while comparing pre and post test scores individually in both the groups.

The post-intervention assessment of outcome variables revealed that Group A (Stabilization Exercises) showed significantly greater improvement in flexion and extension range of motion

Table 3. Comparison of Pre and Post Intervention outcome variables

Sl.No	Variables	Group A (*n* = 12)	*p*-value	Group B (*n* = 14)	*p*-value	
		Mean ± SD		Mean ± SD		
1	CV angle	Pre test	56.50 ± 3.89	0.000	58.14 ± 3.65	*p* = 0.000
		Post test	63.42 ± 4.20		60.64 ± 3.60	
2	Flexion	Pre test	26.75 ± 5.27	0.000	27.21 ± 3.63	*p* = 0.000
		Post test	38.50 ± 4.94		29.43 ± 3.45	
3	Extension	Pre test	34.75 ± 7.96	0.000	30.93 ± 3.56	*p* = 0.000
		Post test	52.17 ± 10.1		32.71 ± 3.26	
4	Flexion LT side	Pre test	38.75 ± 7.99	0.015	36.50 ± 7.73	*p* = 0.000
		Post test	44.08 ± 7.45		39.00 ± 7.01	
5	Flexion RT side	Pre test	43.08 ± 8.78	0.000	42.57 ± 8.34	*p* = 0.000
		Post test	49.75 ± 9.32		43.93 ± 8.30	
6	Left Rotation	Pre test	53.42 ± 15.5	0.079	51.21 ± 13.4	*p* = 0.207
		Post test	59.75 ± 14.5		53.21 ± 13.2	
7	Right Rotation	Pre test	63.25 ± 6.93	0.063	61.71 ± 8.54	*p* = 0.752
		Post test	68.58 ± 11.4		62.93 ± 8.10	

Note: *Not significant (p > 0.05), significant (p < 0.05).*

Table 4. Comparison of Post Intervention outcome variables

Sl. No	Variables	Group A (*n* = 12)	Group B (*n* = 14)	*p*-value
		Mean ± SD	Mean ± SD	
1	CV angle	63.42 ± 4.20	60.64 ± 3.60	$p = 0.083$
2	Flexion	38.50 ± 4.94	29.43 ± 3.45	$p = 0.000$
3	Extension	52.17 ± 10.1	32.71 ± 3.26	$p = 0.000$
4	Flexion LT side	44.08 ± 7.45	39.00 ± 7.01	$p = 0.086$
5	Flexion RT side	49.75 ± 9.32	43.93 ± 8.30	$p = 0.105$
6	Left Rotation	59.75 ± 14.5	53.21 ± 13.2	$p = 0.242$
7	Right Rotation	68.58 ± 11.4	62.93 ± 8.10	$p = 0.156$

Note: *Not significant ($p > 0.05$); significant ($p < 0.05$).*

compared to Group B, which was treated with isometric exercises (Table 4). The post-test scores of other outcomes did not show any statistically significant differences between the groups. The0data suggests that the intervention applied in Group A is much more efficacious than in Group B, whereas the other outcome measures showed no significant differences. The post-test scores in Group A exhibited higher mean and standard deviation compared to the post-test scores in Group B.

DISCUSSION

The study aimed to determine the effect of stabilization exercises on the CV angle and cervical ROM among visual display terminal users with forward head posture.

There is a slight variation between groups based on gender, and it was found to be not f = 1) at the 5 % level, i.e., ($p > 0.05$). The baseline characteristics of age were similar in both groups.

Group A improved significantly the within-group results in the CV angle post stabilization exercises on a swiss ball in the existing study, with the post-test mean and SD of 63.42 ± 4.20 indicating statistically significant improvement (i.e., t = 14.778 and $p < 0.001$). These findings are consistent with the results of a study conducted by Boyoung I'm et al. through his findings the effects of scapular stabilization exercise on neck posture and muscle activation in people with neck pain and forward head posture. The finding suggests that, it can concentrate on muscle activation patterns during different scapular movements, are that scapular stabilization exercise helps to improve head posture and pain in patients with neck pain and forward head posture [22].

In the present study, there was a significant statistical improvement (i.e., $p < 0.001$) in the cervical ROM post stabilization exercise, and the findings were comparable to the effects of the study done by Arins GA et al., who explained in their research that when the individual does not move through a comprehensive range of motion, the muscles regularly shorten, which causes adaptive variations in muscle length as a result, both regular and pain-affected individuals' cervical range of motion will be affected by their head posture [24].

In the present study, there was a statistically significant improvement (t = 6.813, $p < 0.05$) in the extension range and left lateral flexion (t = 10.142, $p < 0.05$) in the stabilization group. The current study's findings are corroborated by Won Gyu Yoo et al. They observed a correlation between the alterations in the cervical spine that occur after the usage of VDT (Visual Display Terminal) and the range of motion in the neck. During their training, they highlighted a negative association between the craniocervical angle and neck extension. The negative correlation can be explained by the association between changes in the craniocervical angle and the shortening of the scalenus muscles, resulting in a limited range of motion in neck extension [25]. They also claimed that there was a negative correlation between left lateral flexion and the cervicothoracic angle because the people used their right hands to operate a work station and it's probable that this repetitive use shortens muscles like the upper trapezius. The study demonstrated that a stabilizing exercise led to an enhancement in left lateral flexion, along with an improvement in muscle control.

In comparison to Group B, Group A's performance significantly improved statistically ($p < 0.001$), according to the data. The results of a study by Hye-Young Cho and colleagues on the impact of swiss ball stabilization exercise on the deep and superficial cervical muscles and pain in patients with chronic neck pain, where he came to the conclusion that the results showed that continuous swiss ball stabilization exercise, at specific timings plays a crucial role.

According to Kim D. et al. [16], neck pain with a forward-facing head posture is linked to a variety of illnesses, including an excessive workload, postural issues, psychiatric conditions, bad postures, and structural disorders. They also showed how treating these conditions can reduce pain and enhance quality of life in patients with forward head posture.

Limitations

1. The exercise program involved in this study lasted just four weeks, the findings could not be used to assess the exercise's long-term benefits.
2. It was challenging to extrapolate the benefits of scapular stabilizing exercise due to the small sample size.
3. People who had neck pain found it difficult to focus for extended amounts of time and were certainly under fatigue.
4. The sessions and exercise intensity has been varied as the concept of exercise intensity is a multifaceted construct that pertains to the metabolic expenditure associated with a certain activity session.

CONCLUSION

Subjects with a forward head posture tend to have neck pain that is correlated with pain intensity. In patients with a forward head posture, the stabilization exercises showed a significant improvement in cervical range of motion and craniovertebral angle. Stabilization exercises significantly affect Craniovertebral angle and cervical range of motion in Visual display unit users with forward head posture. Hence this type of exercise can be incorporated as an ergonomic measure to handle the postural deviations in different rehabilitation setups.

Recommendations

More research is required to evaluate synchronously acquired 3-D motion and electromyography data of the neck and shoulder from several VDT workers as well as to comprehend the nature of motor control issues in deep muscles in patients with work-related musculoskeletal diseases (WRMD).

ADDITIONAL INFORMATION

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Author Contributions. All authors confirm their authorship according to the international ICMJE criteria (all authors contributed significantly to the conception, study design and preparation of the article, read and approved the final version before publication). Special contributions: Shyama S. — conceptualization, investigations, methodology, resources, Visualization; Nagaraj S. — conceptualization, data curation, project administration, review and editing.

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Ethics Approval. The authors declare that all procedures used in this article are in accordance with the ethical standards of the institutions that conducted the study and are consistent with the 2013 Declaration of Helsinki. The study has been approved by the ethical committee vide of Padmashree Institute of Physiotherapy, Ref: PIP/EC/15-10/03-18 dated 15.03.2018.

Data Access Statement. The data that support the findings of this study are available on reasonable request from the corresponding author.

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