



The Effect of Mckenzie Exercise to Increase Craniovertebral Angle in Forward Head Posture of Adolescent

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Abstract

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Background : Adolescents with low physical activity and smartphone addiction has been indicated to reduced the craniovertebral angle, there by causing a forward head posture and increasing scapular dyskinesia, characterized by a craniovertebral angle (CVA) less than 50o. McKenzie is one of exercise that can helm correct posture in forward head posture. This study was aimed to determine the effect of the McKenzie exercise on increasing the craniovertebral angle in the forward head posture of adolescents.

Methods : students of MAN 1 Surakarta (Islamic Boarding School) with advanced head posture, aged 14–17 years using a simple random sampling technique divided into group I as the intervention group (n=16) and group II as the control group (n=14). Group I was given treatment of McKenzie exercise 3 times a week for 4 weeks, and the control group was not given any treatment. The Craniovertebral angle were assessed using photo analysis with Image-J application.

Results : The results of the study indicate that the characteristics of respondents according to age are mostly 16 years old. The mean NDI score in the intervention group was 23.63 and the mean NDI score in the control group was 24.60. The results of statistical test using independent samples test showed that there was a significant difference during the intervention and the control group (p=0.000)

Conclusion : McKenzie's exercise can affect to increasing the craniovertebral angle in the forward head posture of adolescents.

Keywords : forward head posture; McKenzie exercise; craniovertebral angle

INTRODUCTION

Posture is defined as a position or attitude of the body, the relative arrangement of body parts for a specific activity. Forward head posture is characterized by increased flexion of the lower cervical spine and upper thoracic region and increased extension of the upper cervical spine.¹ Bad posture is a serious health problem which causes more musculoskeletal disorder. An adolescent inculcates the habit of forward neck posture at a very early age due to studying in various odd positions. Inadequate posture consists of poor interrelations between parts of the body. These imperfect interrelations cause muscle tension and shortening, which make appropriate joint movements more difficult to achieve and may cause pain.²

Low physical activity in adolescents due to static body position when sitting in class during 4-7 hours of school learning activities with school furniture that does not match body dimensions, such as the table height is too short,^{3,4} and learning activities in dormitories, such as recite in a static position for ≥ 2 hours, can cause changes in neck and shoulder posture. The change in posture is the forward head posture.

Forward head posture is characterized by the position of the head relative to the front of the cervical vertebrae in the sagittal plane. Forward head posture is associated with upper cervical vertebrae hyperextension (C1-C3) and lower cervical vertebrae flexion (C4-C7).⁵ Adolescents who experience forward head posture for a long time cause damage to the muscles, and bone structure, and changes in the body's functional abilities. Therefore, to determine the forward head posture in adolescents, measurements are made by assessing the angle using the craniovertebral angle (CVA) (Figure 1). CVA measurement results $\leq 50^\circ$ are a sign of a forward head posture.^{6,7} The tool used to get the angles of the forward head posture is the Image-J application by analyzing the images in the sagittal section.

Forward head posture in adolescents can be given appropriate interventions to increase craniovertebral angle by using McKenzie exercise. McKenzie exercise is a self-therapeutic, repetitive exercise, focused on extension.⁸ In addition, it can improve function of patients, reduce recurrence pain, and associated stress. Therefore it can provide posture correction in forward head posture and help improve alignment or alignment in the neck.^{9,10}

Understanding forward head posture and related functional changes can help early detection of forward head posture in adolescents, can then determine more appropriate intervention strategies at once, and increase awareness of the need for early intervention.

Therefore, the purpose of the present study was to investigate the effects of McKenzie exercise to increase craniovertebral angle in forward head posture.

METHODS

Study design

This study to determine the effect of McKenzie exercise to increase craniovertebral angle in forward head posture of senior high school adolescents. Subjects were randomly assigned to the experiment group and control group by selecting one of two cards from a box. The participants were not informed of the research hypothesis, and the evaluator was blinded. The subjects in the experimental group underwent McKenzie exercise, whereas the control group received no intervention. This study was approved by the health research ethics committee RSUD Dr. Moewardi. This study has been registered in the number of ethical clearance 1.041/VIII/HREC/2022.

Subjects

In this study, 30 participants with forward head posture were recruited in the boarding school program MAN 1 Surakarta from August to November 2022. The following inclusion criteria were applied: students aged



Figure 1. Craniovertebral angle landmark



Figure 2



Figure 3

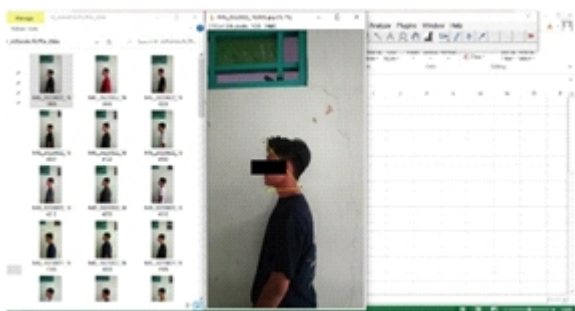


Figure 4



Figure 5

14–17 years, forward head posture with a CVA value of $\leq 50^\circ$, neck disability index or NDI value of $< 28\%$ (mild disability) which is a 10-item questionnaire that measures a patient's self-reported neck pain related disability, the questions include activities of daily living, such as: personal care, lifting, reading, work, driving, sleeping, recreational activities, pain intensity, concentration and headache, willing to take part in the exercise program and sign an informed consent. Participants were excluded if they presented: history of vascular disorders (vertigo), history of injuries vertebral column and upper extremities which made it impossible to perform exercises such as fractures and dislocations, history of surgery on the vertebral column and upper extremities, history of inflammatory disease, presence of tumors in the vertebral column, history of postural congenital disorders. Participants were dropped out if they presented: subjects who did not take part in the exercise more than three times, and subjects who did not take part in the post-test.

Examination procedures

All participants were measured using the craniovertebral angle (CVA). The craniovertebral angle is the acute angle formed between the horizontal line passing through the C7 spinous processes and the line connecting the

midpoint of the tragus to the C7 spinous processes.^{6,7}

The CVA measurement procedure begins with preparation for measurement, by placing the camera perpendicular to the ground using a tripod and oriented camera lens in the sagittal plane as far as 80 cm.^{7,11} Then, prepare for the individual's position standing comfortably in front of a plain wall and looking straight ahead. Next, palpate the midpoint of the tragus and C7 spinous process and attach a sponge mark, then take a sagittal photo of the body. Next, the photos were analyzed using the Image-J application.^{7,11}

The CVA measurement results which indicate a forward head posture is $\leq 50^\circ$ or the smaller the degree of CVA results, it can indicate a forward head posture.^{6,7,9}

Intervention

McKenzie's exercises were carried out in the experimental group 3 times a week for 4 weeks, 10 repetitions for 2 sets, by maintaining the movement position for 7 seconds and resting for 3 seconds before returning to the starting position. McKenzie's exercises included head retraction with overpressure while sitting, neck extension while sitting, head retraction with overpressure while lying, side bending of the neck while sitting, neck rotation while sitting, neck flexion with chin-n in the sitting position.

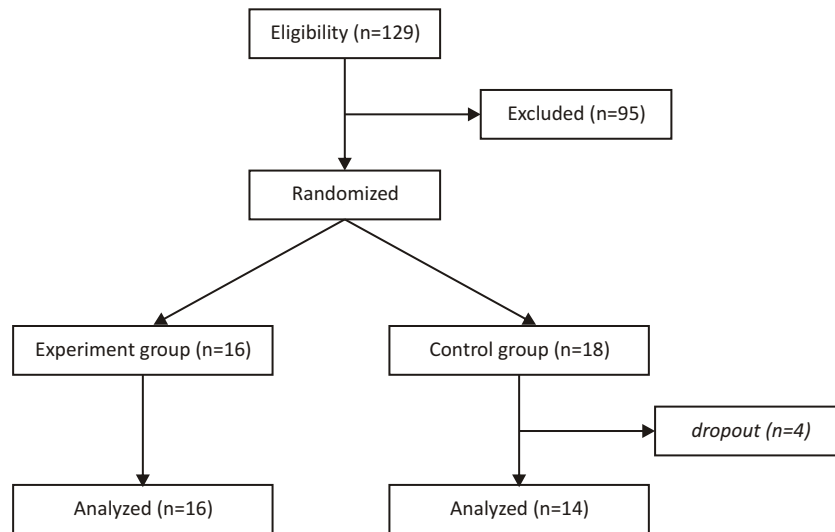


Figure 6. Flowchart of the recruitment, randomization, and follow-up of participants

TABLE 1
Baseline characteristic for the two groups

Characteristics	Experiment group (n=16)	Control group (n=14)	p value
Age*	16.00 ± 0.730	15.71 ± 0.726	0.293
Age (years)			
15	4 (25%)	6 (42.86%)	
16	8 (50%)	6 (42.86%)	
17	4 (25%)	2 (14.28%)	
Gender			
Male	6 (37.5%)	5 (35.71%)	0.923
Female	10 (62.5%)	9 (64.29%)	
NDI*	23.63 ± 2.88	24.60 ± 2.54	0.618

*Mean ± standard deviation

TABLE 2
Comparisons of between-group change scores for CVA

Variable	Experiment group (n=16)				Control group (n=14)				Comparisons	
	Pre-test	Post-test	Pre post-test	p value	Pre-test	Post-test	Pre post-test	p value	Pre post-test	p value
CVA*	50.09 ± 0.28	58.21 ± 4.78	8.11 ± 4.71	0.000	49.68 ± 0.64	50.40 ± 2.96	7.18 ± 2.72	0.342	7.80 ± (4.77 – 10.83)	0.000

*Mean ± standard deviation

Data analysis

The baseline characteristics of participants were compared between treatment groups, using independent t tests to assess the adequacy of the randomization (Table 1). The effects of interventions on CVA was examined by using a paired sample t-test, and CVA for between groups were compared using an independent t test. Data analysis was conducted using SPSS 26.0 version (IBM, Chicago, IL, USA) statistical software for Windows.

RESULTS

Based on the results of this study, 30 out of 168 students were found to have forward head posture and showed no differences in the characteristics of the research subjects between the experimental group and the control group, as shown in Table 1. In each of these study groups the dominance of the age of the research subjects was 16 years, and female sex dominated, namely 62.5% in the experimental group and 64.29% in the control group. Next, the characteristics of the research subjects based on the NDI in each group showed that the maximum NDI was 26.60%, in the mild disability category.

In the experimental group with 16 subjects, the results of the pre-test and post-test were different, $p = 0.000$, Table 2. The results of the paired sample t-test in the experimental group showed a p value < 0.05 , which means there was a significant difference. While the results of the pre-test and post-test differences in the experimental group with 14 research subjects obtained $p = 0.342$. The results of the experimental group's paired sample t-test showed a value of $p < 0.05$, which means there was no significant difference. Furthermore, the post-test difference test between the experimental and experimental groups used the independent t-test, the results obtained were $p = 0.023$, indicating $p < 0.05$ meaning there was a significant difference.

DISCUSSION

The results of this study are in accordance with the results of previous studies which demonstrated the efficacy of McKenzie exercise on forward head posture.^{9,12} Recent research shows that results suggest that the combination of upper thoracic mobilization and mobility exercise may provide short-term benefits to individuals with FHP.¹³

Furthermore, the results of this study show that the dominance of the age of the study subjects is 16 years, and the female sex predominates compared to the male. The chances of forward head posture occurring are more in the teenage years due to low physical activity, static body position while sitting in class during learning activities at school 4–7 hours and school furniture that does not match body dimensions,^{3,4} as well as learning activities in dormitories in a static position for ≥ 2 hours.

Furthermore, the predominance of the female sex in each group is twice as high as that of males, because females have been identified as having 2° – 3° more neck flexion than males.^{14,15} This is related to psychosocial problems such as stress which are partly related to secondary sexual characteristics.¹⁶ The results of this study were similar to those found in previous studies, such as research study on 275 adolescents aged 15–17 years who reported that forward head posture and rounded shoulder postural malalignment were the most common postural disorders, especially in female adolescents ($n = 153$).¹⁴ Then the results of research on 189 research subjects (12–16 years) suggested that a greater percentage of female students (71.1%) experienced forward head posture when compared to male students (55.7%).¹⁷ Next, the characteristics of the research subjects based on the NDI in each group showed that the maximum NDI was 26.60%, in the mild disability category. The research subjects answered 9 out of 10 question sessions on the NDI questionnaire sheet. In the 8th question session (driving) was not answered because the research subjects were dormitory students and female students who did not use vehicles to go to school. According to research found a relationship between forward head posture and disability.¹⁸

Based on the results of this study, McKenzie exercise had an effect on increasing the craniovertebral angle in the forward head posture of high school adolescents, as evidenced by the significant increase in CVA in group I ($p = 0.000$). There was a significant increase in CVA in group I because adolescents who experienced forward head posture had abnormally activated muscles, shortening of the deep cervical flexor and lengthening of deep cervical extensor which resulted in a class 1 lever system in the cervical vertebral region, axis position (A) which is closer to resistance (R).¹⁹ Changes in the lever system 1 in the cervical region can cause a shift in the center of gravity (COG) to the anterior. The upper body will move backwards and the shoulders will move forward to compensate for this shift, so that the head will be more anterior than the vertebrae.²⁰

McKenzie exercise has the goal of activating the deep cervical flexor and deep cervical extensor muscles normally.^{10,13} The synergy of activated muscles will generate strong impulses in the muscle spindles and golgi tendon organs. The muscle spindles and the golgi tendon organs work together to control and detect all tension during muscle contraction. Muscle spindles work to maintain constant muscle length by providing feedback on changes in contraction, where the muscle spindle plays a role in stopping nerve impulses that increase tension in the antagonist muscles to prevent overstretching. This event results in relaxation of the antagonist muscles, or is called reciprocal inhibition. Meanwhile, sensory nerve impulses from the Golgi tendon organs enter the dorsal portion of the spinal cord

and encounter inhibitory motor neurons. This process prevents further agonist muscle contraction from occurring, accompanied by a decrease in muscle tone, resulting in relaxation of the agonist muscle, known as post isometric relaxation.¹⁰

The McKenzie exercise carried out in this study uses repetitive movements which include mobilization and manipulation, and focuses on stretching exercise at each stage. The dose of McKenzie exercise in the group I used was 10 repetitions of 2 sets, by maintaining the movement position for 7 seconds and 3 seconds of rest before returning to the starting position. The total exercise is done 3 times a week for 4 weeks. This dosage refers to the results of research which can increase the CVA value in forward head posture in the McKenzie exercise treatment group.^{9,12}

Cyclical stretching through stretching force is done repeatedly using several repetitions during one therapy session and each movement is maintained for 5–10 seconds can help increase muscle flexibility. Also, if an exercise program is in the form of stretching exercises using a frequency of exercises carried out at least 2 times per week, it can increase the mobility of joint motion.²¹

Proportionally balanced movement through McKenzie exercise can improve proprioception improvement in muscles, tendons, joints and connective tissue around the neck, upper back and shoulders. Thus, it can provide a strengthening and stabilizing effect on agonist and antagonist muscle groups, which directly helps posture correction in forward head posture.¹⁰

Posture correction in forward head posture through McKenzie exercise can increase the value of craniovertebral angle, it is proven from the results of this study that indications of adolescents with forward head posture have a CVA value of $\leq 50^\circ$, after group I was given McKenzie exercise there was an increase of CVA Value at $>50^\circ$, as shown in Table 2. If there is an increase in the CVA value, the severity of forward head posture decreases and can increase the body's functional activities.^{9,10}

CONCLUSION

McKenzie's exercise affects increasing the craniovertebral angle in the forward head posture of high school adolescents, which can be achieved if it is done consistently according to the prescribed dosages of exercise, daily activities, and has a motivational exercise goal. Accordingly, senior high school adolescents with forward head posture can carry out their daily activities without obstacles or complaints. Future studies should examine the effectiveness of different types and dosages of manual therapy, and perform long-term follow-up data collection.

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