Research Paper Review

The efficiency of corrective exercise interventions on thoracic hyper-kyphosis angle

Journal of Back & Musculoskeletal Rehabilitation 2014; 27: 7-16

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ABSTRACT

Background And Objective: *Corrective exercise interventions are often utilized to manage subjects with thoracic hyper-kyphosis, yet the quality of evidence that supports their efficiency is lacking. In this study, the efficacy of local and comprehensive corrective exercise programs (LCEP and CCEP) on kyphosis angle was evaluated.*

Material And Method: *A prospective, randomised controlled design was used in the present study. Sixty patients with postural hyper-kyphosis deformity (⩾42°) entered the study for 12 weeks. Subjects were randomly assigned to a LCEP (n=20), CCEP (n=20), or Control groups (n=20). Pre- and post-participation levels of kyphosis angle were measured by flexicurve ruler.*

Results: *Both the LCEP and CCEP groups demonstrated statistically significant reductions in thoracic kyphosis angle compared to the control group (p=0.001). Furthermore, based on Cohen's d-value, the efficiency of CCEP was larger than LCEP.*

Conclusions: *Considering the extremely large effect size of the CCEP, we recommend that this program be used in the correction of postural hyper-kyphosis deformity in future.*

Keywords*: Thoracic hyper-kyphosis; exercise interventions; postural correction*

ANALYSIS

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Background Information

Hyper-kyphosis (a thoracic curvature of > 40-45°) is one of the most common human postural abnormalities and has been identified as an etiological factor of, or significant cause of, impairment in upper quadrant pathologies (1-4). The incidence of hyper-kyphosis has been shown to range from 15.3% in 11 year-old children (5) to 38% in 20-50 year-old adults (6) and 35% in 20-64 year-old adults (7) depending on the dataset. This abnormality is often managed by manual therapists in many disciplines using a variety of techniques, including exercise prescription.

Exercise prescription for hyper-kyphosis is commonly based on Kendall's theory (8), which focuses on stretching the shortened muscles and strengthening the weakened muscles in the thoracic region. Previous studies using exercises based on this theory have shown decreases in hyper-kyphosis, but have had significant limitations, including lack of supervision of home-based exercise programs and changes in curve that were too small as to be considered clinically significant. Many studies have demonstrated small changes of 1-3° in thoracic curve severity. Others have suggested a higher standard of an 11 degree change in kyphotic curvature to reach clinical significance (9).

Previous studies on this issue have suffered from serious limitations that may have contributed to the ineffectiveness of the exercises. These include:

- The use of a short exercise program
- The quantitative measurement techniques used to find the kyphosis angle
- Lack of supervision with home-based or group exercise programs
- Bias in the data collection
- Simultaneous use of manual therapies and/or physiotherapy leading to uncertainty in the effectiveness of the exercises
- Lack of attention to hyper-kyphosis related abnormalities not covered by Kendall's theory (this includes forward head posture and forward shoulder posture)

Therefore, this study compared the use of a local corrective exercise program (LCEP) similar to those previously used, and based on Kendall's theory, with a new comprehensive corrective exercise program (CCEP) based on a more comprehensive view of hyper-kyphosis abnormality, which takes into account the work of Vladimir Janda (1923-2002) to promote the interaction of various parts of the body in the form of a kinetic or biomechanical chain.

PERTINENT RESULTS

There were no significant differences in pre-participation kyphosis angles, forward head angles, and forward shoulder angles between the groups but in the post-participation groups significant differences were found. Post-participation kyphosis angles decreased by 5.04° in the LCEP group and 12.25° in the CCEP group but only by 0.64° in the control group. *This indicates that both the LCEP and CCEP programs were effective in reducing thoracic kyphosis and that the CCEP program was significantly more effective than the LCEP program*. This may be due to the CCEP addressing all changes in the upper body due to the hyper-kyphosis abnormality simultaneously, rather than focusing on the hyper-kyphosis in isolation as in the LCEP. This may also be a result of the LCEP being performed most often in passive and static positions, while the CCEP was designed to ensure that most of the muscles of the head, neck, trunk, and upper limb are simultaneously active during each movement in order to more closely approximate how the participant experiences their thoracic kyphosis in the real world. Finally, the CCEP is designed to help with proprioceptive losses that are often seen in individuals with hyper-

kyphosis by focusing on dynamic movements, which have been shown to have more positive effects of proprioception.

Significant post-participation differences in forward head and forward shoulder angles were seen in the LCEP and CCEP groups. In the CCEP group significant increases in height were also seen.

CLINICAL APPLICATION & CONCLUSIONS

Based on the results of the study, it would be advisable to incorporate the use of the CCEP over the LCEP in clinical practice for patients with hyper-kyphosis. These patients should be given dynamic exercises that address all postural abnormalities related to their postural hyper-kyphosis simultaneously. The authors' particular exercise program worked well and is an excellent starting point (with obvious room for modification). It would be useful to further investigate the use of their program in different populations.

STUDY METHODS

A pre-test was performed where potential participants had their thoracic kyphosis angle from T2 to T12 measured using the flexicurve method (2, 12-15) and their forward head and forward shoulder angles measured using the lateral photographic method (16, 17). 60 subjects (30 male and 30 female) qualified for this study. Participants were randomly assigned to the LCEP (local corrective exercise program), CCEP (comprehensive corrective exercise program), or control groups with 20 participants in each group. 4 subjects did not complete the study due to disease or excessive absence from exercise sessions. This included 1 from the LCEP group, 2 from the CCEP group, and 1 from the control group.

Inclusion criteria included:

- Excessive thoracic kyphosis (≥ 42°)
- Simultaneous excessive forward head abnormalities (≥ 44°)
- Simultaneous excessive forward shoulder abnormalities (≥ 49°)
- Age 18-25 years

Exclusion were as follows:

- Any pathological signs
- History of fracture, surgery, and/or arthritic diseases, especially in the spinal column, shoulder girdle, and pelvis
- Having a medical prescription specifically dictating therapeutic exercises for posture
- A Scoliometer reading of > 5° at the point of peak axial rotation on the forward bending test
- Having a structural excessive kyphosis, confirmed by radiograph
- Participating in a regular weekly physical activity program

Thoracic Kyphosis Measurement

A flexicurve ruler, 50cm in length and 2cm wide, was used to measure thoracic kyphosis angle. Removable, red adhesive dots were used to mark the spinous processes of T2 and T12. Participants were then asked to stand barefoot on the base of a platform in a comfortable, erect posture with their body weight evenly distributed between their feet and their eyes fixed on the opposite wall. The examiner then waited 1-minute until the participant returned to their normal posture before positioning two dowels, which were horizontally mounted on the spine stabilizer instrument (SSI) on an adjustable stand, to lightly touch the xyphoid process of the participant's sternum and their pubic symphysis in order to control postural sway. The examiner then molded the flexicurve ruler to the participant's thoracic spine and marked the intersection with the red adhesive dots at T2 and T12 on the ruler with a marker. The flexicurve ruler was then carefully lifted from the participant's spine without altering the configuration of the curve and placed on a piece of white poster board where it was held while an assistant traced the outline of the curve and marked the points corresponding to T2 and T12. The participant stepped off the platform for 1-minute of rest. The participant then stepped back onto the platform into previously traced outlines of their feet, the spinous processes of T2 and T12 were again marked and the measurement procedure was repeated. The thoracic curve was traced onto the opposite side of the white poster board to prevent the initial contour from influencing the examiner. The T2 and T12 points on each curve were connected using a straight line (L line) and then this line was bisected at the deepest point of the curve (H line).

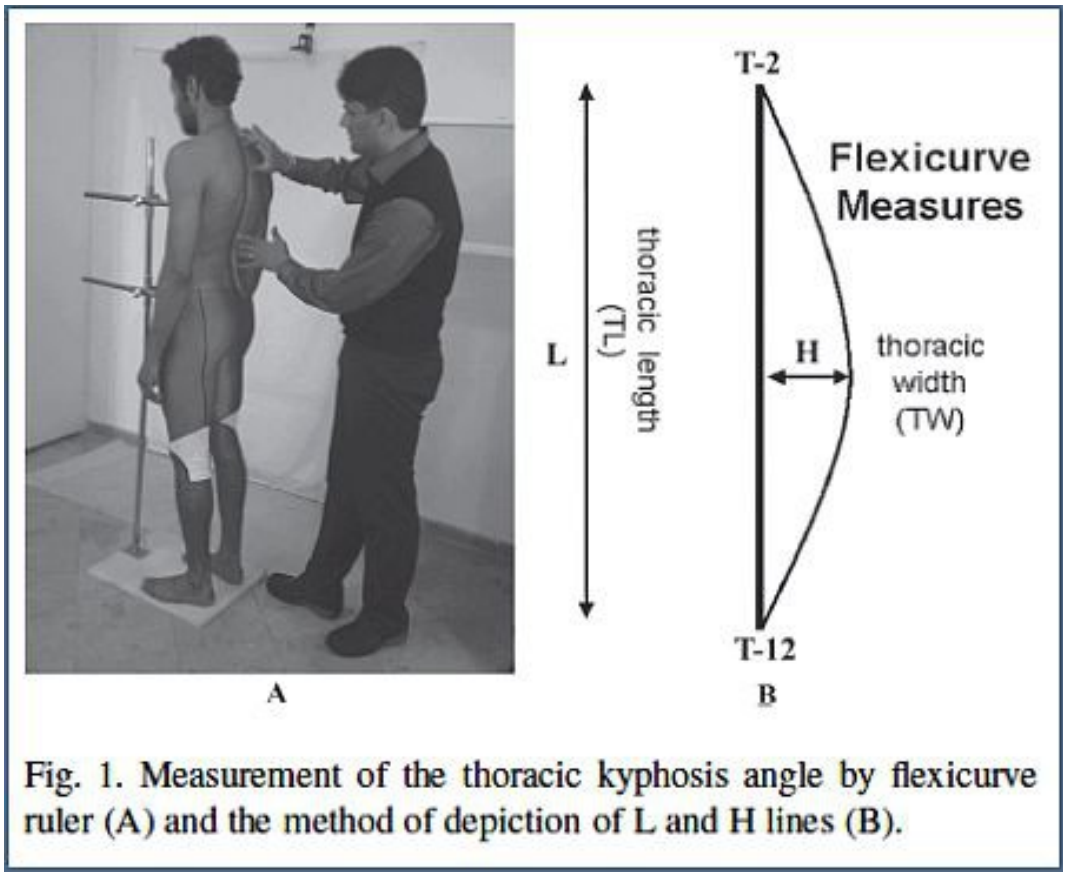
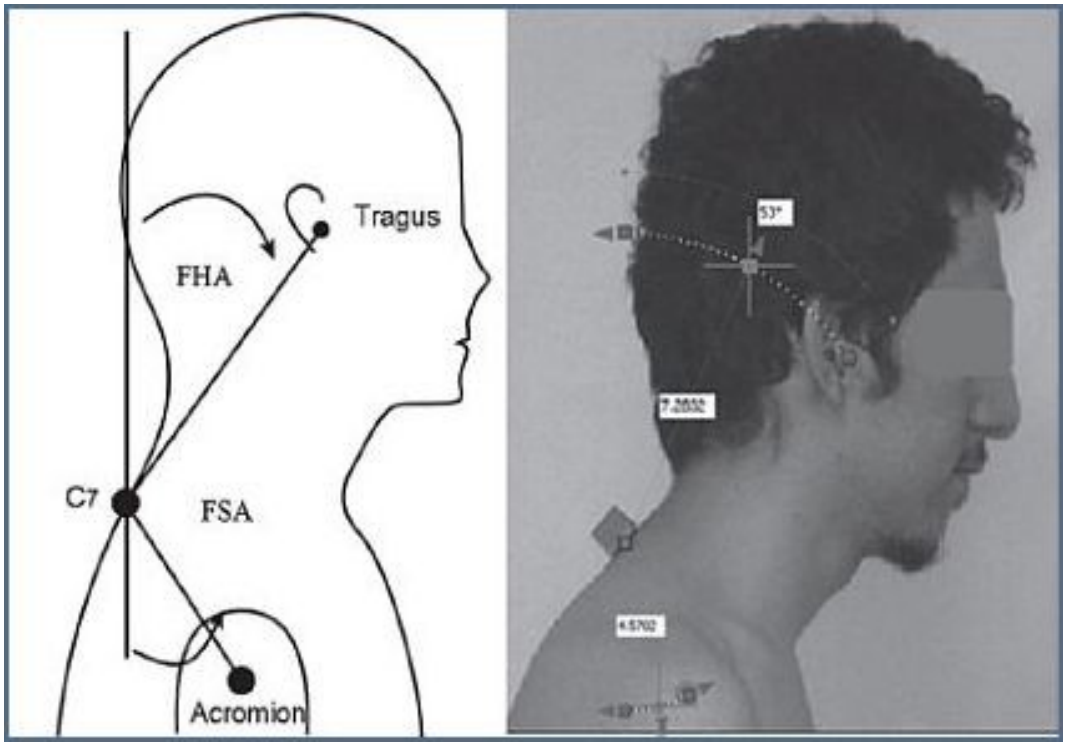


Fig. 1. Measurement of the thoracic kyphosis angle by flexicurve ruler (A) and the method of depiction of L and H lines (B).

These measurements were then inserted into an equation to calculate the thoracic kyphosis angle. The average of the two angles was recorded as the thoracic kyphosis angle of each participant.

Lateral photographic technique was used to measure forward head and forward shoulder angles. The

right tragus, acromion process of the scapula, and the spinous process of C7 were marked with removable, red adhesive dots and the participant was placed 9 inches out from a wall which was set up with a wall mounted grid. A tripod-mounted digital camera was placed 104 inches from the wall and adjusted to place the tripod level with the participant's right shoulder. The participant was instructed to bend forward three times and then raise hands overhead three times before assuming a comfortable, erect posture with their weight distributed evenly between their feet and their eyes fixed on the opposite wall. Three photos were then taken within 5 seconds. Adobe AutoCAD 2010 was used to measure the angle between a line connecting the tragus and C7 and a vertical line through C7 (forward head angle) and the angle between a line connecting C7 and the acromion and the same vertical line (forward shoulder angle). The average from the three photos was recorded as forward head and forward shoulder angles for each participant.



Exercise Interventions:

Both the LCEP and CCEP groups were given exercises to perform three times per week for 12 weeks under the direct supervision of the examiners.

Local Corrective Exercise Program (LCEP):

The LCEP group received exercises based on Kendall's theory that had been included repeatedly in previous studies. They aimed to stretch the pectoral muscles and strengthen the thoracic extensor muscles through the use of stretching, self-mobilization, and strengthening, with an emphasis on endurance. In each session the participants warmed up with light aerobic activity for 5 minutes, then performed two stretching (exercises 1 and 2), one self-mobilization (exercise 3), and two strengthening exercises (exercises 4 and 5) sequentially, then cooled down with general stretching exercises and slow walking for 5 minutes. The foam rollers used in stretching exercise 2 were gradually increased in diameter from 15 cm to 20 cm and then to 25 cm to increase the stretch.

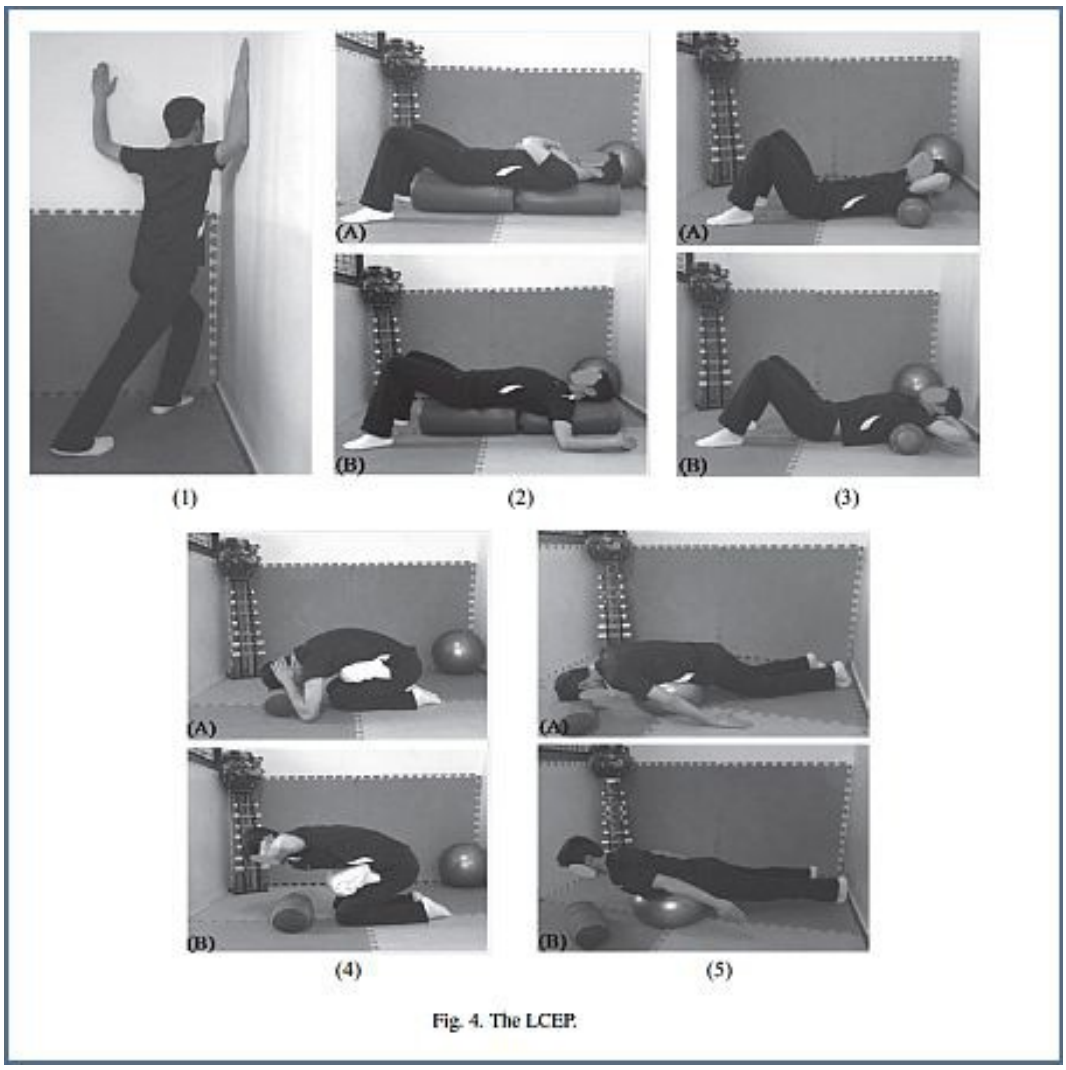


Fig. 4. The LCEP.

Comprehensive Corrective Exercise Program (CCEP):

The CCEP group participated in a program designed by the authors. During all exercises, the participants were asked to maintain a chin tuck, erect the thoracic spine, and adduct their scapula as much as possible. Again, the participants began with a 5-minute general warm-up as in the LCEP group, then their 5 exercises, and finally a cool down as in the LCEP group.

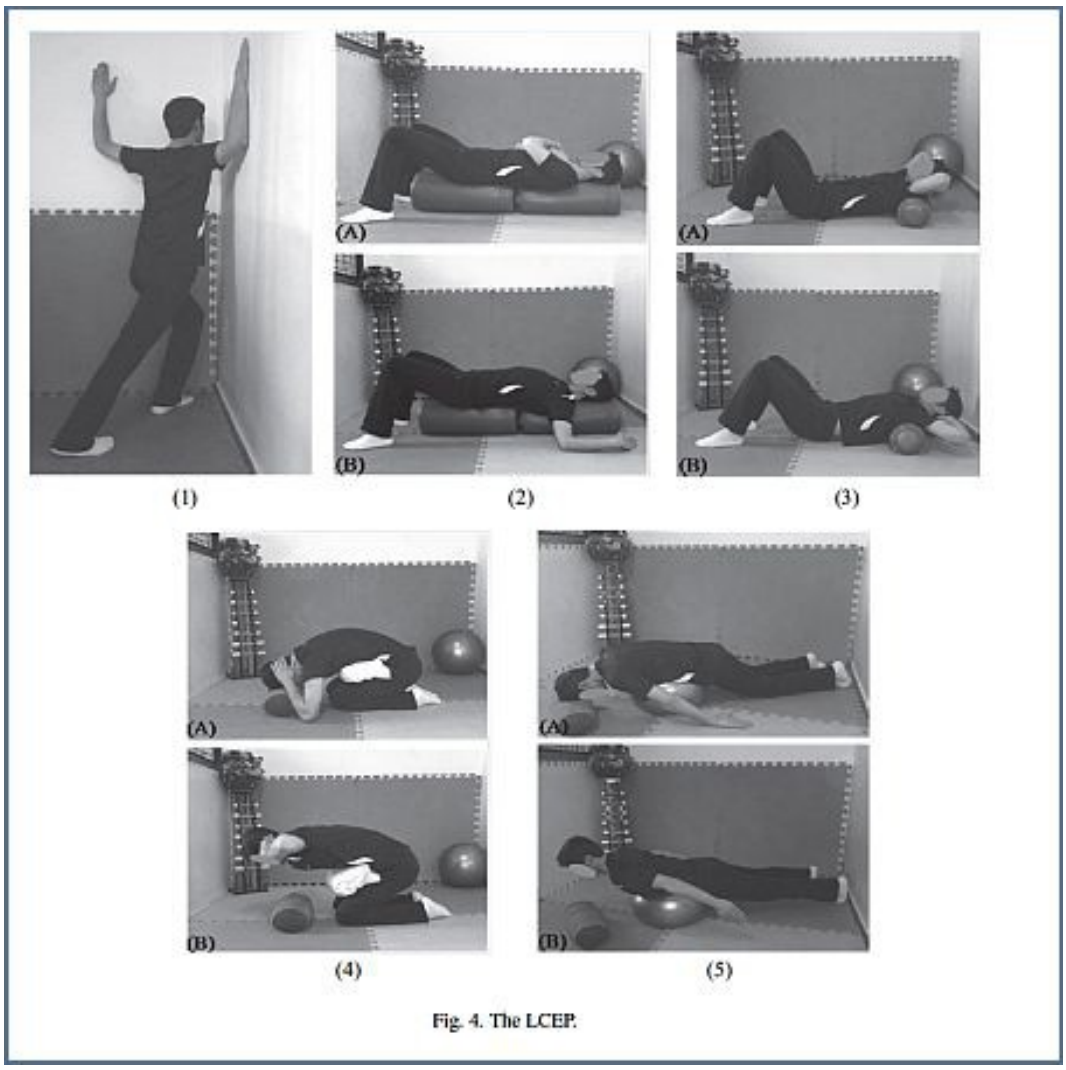


Fig. 4. The LCEP.

At the end of week 12 the initial measurements were repeated. A repeated measures ANOVA, paired-samples t-test, and one-way ANOVA were performed to compare pre- and post-participation data with and between the groups.

STUDY STRENGTHS / WEAKNESSES

Strengths

- The use of both the most commonly used exercises program from the literature (LCEP) and the researcher's proposed exercise program (CCEP).
- The use of the flexicurve ruler to measure thoracic curve. This method has been well established in previous studies (10, 11).
- Having the exercise programs monitored to ensure the exercises were performed properly and consistently over the 12-weeks.

Weaknesses

- This study had a relatively small sample size.

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