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The Effects of ReaLine® Core Exercises on Thoracic Flexibility

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Abstract

Background: ReaLine Core® (RLC) exercises were introduced as a way to improve thoracic flexibility, which has been identified as a factor in the development of low back pain. However, it is unclear clear if thoracic flexibility needs to be improved in a particular direction to have a positive effect on an individuals low back pain. The purpose of this study was to assess the effects of RLC exercises on thoracic expansion, flexibility, and trunk mobility.

Materials and Methods: Subjects included 12 amateur male golfers, assigned to either the RLC or the orange whip trainer (OWT; i.e. control) group. Outcome measures were thoracic flexibility and trunk mobility (flexion, extension, and rotation), with measurements taken before and after exercise. Statistical analysis included a two-way analysis of variance and tests of main effects to compare each parameter before and after the intervention for each group.

Results: We conducted a randomized controlled trial with a 2-week follow-up in a laboratory. The transverse diameter of the lower thorax was larger in the RLC group than in the OWT group ($p=0.045$). Further, trunk flexion range of motion increased in both groups at the T1-T2 level after each intervention ($p=0.011$).

No significant change was observed at the T12-L1 level. For range of motion for trunk extension, there were no significant changes at either the T1-T2 or T12-L1 levels for both groups. The angle of trunk rotation was greater after the intervention compared to baseline for both groups ($p=0.032$), with no significant between group difference.

Conclusions: After two weeks of RLC exercises, the lower lateral thoracic diameter increased, as did the ranges of trunk flexion and rotation. This suggests that thoracic flexibility improved after the RLC exercises. An important next step is to determine the effect of RLC exercises on patients with low back pain.

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Abbreviations:

LBP - Low back pain
RLC - ReaLine Core
OWT - Orange whip
ICC -Intraclass correlation coefficients

Introduction

Low back pain (LBP) is a common musculoskeletal disorder with a high incidence and social economic burden [1,2]. It has been reported that 70-80% of people suffer from LBP at least once in their lifetime and that 18-30% do so continuously [1,3-5]. In Japan, specific LBP accounted for 78% of all patients with low back pain, and nonspecific (undiagnosable) LBP for 22% [6].

Nonspecific LBP may be caused by compensatory mechanical stress on the lower back due to reduced muscle and joint flexibility during movement. Harding and colleagues have reported that shortening of the iliopsoas muscle causes limitation of hip extension, therefore promoting lumbar curvature and thus LBP [7]. Furthermore, Lee reported that a lack of lower thoracic spine flexibility during lumbar extension is associated with lumbar hyperextension [8]. Therefore, thoracic flexibility may be an important factor in the development of LBP. The treatment and prevention for nonspecific LBP may require improving the flexibility of the thorax in combination with the spine to reduce mechanical stress. However, it is not clear if direction of thoracic flexibility is an important consideration when implementing a treatment program, For example,, the rotational motion of the thorax and pelvis in the golf swing is an important determinant of performance, and it may be this complex trunk motion as well as high loads that contribute to the increased incidence of low back pain in golfers. Interestingly, it has been observed that golfers from higher skill levels tend to have greater thoracic mobility. Maintaining and improving thoracic mobility may not only be an important injury protection consideration but may potentially contribute to improved golf swing performance.

The ReaLine Core® (RLC) device (GLAB Corp, Higashihiroshima) was developed as a pelvic thoracic realignment device for patients with LBP [9]. The aim of using the device is to assist obtaining symmetrical alignment of the thorax and pelvis and improving flexibility of the lower thorax when worn during specific exercises. However, the effect of RLC on thoracic flexibility, as well as expansion has not been investigated. Therefore, the purpose of this study was to examine the effect of performing exercises with the RLC on the lateral and longitudinal thoracic diameter flexibility of the thorax.

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Methods

Research design

We performed a randomized controlled trial in a laboratory based setting to compare the outcomes of a group undertaking RLC exercises (experimental intervention) and a conventional exercise group who used an 'orange whip trainer' (OWT) commonly used by golfers (control intervention). The OWT group undertook a training program that aimed to increase trunk flexibility during the golf swing. The training intervention period was 2 weeks, with measurements at baseline and 2 weeks after the study's primary end point.

Participants

Participants were required to be amateur golfers 18 years of age or older. Inclusion criteria included playing at least four full rounds of golf per year and being able to participate in three exercise sessions per week. Exclusion criteria were the presence of any of the following: musculoskeletal conditions that generated pain, prior spinal surgery, and obvious spinal deformities. The participants were randomly assigned to an experimental group and a control group. All participants provided written informed consent before participation.

Ethical approval

Approval to conduct the study was obtained from the Ethical Committee of Kyoto Tachibana University (approval no.18-3).

Measurements and Data Collection

Demographic data

Baseline data including age, golf history, and presence of pain were collected by questionnaire. Body composition variables such as height and weight were measured using a stadiometer and electronic scales, respectively.

Thorax expansion

Measurement variables included change in anterior-posterior and lateral diameter between maximum expiration and inspiration. Measurements were taken in standing posture, at the level of the 10^{th} rib with a rectangular thorax-measuring device (GLAB Corp, Higashihiroshima) [10]. Breathing at maximal expiration and maximal inspiration was performed while the examiner placed the instrument over the subject's thorax (Figure 1). The subject was instructed to take three slow, deep breaths; the average of the three breaths was taken as the representative value.

The intraclass correlation coefficients (ICCs) were calculated in a preliminary study to confirm the reproducibility of the measurement method of the rectangular thorax-measuring device. ICCs (1,1) for anterior-posterior and lateral diameters were 0.983 and 0.995, respectively, and the ICCs (1,3) for anterior-posterior and lateral diameters were 0.994 and 0.998.

Trunk flexion and extension

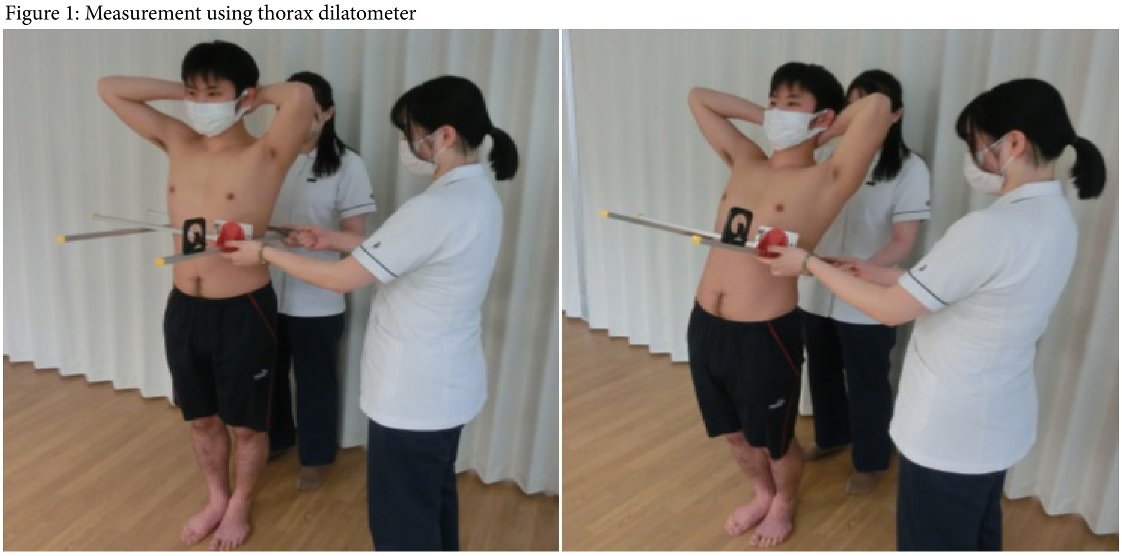
Trunk extension and flexion angles were measured in the standing position using an inclinometer [11], which was placed at the levels of Tl-T2 and T12-L1. Patients were then asked to move their trunks in the direction of flexion or extension as far as possible. At each level, the amount of change from the angle in the standing position to the angle during trunk extension or flexion was calculated. Measurements were performed three times, and the maximum value was taken as the representative value.

Trunk rotation

To measure trunk rotation, subjects were asked to stand on a line with their feet shoulder-width apart so that they were placed symmetrically on either side. A lightweight wooden bar 122-cm long and 3-cm wide was placed evenly across the shoulders and was held by subjects' hands resting on the bar as close to the shoulders as comfortable.

Subjects were then instructed to rotate at the spine as far as possible to either the left or right, keeping the bar resting on their shoulders, the knees straight, and feet stationary. A level was attached to the end of the bar to ensure that it was equally balanced throughout the test. At the end range of the rotation movement, a plumb bob attached to the left end of the bar for right-handed rotation or to the right end of the bar for left-handed rotation was stabilized by the measurer and dropped until it touched the floor. The position at which the pencil

Figure 1: Measurement using thorax dilatometer



upright position trunk extension position

Lateral and longitudinal diameter were measured in the standing position with knees extended.

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made contact with the floor was then marked. The axis of a goniometer was placed in the center of the line and the fixed arm was placed along the line. A metal ruler was fixed to the movable arm of the goniometer to reach the mark. The axis of the goniometer was then placed on the center of the line, and the stationary arm was placed along the line. A metal rule was secured to the moving arm of the goniometer to reach the mark. The reliability of this method has been previously verified by Evan et al. [12]. Measurements were taken three times alternately in each direction, and the total of the left and right directions were calculated. The maximum value of the three values was taken as the representative value.

Muscle strength of trunk extension

Trunk extension muscle strength testing was performed in the standing position using a hand-held dynamometer (HHD) (Lafayette Manual Muscle Testing Systems; Lafayette, IN, USA) according to the previously published method of Harding et al. [13]. Participants stood with their backs against a wall and their trunks were anchored by two inelastic belts passing under the anterior superior iliac spine to firmly immobilize the subject. In addition, both arms were crossed over the chest, and the trunk was flexed at 15 degrees to place the HHD over the thoracic spine (T7).

Intervention

Prior to undertaking the intervention, participants were randomized into two groups: the RLC group [14] and the OWT group [15]. The RLC group members were given four different programs (Figure 2), with exercises performed 10 times on each side. The OWT group was provided four different programs (Figure 3), with all drills performed in the two steps of small/large, 10 times each, on both the left and right sides. For both groups, each exercise session lasted 10 minutes and was performed three times a week for a period of two weeks.

Statistical Analysis

Statistical analyses were performed using SPSS 21 (SPSS, IBM Corp., Armonk, NY, USA). Comparisons between the RLC and OWT groups for pre-intervention physical characteristics, trunk flexibility, and muscle strength were made using a paired t-test. Two-way analysis of variance was performed for each measure before and after the intervention. In addition, simple main effect tests were performed before and after the intervention, and between groups. The statistical significance level for p-values was set at 5%.

Figure 2: RLC exercises.

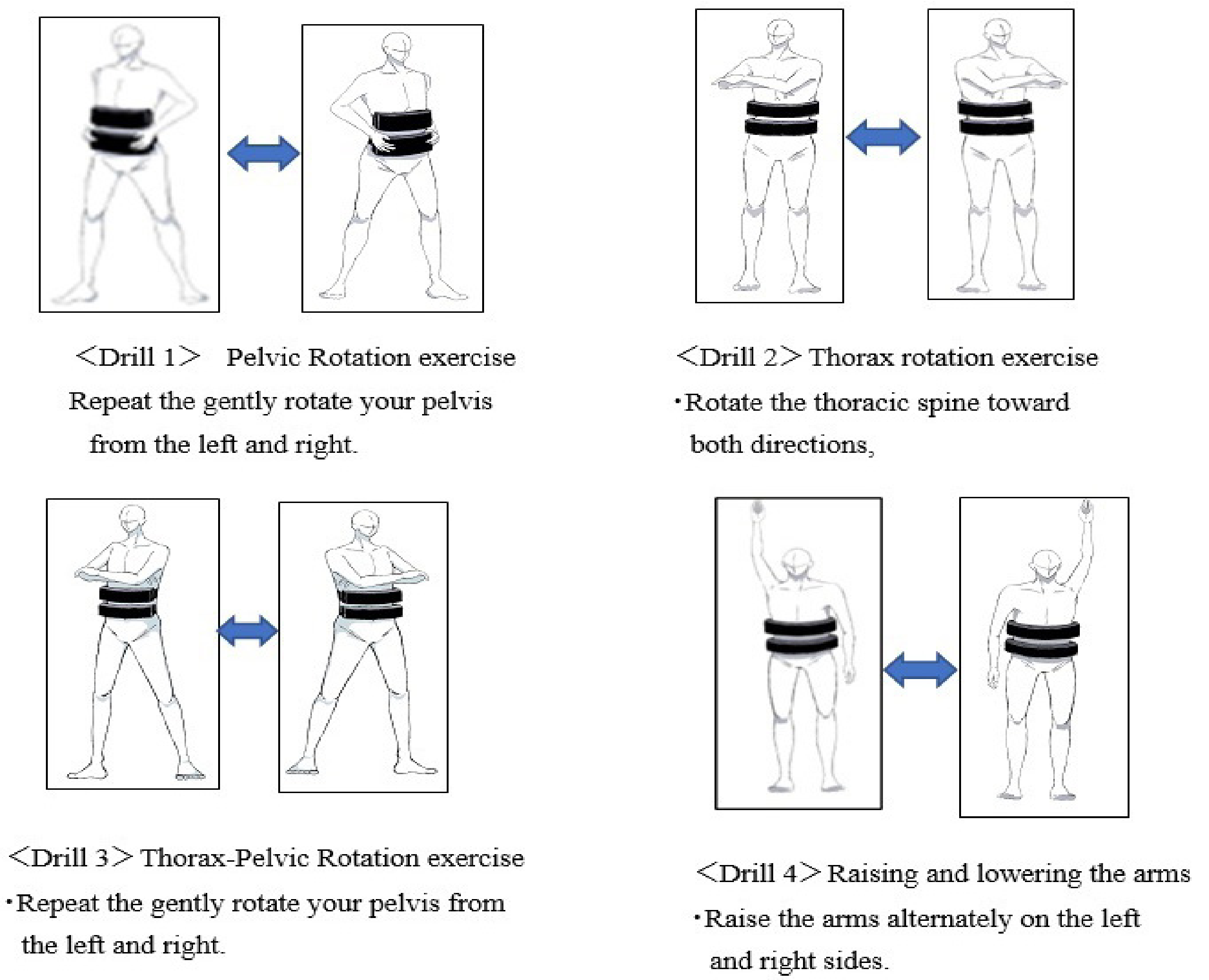
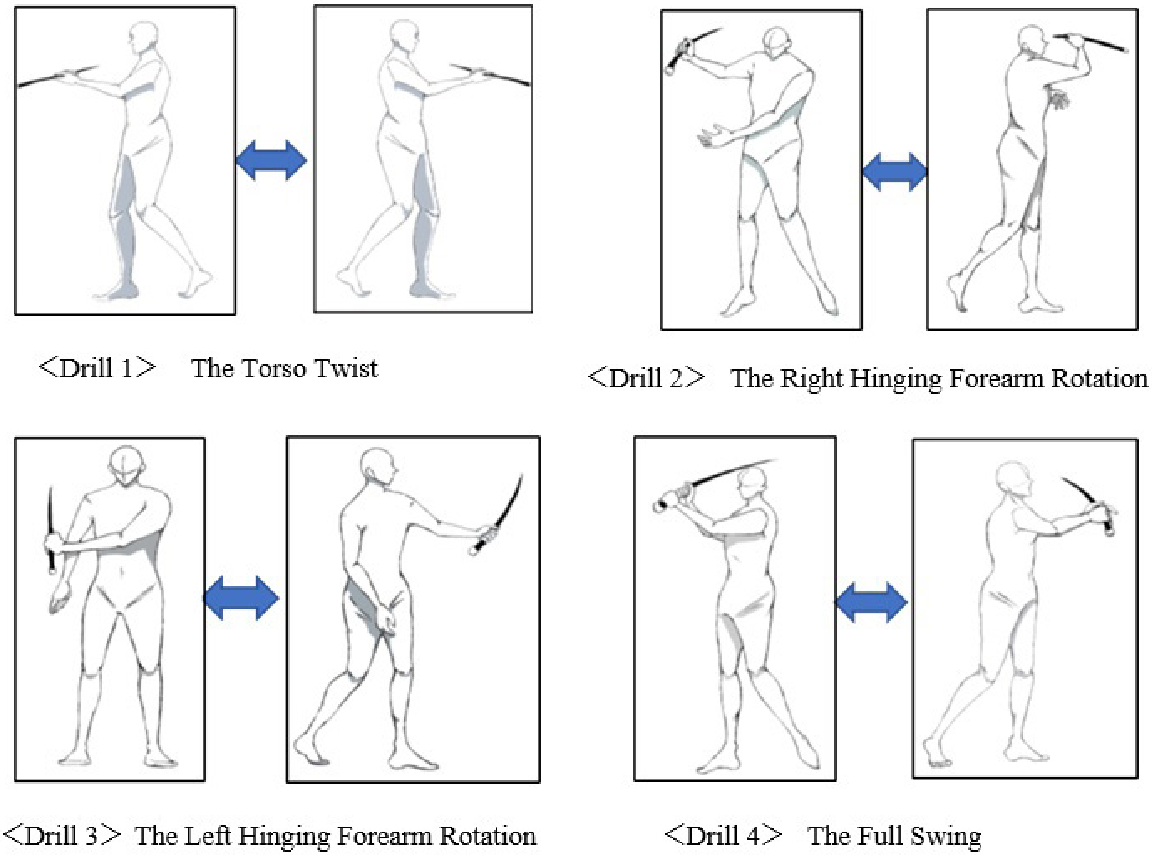


Figure 3: Orange Whip Trainer (OWT) exercise



This exercise improves trunk flexibility by focusing on trunk rotation movements using the orange wrap.

Results

Demographic characteristics of participants

Demographic data for the 12 amateur golfers who agreed to participate in this study are shown in Table 1. There were no differences in age or physical characteristics (height, weight, body mass index) between the RLC and OWT groups. The male/female ratio was four males to two females in both groups.

Table 1: Physical characteristics of participants.

	RLC-group (n=6)	OW-group (n=6)	P-value	95%CI
Gender (male/ female)	4/2	4/2	0.73 [a]	
Age (yr)	35.3±17	39.5±10.1	0.74 [b]	-31.6 - 23.3
Height (cm)	175.2±8.3	177±14.7	0.80 [b]	-17.2 - 13.6
Weight (kg)	80.5±17.7	81.2±22.9	0.96 [b]	-27.0 - 25.7
BMI (kg/m^2)	26.0±4.0	25.6±5.9	0.91 [b]	-6.1 - 6.8

Values are presented as mean ±standard deviation
95%CI: 95% confidence interval
a : χ^2 test , b : t-test

Thorax expansion

There was no difference between the RLC and OWT groups in the longitudinal diameter of the lower thorax. However, the thoraxes of the RLC group expanded more in lateral diameter after the intervention than those of the OWT group (p=0.045) (Table 2).

Trunk mobility

Trunk flexion range of motion increased in both groups following the intervention at the T1-T2 level (p=0.011). However, there was no significant change at the T12-L1 level. For trunk extension, there were no significant changes at the T1-T2 and T12-L1 levels for either of the two groups. Trunk rotation angle was significantly greater in both groups after the intervention than beforehand (p=0.032). However, there was no significant difference between the two groups.

Strength of trunk extensors muscle

Muscle strength did not change significantly after the intervention for either group.

Discussion

The purpose of this study was to investigate the effects of exercises using the RLC device on thoracic flexibility. Results demonstrated that RLC exercises lead to increased lateral diameter of thoracic expansion. RLC exercises were designed to improve flexibility of the lower thorax and symmetry of the pelvis by performing active exercise, while the RLC unit applies pressure to the thorax and pelvis from the front and back [16]. The application of force to the anterior thoracic region may have made the middle and lower thoracic regions more symmetrical and enhanced the expansion in their lateral diameter.

In addition, the RLC group showed improvement in range of motion in trunk flexion and rotation. Diane and colleagues previously reported that the ribs slide upward while rotating forward in the

Table 2: Results of thorax expansion, trunk range of motion and muscle strength.

			Group	pre	post
Thorax expansion diameter	Longitudinal	(cm)	RLC	1.52±0.65	1.49±0.95
			OWT	2.12±0.44	2.07±1.37
	Lateral diameter	(cm)	RLC	1.70±0.43	2.09±0.54 §
			OWT	1.27±0.59	1.33±0.61
Trunk flexion ROM	T1-T2	(°)	RLC	116.3±11.0	129.7±16.5 †
			OWT	116.9±24.7	126.9±22.8 †
	T12-L1	(°)	RLC	90.5±9.7	80.4±10.8
			OWT	94.8±20.1	85.8±10.5
Trunk extension ROM	T1-T2	(°)	RLC	51.3±12.4	49.9±11.7
			OWT	47.5±9.4	50.8±10.4
	T12-L1	(°)	RLC	35.7±10.2	30.9±7.1
			OWT	30.8±5.6	30.4±7.6
Trunk rotation ROM		(°)	RLC	109.5±16.4	118.4±24.4 †
			OWT	119.3±15.8	127.8±11.8
Trunk extension muscle strength		(N/kg)	RLC	506.7±154.1	503.0±125.3
			OWT	578.9±184.8	605.8±183.0

Values are presented as mean ±standard deviation.
†; Significant at the 0.05 level for pre vs post by simple main effect
§; Significant at the 0.05 level for RLC vs OWT by simple main effect

transverse costovertebral plane during trunk flexion, and the opposite side of the rotation direction slides upward during trunk rotation [8]. In our study, the RLC group might have increased the range of motion of trunk flexion and rotation by improving these accessory movements.

However, while the OWT exercises improved the range of motion of trunk flexion and rotation, they did not improve lower thoracic dilation. This phenomenon may be attributed to the fact that the OWT exercises did not approach the thorax directly.

Limitations of this study include the wide age range of the participants and differences in age and golfing history. Changes in posture associated with age may have influenced the results of this study. Furthermore, the clinical significance of the results was not completely clear owing to the very small degree of change in thoracic dilation. We encourage future studies to verify the effectiveness of RLC exercises on patients with low back pain.

Conclusion

In this study, the RLC exercises enhanced the flexibility of the lower thoracic transverse diameter and the flexibility of the trunk more than the OWT group. Specifically, the lateral diameters of the lower thorax were expanded in the RLC group. In addition, the range of trunk flexion and rotation tended to increase. These findings suggest that lateral thoracic expansion of the lateral thoracic diameter might reduce low back pain during exercise.

Competing Interests

The authors declare that they have no competing interests.

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