The Efficacy of Sling Exercise with Trunk Stability Technique on Improvement of Trunk Muscle Thickness and Flexibility in Adolescent with Low Back Pain

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Abstract

The purpose of this study was to examine effects of sling exercise with trunk stability technique on trunk muscle thickness and flexibility in adolescent with low back pain (LBP). Thirty subjects participated in the current study, adolescents with chronic LBP were selected randomly divided to 2 groups: general sling-trunk stability exercise (GSE) group (n=15) and sling-trunk stability exercise using PNF technique (SEP) group (n=15). These subjects received individual sessions program 5 times a week for 4 weeks, GSE group trained general bridge exercise with sling, SEP group trained rhythmic stabilization exercise of PNF technique with sling. The trunk muscle thickness and flexibility were measured before and end of the exercise program. The trunk muscle thickness was significantly improved in the SEP group (p<.005) and the SEP group showed significantly different form GSE group at post of exercise (p<.005). The trunk muscle flexibility was significantly increased in the two groups (p<.005) and the SEP group showed significantly different from GSE group at post of exercise (p<.005). The results suggest that sling-trunk stability exercise using PNF technique may be appropriate for improving trunk muscle thickness and flexibility in adolescent with LBP.

Keywords : Low Back Pain, Sling-Trunk Stability Exercise, PNF Technique, Muscle Thickness, Flexibility.

1. Introduction

Low back pain (LBP) is now a prevalent and burdensome issue for both individual and society, affecting approximately 60~80% of the world’s population [1][2]. The lifetime prevalence of LBP is reported to be up to 84%, however there is currently little evidence to support the use of one intervention over the other in the medium-term [3][4]. A high prevalence of LBP in adolescent has been identified in the last few decades [5][6]. The epidemiology of LBP has been extensively researched in adults but is less well understood in adolescent [7]. According to the previous studies, LBP in adolescence is associated with LBP in the adult [8][9]. LBP

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impacts significantly on adolescents, as over nine in ten report disability that may include reduced physical activity, school absenteeism, and limitations in daily activities [10-12]. The high prevalence of LBP in adolescent is strongly associated with LBP in adulthood and therapeutic physical therapy treatment [13] for LBP being carried out in the adolescent stage[14].

Exercise therapy appears to be the most often-used physical therapy intervention in treating people with LBP [15]. The aims of exercise therapy are to abolish pain, restoring and maintaining full range of motion, improving the strength and endurance of lumbar and abdominal muscles, thereby contributing to early restoration of normal function [16]. The stabilization exercise interventions is effective for treating LBP [17]. In a study by Franca et al. [18] stabilization exercise effectively reduced pain and functional disability in individuals with LBP.

Sling exercise is performed using rope; while the trunk or extremities are supported or suspended in a sling. Because it uses a string, the sling exercise also provides an unstable support surface. According to the Ljunggren et al. [19], sling exercise is easy to use and effective for stabilization exercise, the control of nerve muscle, and the strengthening of muscle. Therefore, sling exercise could maximizing the sense of balance and enhancing trunk stabilization compared with traditional treatment [20]. PNF exercises are used to promote the neuromuscular response of the proprioceptor. Pelvic PNF helps to improve control of pelvis which is a key point for maintaining trunk control by stimulation of muscle and joint proprioceptor [21]. Also, PNF exercise involve the stretching of muscles through rhythmic joint movement and manual resistance, to enhance neuromuscular responsiveness by stimulating proprioceptor [22]. PNF exercise may enhance performance more effectively than conventional single plane or sing direction training program. There is various form of PNF exercise. The rhythmic stabilization is one of PNF technique that isometric contraction of antagonistic patterns and results in co-contraction of the antagonists if the isometric contraction is not broken by the physical therapist for improve stabilization and muscle strength [23].

Most studies concluded that exercise were a valuable therapeutic approach in managing LBP, despite the lack of consensus on the optimal exercise techniques, intensity or active intervention [24]. This is of great clinical importance and needs to be further clarified through research. Furthermore, the effects of sling stability exercise using PNF technique on trunk muscle thickness and flexibility is unclear. Therefore, this study aimed at comparing the effectiveness of two stabilization exercise (GSE and SEP) on trunk muscle thickness and flexibility in adolescent with LBP.
2. Subjects and Methods

2.1 Experimental Design

The experimental design of this study was a randomized controlled trial design. The 30 subjects were randomly divided into a general sling-trunk stability exercise (GSE) group and sling-trunk stability exercise using PNF technique (SEP) group. Each group consisted of 15 subjects. Subjects were not aware of the theoretical bases of each of the exercise. The trunk muscle thickness and flexibility were measured at before and end of the exercise program.

2.2 Subjects

Thirty subjects participated in this study with an average age of 16.4±2.6 years. The participants selection criteria for this study were as follow: subject were eligible for the study if they had a history of recurrent LBP (repeated episodes of pain in past year collectively lasting for less than 6 months) of a non specific nature [25]. All the subjects of this study voluntarily agreed to participate after listening to an explanation of the purpose and methods.

2.3 Training Program

Two experimental groups (GSE, SEP) participated in 4 weeks programs that aimed to improve trunk muscle stability. The training frequency for both groups was 5 times a week and the training volume per session include 3 set of 15 repetitions.

2.3.1 General Sling-Trunk Stability Exercise (GSE)

In the GSE group, the sling were attached to the feet while the subjects performed the exercise. The subjects performed by starting in a hook-lying position with both knees at 90 degrees of flexion and the hip in 0 degree of flexion. The subjects lift their hip into the air while maintaining straight alignment of the knees, hips, and shoulders. The subjects held this position for 5 seconds and then turned back to the starting position [18] (Fig. 1).

2.3.2 Sling-Trunk Stability Exercise using PNF Technique (SEP)

In the SEP group, the sling were attached to the both thighs while the subjects performed the exercise. The subjects were maintained the bridge position in a sling while the therapist
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applies rotational resistance to the pelvis. Therapist’s one hand is placed on the dorsal pelvis on one side, pulling up at the hip while the other hand is on the opposite side, pushing down on the ventral pelvis [26]. The subjects performed exercise by alternating isometric contractions against resistance for 10 second [27] (Fig. 2).

![Fig. 1 General sling-trunk stability exercise](image1)
![Fig. 2 Sling-trunk stability exercise using PNF technique](image2)

2.4 Outcome Assessment

Trunk muscle thickness was measured using ultrasound scanning device. To investigate the trunk flexibility, Fingertip-to-Floor test was used [28]. The subjects standing on a foothold with the feet 10 cm apart, and asked to flex forward with straight knees and try to touch the floor with the fingertips. The distances between middle fingertips and foothold seat and below foothold level were recorded in centimeters.

2.5 Statistical Method

The SPSS 18.0 statistical analysis program (SPSS Inc. USA) was used for the statistical analysis. The independent t-test was performed to compare between group change in trunk muscle thickness and trunk flexibility over time. Paired t-test was used to investigate comparative verification on pre and post of exercise programs in each group. Values of p<0.05 were accepted as significant.

3. Results

3.1 Changes of Transverse Abdominis Thickness

The value of transverse abdominis thickness for the GSE group was 0.33±0.08 (Rt.), 0.37±0.08 (Lt.) at before exercise, it was changed to 0.38±0.07 (Rt.), 0.43±0.06 (Lt.) at 4 weeks. The value of transverse abdominis thickness for the SEP group was 0.37±0.05 (Rt.), 0.39±0.13 (Lt.) at before exercise, it was changed to 0.49±0.04 (Rt.), 0.59±0.18 (Lt.) at 4 weeks. SEP group showed
significantly different between pre and post of exercise (p<0.05). SEP group showed significantly different from GSE group at post of exercise (p<0.05) (Fig. 3).

![Graph showing changes of transverse abdominis thickness in each group.](image1)

**Group I : GSE**
**Group II : SEP**
Tested by paired t-test and independent t-test
*: p<0.05, **: p<0.01, #: p<0.05

[Fig. 3] Changes of transverse abdominis thickness in each groups

### 3.2 Changes of External Oblique Abdominis Thickness

The value of external oblique abdominis thickness for the GSE group was 0.37±0.07 (Rt.), 0.41±0.05 (Lt.) at before exercise, it was changed to 0.41±0.07 (Rt.), 0.42±0.02 (Lt.) at 4 weeks. The value of external oblique abdominal thickness for the SEP group was 0.39±0.11 (Rt.), 0.44±0.1 (Lt.) at before exercise, it was changed to 0.49±0.1 (Rt.), 0.54±0.06 (Lt.) at 4 weeks. SEP group showed significantly different between pre and post of exercise (p<0.05). SEP group showed significantly different from GSE group at post of exercise (p<0.05) (Fig. 4).

![Graph showing changes of external oblique abdominis thickness in each group.](image2)

**Group I : GSE**
**Group II : SEP**
Tested by paired t-test and independent t-test
*: p<0.05, **: p<0.01, #: p<0.05

[Fig. 4] Changes of external oblique abdominis thickness in each groups

### 3.3 Changes of Trunk Flexibility
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The value of trunk flexibility for the GSE group was 6.13±1.51 at pre exercise, it was changed to 4.13±1.3 at 4 weeks. The value of trunk flexibility for the SEP group was 6.6±1.45 at pre exercise, it was changed to 2.13±0.74 at 4 weeks. Both groups showed significantly different between pre and post of exercise (p<0.001). SEP group showed significantly different from GSE group at post of exercise (p<0.001) (Fig. 5).

4. Discussion

The specific objective of this study was assess which exercise method is more effective for administration of stabilization for adolescent with LBP. The main discovery of this study are that sling trunk stabilization exercise using PNF technique is effective in treating adolescent with LBP, when compared to general sling trunk stabilization exercise. Subjects allocated to the SEP group showed significant improvement on trunk muscle thickness and flexibility as compared to the GSE group.

The aims of exercise therapy for LBP are to abolish pain, restoring and maintaining full range of motion, improving the strength and endurance of lumbar and abdominal muscles, thereby contributing to early restoration of normal function [16]. Clinical application of exercise has been shown to improve strength of the muscle resulted in decrease LBP, disability index and increase in lumbar muscle strength and balance ability [29]. Smith et al. [30] reported that stabilization have been suggested to reduce symptoms of pain and disability and form an effective treatment in patient with LBP. The sling exercise is the recommended for stabilization exercise of LBP patients. The sling exercise showed greater co-contraction of other muscle because their instability was higher compared to the exercise using a balance ball. One
characteristic of the sling is that the directions of the string and the body can be adjusted. A recent study reported that sling exercise and core exercise were effective intervention for the control of LBP [20]. So, this study assessed trunk muscle thickness (transverse abdominis, external oblique abdominis) and trunk flexibility by ultrasound scanning, Fingertip-to-Floor Test at before and end of the exercise program.

The present study showed that trunk muscle thickness of GSE and SEP group increased with time. SEP group showed significantly different between pre and post of exercise (p<0.05). SEP group showed significantly different from GSE group at post of exercise (p<0.05) (Fig. 3, 4). The exercise may have been more effective in increasing trunk muscle thickness in the SEP group because the effects of PNF resistance were adjusted through body. This is agreement with previous studies. The sling trunk stability exercise when combined with dynamic movement resulted in a significantly higher activation of the local stabilizers of the spine compared to traditional bridging exercise [31]. Chance-Larsen et al. [32] studied subject in their 20 with LBP. They observed an increase in rectus abdominis muscle activation when the subjects performed a bridge with sling compared to a conventional bridge.

The present study showed that trunk flexibility of GSE and SEP group improved with time. SEP group showed significantly different between pre and post of exercise (p<0.001). SEP group showed significantly different from GSE group at post of exercise (p<0.001) (Fig. 5). The exercise may have been more effective in improving trunk flexibility in the SEP group the GSE group because the effects of PNF body’s inhibitory reflexes to improve muscle relaxation. Our results are different from the study by Saliba et al. [31] that no evidence that treatments with individually instructed motor control exercise or sling exercise were superior to general exercises for chronic low back pain. The reasons for these differences may be related exercise intensity and intervention duration. This results are similar to the study by Kofotolis and Kellis [23]. They suggested that PNF programs may be appropriate for improving short-term trunk muscle endurance, mobility and functional performance in women with LBP. This study provided further support of previous discovery on the positive effects of PNF techniques on trunk muscle thickness and trunk flexibility.

This study provides important clinical information of the effects of sling exercise using PNF technique performed on trunk muscle thickness and trunk flexibility in adolescent with LBP. Additional studies are needed to identify the change of trunk muscle activity, and type of PNF technique, duration, intensity.

5. Conclusion
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The application of sling-trunk stability exercise and sling-trunk stability exercise with PNF technique improved the trunk muscle thickness and flexibility in adolescent with low back pain. The sling trunk stabilization exercise using PNF technique is effective in treating adolescent with LBP, when compared to general sling trunk stabilization exercise. These results suggest that spinal stabilization exercise seem to be effective for LBP in adolescent, with the combination of sling-trunk stability exercise and PNF technique showing the best results.

References


