J Biochem Tech (2019) Special Issue (2): 167-173
ISSN: 0974-2328

Comparison of the Effect of Thoracic and Lumbar Stability Exercises on the Pain and Disability of Women with Non-Specific Chronic Low Back Pain

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Received: 25 December 2018 / Received in revised form: 14 April 2019, Accepted: 03 May 2019, Published online: 25 May 2019

Abstract

Background and objectives: Segmental instability of lumbar vertebrae is one of the complications of patients with non-specific low back pain, accounting for 30-40% of them. The aim of this study was to determine the effect of the thoracic and lumbar stability exercises on pain and disability of women with non-specific chronic low back pain. Methods and Materials: For this randomized clinical trial, 20 women with non-specific chronic low back pain were selected using the convenient sampling method. Patients were randomly assigned into two equal groups: thoracic stability exercises and lumbar stability exercises. The thoracic stability exercises and lumbar stability exercises were selected based on McGill's principles. Before and after intervention, the pain severity was measured through Visual Analog Scale (VAS) and the disability was measured through Oswestry Disability Index (ODI). The exercises of both groups were performed 6 weeks and three times per week. Paired t-test and independent t-test were used to analyze the data. Results: The mean pain severity decreased from 6.00 ± 0.81 to 2.00 ± 1.49 (p = 0.00) in the thoracic stability exercise group, and it decreased from 5.30 ± 0.82 to 2.30 ± 1.56 in the lumbar stability exercises group (p = 0.00). The mean disability severity decreased from 42.00 ± 9.6 to 26.40 ± 7.64 in the thoracic stability exercise group (P = 0.00) and it decreased from 47.00 ± 5.75 to 28.60 ± 4.52 in the lumbar stability exercise group (P = 0.00). There was no significant difference between two groups in terms of severity of pain and severity of disability (P>0.05). Reduction in pain severity in the thoracic stability exercises group was higher than lumbar stability exercises group, while the reduction in functional disability was more in lumbar stability exercises group compared to that of thoracic stability exercises. Conclusion: Thoracic stability exercises and lumbar stability exercises reduced pain and disability in women with non-specific chronic back pain.

Key words: Thoracic Stability Exercises, Lumbar Stability Exercises, Pain, Disability

Introduction

Low back pain is considered as one of the major musculoskeletal disorders and one of the most common and most expensive healthcare problems in the United States (Hill and Keating, 2009). Almost 80% of the people in world experience these problems at least once (Mohseni-Bandpei et al., 2007) and about 5-15% of them experience chronic low back pain (Liddle, Baxter and Gracey, 2004). However, 90% of the low back pains have no recognizable pathology (Haldeman et al., 2012). In addition, the highest prevalence of low back pain in Iran is observed at the age of 15-50 years, with a prevalence of 54.2% (Azizpoor, Hemmati and Sayehmiri, 2013).

Investigations suggest that reducing lumbar stability is one of the most common causes of low back pain (McGill et al., 2003). Based on Punjabi, 3 subsystems provide the lumbar stability including: passive subsystem including bone structures and ligaments, active subsystem including muscles and a control subsystem including neural structures. Based on this model, these sub-systems are working together to provide the stability for the vertebral column (Norris, 2000). Punjabi believed that any harm to one sub-system would cause that two other sub-systems remove the pressure imposed on the harmed sub-system by increasing their activities. In general, it can be stated that vertebral column stability is provided by the activity and coordination of the trunk muscles and the nerve system (McGill et al., 2003). This created stability and improvement in vertebral column control leading to reduced mechanical problems and mitigated pain and improved performance (Panjab, 1995). Given the important role of muscles in creating stabilization, therapeutic exercises are

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one of the most common therapeutic modalities to increase muscle activity and improve stability in CLBP patients (Kofotolis and Kellis, 2006). Various exercises have been suggested for the treatment of low back pain, including aerobic exercises, Williams, Pilates, and many other types of stability exercises. Over the past decades, stability exercises have been widely used for the treatment of patients with low back pain (Hubley-Kozey and Vezina, 2002). Stability exercises are a series of progressive exercises designed based on the motor learning theory, with the aim of improving neuromuscular control, strengthening and improving muscle tolerance to maintain trunk stability. It makes several muscle groups involved. In fact, the main approach of trunk stability exercises, emphasizes on the improvement of vertebral column stability by improving motor control of trunk muscles. These exercises are performed with the aim of activating and re-training the local muscular system. The deep local muscles which is the basic structure for the joint protection system, is activated and provides the necessary protection and stability. In general, these exercises have been designed with the aim of increasing kinesthetic knowledge and muscle control to apply the necessary stability (R. C, H. PW and H. J, 2004; Hodges and Richardson, 1996). Many studies have been carried out on these exercises, most of which provide evidence on the effectiveness of these exercises.

In a meta-analysis research conducted by Wang et al in 2012, a comparison of the stability exercises and general exercises in patients with non-specific chronic low back paining was proposed through which, it was found that stability exercises were more effective in reducing short-term pain and disability compared to general exercises (Wang et al., 2012). In a systematic review study conducted by Kriese et al. (2010), in) on patients with chronic low back pain, it was found that the effect of stability exercises was equal to that of medical treatments in reducing pain and disability, but it was more effective than other treatments in reducing pain and disability in patients with chronic low back pains (Kriese et al., 2010). In another research conducted by Koumantakis et al in patients with chronic low back pain, the results showed that a reduction in pain and functional disability after 8 weeks of treatment was higher in stability exercises group than that of strengthening exercises group (Koumantakis, Watson and Oldham, 2005). The research conducted by Ferreira et al on comparing three types of treatments including routine exercises, stabilization exercises and manipulation on pain and functional disability in patients with chronic low back pain showed that manual treatments in the short term reduced the pain more than the other two groups. However, the stabilization exercise group showed more reduction in pain and disability compared to the other two groups in long-term (Ferreira et al., 2007). Investigating the effect of stabilizing exercises in the study conducted by Hids et al, showed that simultaneous contraction of multifidus muscle and sectional abdominal muscles in stabilizing exercises, compared to control group, had the same effect on pain in patients with acute low back pain in the first phase, but in the long term, the rate of back pain relapsed in stabilizing exercises group was much lower (Hides, Jull and Richardson, 2001).

Given the high prevalence of low back pain, the injuries imposed on workforce and consequently economy of community, cost for an individual and government following low back pain. Considering the increasing growth in the rate of low back pain in community, it is necessary to pay attention to the issue of low back pain and its appropriate treatment (Dagenais, Caro and Haldeman, 2008). While great number of studies has been conducted on the effects of stabilizing exercises, no study has been conducted to compare thoracic stabilizing exercises and lumbar stabilizing exercises. Thus, the objective of this research was to compare the effect of thoracic stability exercises and lumbar stability exercises on the level of pain and disability in women with non-specific chronic low back pain.

Methods and Materials

This study was a randomized clinical trial study conducted on patients who were randomly assigned into two groups: thoracic stability exercises (n=10) and lumbar stability exercises (n=10). The treatment program for both groups included 18 sessions of treatment for 6 weeks, 3 times per week, and one hour per session. It was conducted at the Zahedan Social Security Hospital. The variables of the study were measured and recorded before and after the end of the treatment.

Participants

A total number of 20 women with non-specific chronic low back pain were voluntarily selected using convenient sampling. The inclusion and exclusion criteria of the study were as follows. The patients included women at age range of 18 to 55 years with pain in the area between rib 12 and rump without a referral to the lower limbs lasting for more than 3 months. They felt no specific pathological cause as well as pain which caused physical impairment and disability. In addition, the patients had to not have any history of neurological disorder, radicular pain in the lower limb, infection, cancer, rheumatic disease, inflammation diseases, prolonged immobility, history of surgery in the waist and abdomen. Those having structural injuries such as spondylolisthesis, vertebral column fracture , scoliosis, kyphosis or any contracture in lower limb, systemic and mental diseases, pregnancy or a history of delivery in a recent year, and those who had undergone treatment over the last 3 months were excluded (Andrusaitis et al., 2011; Karimi et al., 2014). Exclusion criteria included risky exercise for the patient, incomplete exercise, exacerbation of symptoms, receiving other treatments along with exercise therapy, and finally, the patients who had absents for more than three consecutive sessions (Andrusaitis et al., 2011). The eligible patients were included into study after signing the written consent form. This study was approved by the Ethics Committee of Zahedan University of Medical Sciences. The rights of the subjects were observed at all steps of the study. The current research was registered at the Iranian Clinical Trials Registry Center under the code of IRCT20090210001675N14.

Measurement

The eligible patients were included into study after signing the written consent form. All investigation and evaluation activities were performed at Razmjo Moghadam Clinic of Zahedan University of Medical Sciences during one session. After patients' inclusion, their age, height, weight, and body mass indexes were assessed, respectively, by asking questions, the strip meter (cm), the digital scale (kg), and the ratio of weight (kg) to height (m) and the answers were recorded in the sheet for each person. The functional disability of patients was assessed by the Oswestry Disability Index, which is a golden standard for assessing low back pain. This index had 10 items assessing the severity of pain, personal care, carrying things, walking, sitting, and standing, sleeping, having sex, social life, and travelling. Each item had 6 ranks, ranked from 0 to 5, and the maximum score of it was 50.

The score of different items was summed up and divided by the number of 50 and multiplied by the number 100 to achieve the percentage of disability. If the patient does not answer one of the items, the total score of the items was divided by the number 45 and multiplied by the number 100 (Melzack, 1987). In order to assess the level of pain perception (rank), the Visual Analogue Scale (VAS) of the McGill Short Questionnaire was used. It was a scale sensitive to pain and its information had the reliability and validity. This scale was a 10-cm graded line, in which the patient had to determine his pain severity on this graded line from zero (no pain) to 10 (the most severe pain perceived) (Arokoski et al., 1999).

Intervention

Treatment in both groups included electrotherapy and exercise therapy. Electrotherapy was the same in both treatment groups and was performed before the treatment. It included:

- Conventional Transcutaneous Electrical Nerve Stimulation (TENS) with the frequency of 80 Hz and 120 milliseconds for 20 minutes
- Ultra sound (US) with a frequency of 1 MHz and 1.5 W / cm 2 for 5 minutes on the para-spinals of lumbar area
- Infra-Red (IR) over the lumbar area for 20 minutes

The exercises were different in two groups. They included thoracic stability exercises in one group and the lumbar exercises in the other group. Patients were randomly assigned to each of the groups.

Thoracic stability exercises

The intervention group involved 5 thoracic stability exercises, which were performed complementarily and progressively.

The exercises included:

1. Abdominal Bracing: The patient was bent backward with knees and thighs in supine position. The person was asked to extend the muscles of the abdomen without disturbing the rhythm of breathing and hold it without embossing the muscles above the navel. To ensure the contraction, the person placed her hand above ASIS and felt the contraction. The person held the contraction for 5 seconds and repeated it for 10 times.
2. The patient lied on the back so that the trunk and pelvis were in the same direction and her knees and thighs were bended and the patient's hands were placed at 90 degrees of flexion. One hand of the patient was on her knee and the opposite site hand was on the ball or wall. The patient pressed the ball or the wall with her hands and knees simultaneously and held the pressure for 10 seconds and repeated it for times, and then, she repeated the same movement in the opposite direction for 5 times.
3. The patient sat on her knees and bended forward. The forearm was placed on the sides of the body and in the pronation. Without changing the flexion of the waist, the thoracic was extended and the hands were supinated. The patient maintained the position for 5 seconds and repeated this exercise 10 times.
4. The patient was placed in the form of four hands and feet, and one hand was taken to 90 degrees of abduction and moved the hand backwards by rotation of the trunk. The patient maintained the position for 5 seconds and repeated it 10 times. At the same time, she maintained the abdominal.
5. The patient was in her four hands and feet position and held up the opposite hand and foot for 5 seconds, and repeated this exercise for the opposite side, while she held abdominal contraction simultaneously. This exercise was repeated 5 times for each side (Hertling and Kessler, 2006).

Lumbar stability exercises

The exercises of the lumbar stability exercises included:

1. Cat-camel exercise in which a patient stayed in her four legs and feet position and flattened her lumbar arch, without any stretch in the muscles and pain, and she re-created the arch and repeated this exercise 5 times.

2. Curl-up: The patient lied down and bended her knees. In this position, she raised the head and trunk and held for 5 seconds and repeated the exercises for 10 times.
3. The patient lied down on her abdomen and took one foot to the hip extension and held the position for 5 seconds and repeated it 5 times for each leg.
4. The patient on her side was placed on her knees and knees were bent. The person supported the trunk with her hand and took the pelvic to the side flexion. She maintained the position for 5 seconds and repeated 5 times for each side.
5. Patient was in supine position and the knee and tights were bent. The patient lifted the pelvic from the ground with the pressure of the trunk and legs and held the position for 5 seconds and repeated it for 10 times. In order to ensure the correctness of the exercises, the exercises were performed under full supervision of the therapist and in the physiotherapy clinic, and no exercise was performed at home and without supervision. After the completion of therapeutic sessions, the severity of pain and disability was re-measured (McGill, 2018).

Determining the sample size

The sample size was determined according to the pilot study. For this purpose, 10 patients were selected and randomly assigned into two groups so the main stage of the study was conducted on them. Based on the mean and standard deviation obtained from these two groups, the number of samples required for the main research was estimated with 95% confidence and 90% test power.

Statistical analysis

Data were analyzed by using SPSS, version 17, software. The normal distribution of data was examined by Kolmogorov -Smirnov test. Levin test was used to examine the equality of variances. For data with normal distribution, Paired t-test was used to compare the results before and after the intervention of each of the groups (intra-group) and independent t-test was used to compare the results before and after the intervention between the two groups (inter-group). The significance level (α) was considered less than 5% for statistical comparisons,

Results

Table 1 presented demographic data of patients including age, height, weight, body mass index, history of onset and duration of the current pain. Demographic characteristics of patients, were recorded before treatment, later they were compared between the two groups. There was no significant difference between the two groups in terms of these variables (Table 1). Using a pilot study, the sample size was estimated to be 20 in two groups (each group contained 10 subjects). A total of 20 eligible subjects completed the research. Table 2 represented the pain severity and disability intensity, comparing the results before and after treatment in two groups. The p-value related to comparing the results after and before treatment and comparing the results between two groups after treatment and p-value related to results after treatment were all indicated in table 2.

Intragroup comparison

The mean of pain severity in both groups showed significant reduction using paired t-test (P = 0.00) (Table 2).

Inter-group comparison

To know that the randomization process was correct or not, data of two groups were compared before the research. The results revealed no difference between the two groups in terms of the variables studied. The patients in two groups were matched in terms of mean pain severity and lumbar disability severity. Inter-group comparison of thoracic and lumbar stability exercises after the treatment using independent t-test revealed no significant difference between the two groups in terms of pain severity and disability ($p > 0.05$). The level of reduction in pain severity in thoracic stability exercise group was higher than that of lumbar stability exercises, while the level of reduction in functional disability was more in lumbar exercise group than that of thoracic stability exercises group (Table 2).

Discussion

The results of our research supported the first hypothesis which stated that thoracic stability exercises and lumbar stability exercises reduce pain and disability in women with non-specific low back pain. They also supported the second hypothesis of research which stated that the thoracic stability exercises are more effective in reducing pain and disability in women with non-specific low back pain, compared to lumbar stability exercises. Results suggested that low back pain could be the result of impairment in the functions of lumbar muscles and fatigue of para-spinal muscles. Low back pain led to changes in type 1 and type 2 fibers in patients with low back pain. In these patients, the reduction in the level of type 1 to 2 fibers was observed in deep stabilizing muscles (Parkkola, Rytökoski and Kormano, 1993; Norris, 2000). Stability exercises were appropriate methods for modifying and re-activating the vertebral stabilizing muscles. In fact, the focus in thoracic stabilizing exercises was on the simultaneous activation of both muscle groups stabilizing the vertebral column.

According to McGill's and his colleagues, the activity of different muscles in the vertebral column can be similar to an orchestra, which includes different musical instruments with different voices. He believed that trumpet creates the bam voice similar to global muscular system, which has the ability to control buckling force and stiffness in the vertebral column. He also considered the flute similar to the local muscle system. While local system is not involved in the control of buckling force, it provides an effective mechanism for controlling intervertebral and segmental stiffness, so that 70% of segmental stiffness in the vertebral column is caused by the contraction of the multifidus muscle. In general, he believed that both of these muscle systems in a consistent interaction could provide the stability and health for vertebral column (R. C, H. PW and H. J, 2004; McGill, 2018; McGill, Juker and Kropf, 1996).

While local muscles are activated as a result of lumbar stability exercises, it seems that the interaction between local and global muscles is also essential. Biomechanical studies and examinations on muscle activity have clearly shown that there was no superiority between local and globular muscles in creating stability in vertebral column. In fact, not only the local muscle system was important, but also the control of the cooperation and interaction between these two muscular systems created a stable structure (Arokoski et al., 2001; Stevens et al., 2007). Stability exercises modified the movement pattern and reduced the pain in patients by changing the muscles coordination pattern (McGill, 2002). In a research on the effect of McGill's stability exercises and routine physiotherapy, it was found that McGill's stability exercises were more effective in reducing pain and disability. By activating the muscles of the global system and especially the local system, these exercises could improve the movement pattern and create coordination between the vertebral muscles, and thus reduce pain, and disability (O'Sullivan, 2000).

Very limited studies have been conducted to evaluate the effect of muscles of thoracic area on low back pain. In a research conducted by Woo et al, they found that the effect of stability exercises along with thoracic extensor exercises was higher in improving the lumbosacral angle, and disability index compared to only stability exercises (Woo and Kim, 2016). In another study, the effect of stability exercises and general exercises and combinations of two exercises on lumbar pelvic muscles activity was examined and it was found that the combined exercises had a greater effect on the activity of the lumbar pelvic muscles and on change in the pattern of electrical activity of the muscles compared to general-stability and only stability exercises (Kalantari et al., 2014).

The results of these two studies suggested that lumbar stability exercises alone could not meet the needs of all lumbar stabilizing muscles, whether local or global muscles, and with a slight modification or combination with other exercises, they could provide both local stability resulting from multifidus and global stability resulting from iliocostalis thoracic (similar to the thoracic stability exercises). In thoracic stability exercises, in addition to emphasizing on the stabilizing role of erector spinae muscles of thoracic area was also emphasized.

By changing the pattern of multifidus, these exercises could provide local stability. They could also provide the global stability through the erector spinae muscles of the thoracic area, which could prevent anterior shear force resulting from lumbar flexion by creating posterior shear force. In addition, these muscles had the highest moment arm, and consequently, the highest mechanical advantage and extensor torque, led to a reduction in compressive force on the vertebral column. It could be concluded that the thoracic stability exercises were effective in improving the pain and disability through leaving an effect on improving the activity of local and global muscular system (Norris, 2000).

It is believed that thoracic stability exercises had a greater effect on the low back pain of NCLBP patients compared to routine stability exercises due to several reasons: 1- Based on the studies conducted on patients with low back pain, para-spinal muscles, either deep or surface muscles, experienced atrophy and both group required re-training through therapeutic exercises to improve the stability (Danneels et al., 2015). The stability of columns was not just the result of deep muscles, such as multifidus, but rather it was the result of the orchestra-like activity of various muscular systems (McGill, 2018) 3- Results of most studies had indicated the positive effects of stability exercises, but studies in contradiction with the results of these exercises had been found which could be due to a defect in the set of lumbar stability exercises (Salamat et al., 2017). The set of these factors encouraged the researcher to perform a different kind of stability exercise with a greater emphasis on the muscles attaching to the thoracic area, so that these kinds of exercises could provide more contribution in treatment of patients with low back pain.

Conclusion

Thoracic stability exercises and lumbar stability exercises reduced pain and disability in women with non-specific chronic low back pain. While thoracic stability exercises were more effective than lumbar stability exercises in mitigating the pain, lumbar stability exercises were more effective than thoracic stability exercises in reducing the functional disability.

Table 1- Inter-group comparison of basic characteristics of patients

Variable	Thoracic stability exercises n=10	Lumbar stability exercises n=10	p-value
Age (year)	36.95±6.77**	39.50±8.31	0.45*
Weight (kg)	78.30±9.58	79.80±7.23	0.69

Height (m)	1.62±0.05	1.60±0.03	0.27
Body mass index (kg / m 2)	29.70±4.71	30.98±2.65	0.46

**mean and SD of data
*Significance in p<0.05

Table 2- Comparing the mean data after and before treatment of pain and disability in two groups and comparing the results after treatment in two groups

	Thoracic stability exercises group N=10			Lumbar stability exercises group N=10			Comparing the results of after treatment in two groups	Mean diff
Variable	Before intervention	After intervention	p-value	Before intervention	After intervention	p-value	p- value	
Pain	6.00±0.81**	2.00±1.49	0.000*	5.30±0.82	2.30±1.56	0.000*	0.587	1
disability	42.00±9.06	26.40±7.64	0.000*	47.00±5.75	28.60±4.52	0.000*	0.446	-2.6

*Significance in p<0.05
**mean and SD of data.

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