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Effect of core strengthening with inspiratory muscle training versus core strengthening on pain, strength and range of motion in chronic low back pain individuals: A randomized control trial

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Abstract

Topic: "Effect of core strengthening with inspiratory muscle training versus core strengthening on pain, strength and range of motion in chronic low back pain individuals: A Randomized Control Trial."

Background: Low back pain is one of the most common health problems among all the population of the world. Men and women are equally reported to be affected by this condition. 50% of adults and 30% of adolescents are affected at least once. Low back pain often involves altered muscle length relationships, postural changes, Muscular imbalances, variations in location of the centers of mass and of pressure. It has been suggested that the diaphragm plays a role in contributing to spinal stiffness via its influence on intra-abdominal pressure, as well as via direct mechanical effect via the attachments of the diaphragm crurae. The diaphragm, a component of core Stability, plays a role in respiration and trunk stability by controlling intra-abdominal pressure and reducing the stress on the spine through cooperative action with the abdominal and pelvic floor muscles.

Objectives: To compare the effect of core strengthening with inspiratory muscle training versus core strengthening on pain, strength and range of motion in chronic low back pain individuals at the end of 6 weeks.

Methodology: Ethical committee clearance was taken for the study

- A written consent was taken from every subject and the entire procedure was explained to the patient in a language understood by the patient.
- The subjects were divided into two groups by randomization: Group A (n=31) and Group B (n=31)
- Group A was to continue with the inspiratory muscle training exercises with core strengthening exercises and Group B received the core strengthening exercises for three times a week
- Single - blinding was maintained throughout the process by blinding the subject to the treatment
- Numerical Pain Rating Scale, Pressure Biofeedback and Modified Schobar's test were conducted pre and post intervention.

Result: Total 62 male and female of age group 18-35 years, with chronic low back pian volunteered to participate in the study, after 7 dropouts due to various reasons, 30 males (54.5%) and 25 females (45.5%) have completed the 6 weeks of protocol.

There was statistically significant difference in NPRS, Pressure Biofeedback values and Modified Schober's Test scores in both the groups.

Conclusion: In the present study core strengthening with inspiratory muscle training and core strengthening both were effective in reducing pain and improving strength and range of motion after completing the treatment protocols. But the improvement in extension range of motion is more in core strengthening group when compared with core strengthening with inspiratory muscle training group.

Keywords: core strengthening, inspiratory muscle training, chronic LBP, maximum inspiratory pressure

Introduction

Low back pain is one of the most common health problems among all the population of the world [1]. Men and women are equally reported to be affected by this condition. 50% of adults and 30% of adolescents are affected at least once [2]. Low back pain often involves altered muscle length relationships, postural changes, Muscular imbalances, variations in location of the centres of mass and of pressure.

LBP is defined as pain which starts below the scapulae and above the cleft of the buttocks, with or without radiation to the lower extremities, including nerve root pain or sciatica (Hayden *et al*., 2005) [3]. Based on the etiology, LBP is classified as specific LBP and nonspecific LBP. Nonspecific LBP is defined as LBP not attributed to specific pathology (e.g., infection, tumor, osteoporosis, arthritis, fracture, Cauda equina syndrome, etc.). It is thought that in some cases the cause may be a sprain (an overstretch) of a ligament or muscle or minor problem with a disc, facet or minor problems in the structures and tissues of the lower back that result in pain (Koes *et al*., 2006) [4]. LBP is also categorized in three subtypes based on duration of symptoms as: acute (lasting for few weeks), subacute (6–12 weeks), and chronic (more than 12 weeks) LBP (Krismer *et al*., 2007). Chronic pain is represented by a protective adaptive muscle response in which agonists and antagonists decrease and increase in tone respectively (Graven-Nielsen *et al*., 1997).

Chronic low back pain (CLBP) is generally accepted as one of the most common musculoskeletal disorders, affecting, on average, 4% to 33% of people. CLBP can also affect the quality of life and lead to disability and absenteeism. Approximately 85% of the cases of low back pain (LBP) are described as nonspecific CLBPs due to the lack of compatibility between their symptoms and radiological findings [1]. The prevalence rate of CLBP in athletes ranges from 1% to 40% [2]. Back injuries occur in 10% to 15% of young athletes and, as such, are a common phenomenon [3]. CLBP also strikes without a specific pathology or anatomy, and the associated pain usually takes more than 6 months in these patients. The joints, intervertebral discs, tendons, ligaments, and muscles can individually play a major role in the progression of this disease. For example, if transverse abdominis muscle (TVA) activity is delayed, the activity of the global muscles increases in some cases, and vice versa.[4] The incidence of multifidus muscle (MF) atrophy also results in a reduction in muscle size and an alteration in muscle contraction in those with CLBP.

According to a previous study, impaired postural control may be due to reduced coordination in the core muscles, along with increased muscle tension [5]. Examining and treating the trunk muscles comprise an important part of physiological treatment for patients with CLBP. Patients with CLBP will be more exposed to negative physical, social, psychological, and economic experiences if they do not receive proper treatment; therefore, giving proper rehabilitation to these patients is essential. For these patients, rehabilitation should be directed toward increasing coordination between the activities of the local and global core muscles [5]. In general, respiratory movements in the standing position lead to an internal perturbation of body balance, and the resultant disorder can be partially compensated by the hip and the spine movements. Therefore, a decrease in the range of motions and velocity in patients with CLBP causes a reduction in the compensation for respiratory distress, the enhancement of postural sway, and a greater perturbation compared with people without this condition. Some of the outcomes induced by inspiratory exercises in athletes include increased overload tolerance, improved athletic performance, enhanced muscle strength, and elevated airway capacity [6]. One of these exercises is inspiratory muscle training (IMT), which is believed to improve the strength and endurance of the respiratory muscles.[7]

The management of LBP comprises with range of different interventional strategies, including drug therapy and nonmedical interventions. Nonsteroidal anti-inflammatory drugs may be of short-term benefit and are included in medical management. Physical therapy includes exercises and pain-relieving modalities (Burton *et al*., 2006). (8) Short wave diathermy, interferential currents and transcutaneous electrical nerve stimulation have been known to reduce muscle spasm and blocking pain (Deyo *et al*., 1990). There are various forms of exercise that can be prescribed based on different schools of thought. This includes intensive dynamic back extensor exercises (Manniche *et al*., 1991), motor control exercises (Macedo *et al*., 2009), yoga (Sherman *et al*., 2005), aerobic exercises (Sculco *et al*., 2001). Lumbar stabilization exercises are aimed at improving the neuromuscular control, strength, and endurance of the muscles that are central to maintaining the dynamic spinal and trunk stability. The effect of lumbar stabilization exercise has been studied in subjects with recurrent LBP (Koumantakis *et al*., 2005), pelvic pain (Ferreira *et al*., 2006) and LBP with leg pain (Saal and Saal, 19)

There is growing evidence in the literature to suggest that the presence of CLBP is associated with dysfunction in the deep abdominal muscles. Studies have recently shown that individuals with chronic obstructive pulmonary disease (COPD), in particular those with compromised inspiratory muscle function, exhibit postural control strategies that are similar to those of people with LBP.

Transverse abdominis contraction occurs before the initiation of movement of the upper limbs in healthy adults. The diaphragm and transversus abdominis muscles are both important for posture and trunk stabilization. Contraction of the transverse abdominis also has been shown to occur before movement of the extremities to ensure stabilization of the spine. In addition to providing intra-abdominal pressure, the abdominal muscles work together to decrease compression of the spine and reduce force of the trunk extensors.

The human diaphragm is the principal inspiratory muscle, and it plays an essential role in controlling the spine during postural control [8]. It seems reasonable that an increased demand for inspiratory function of the diaphragm might inhibit its contribution to trunk stabilization during challenges to postural balance. Healthy individuals seem to be capable of compensating efficiently for modest increases in inspiratory demand by active multisegmental control [9]. Nevertheless, this compensation seems less effective in individuals with LBP, resulting in impaired balance control. Furthermore, and as mentioned previously, specific loading of the inspiratory muscles impairs postural control by decreasing lumbar proprioceptive sensitivity, forcing dominant ankle proprioceptive use [10]. This might be explained by fatigue signalling of the inspiratory muscles, inducing a decrease in peripheral muscle oxygenation and blood flow, which also affects the back muscles. Furthermore, individuals with LBP show a greater magnitude and a greater prevalence of diaphragm fatigue compared with healthy control [11].

It has been suggested that the diaphragm plays a role in contributing to spinal stiffness via its influence on intra-abdominal pressure, as well as via direct mechanical effect via the attachments of the diaphragm crurae.

Studies have also reported that stiffness and stability of the spine is increased, and mobility reduced, by increased activity of the trunk muscles in people with Low back pain [7]. The abdominal exercises have yielded different pressures, some greater than 50% of the pressures generated during a maximal inspiratory maneuver. Some of these exercises generated high enough pressures to help strengthen the diaphragm [10].

Deep breathing exercises have been shown to require more abdominal muscle activity than abdominal crunches, and it is suggested that breathing exercises can be incorporated into a core training program in order to achieve maximum benefits. Inspiratory muscle training is one way to train the muscles used during respiration. Research has consistently shown that inspiratory muscle training improves respiratory muscle strength, but how this influences core stability is unknown.

Inspiratory muscle training is a form of resistance (weight) training that strengthens the muscles of respiration. When these muscles are regularly strengthened for a few weeks, they can manage to work longer. By improving muscle strength before an operation, IMT can reduce breathing complications following orthopedic surgery.[7]These exercises can be as effective as traditional exercises applied to increase total body performance.[8] Based on theoretical foundations, long-term inspiratory exercises are likely to affect core muscle activity and improve pulmonary parameters [9,10].

IMT is often used in people with diseases such as Chronic Obstructive Pulmonary Disease (COPD) and asthma. Improving inspiratory muscle strength in these populations can improve patients' independence, performance of activities of daily living, and quality of life.

Hence, after reviewing the available literature, the purpose of this study is to find out the combined effect of core training and IMT on CLBP in comparison to core training alone.

Materials and Methodology

1. Study Design: A Randomized Control trial
2. Sample Size: 62

Calculated using the formula

n (max)= Z2. P(1-P)/E2

= (1.96)20.2(1-0.2)/ (0.01)2

= 0.614/0.01 = 61.44

3. Sampling Method: Purposive random sampling
4. Study Population: young adults (18-35 years of age)
5. Duration of study:1 year
6. Duration of intervention:6 weeks
7. Study setup- in and around various hospitals and clinics

Inclusion Criteria

1. Chronic low back pain (>3 months)
2. Adults (age between 18-35 yrs.) (13)
3. Mild to moderate pain intensity (NRS: 2-6)
4. Both males and females

Exclusion Criteria

1. Patients with specific underlying pathology as cause of LBP or with primary respiratory diseases were excluded.
2. Patient with neurovascular and cardiorespiratory conditions.
3. Congenital/acquired malformation
4. Spine surgeries
5. Pre- and post-natal women
6. Fibromyalgia. (14)

Withdrawal procedure

- Subject's participation in this project is completely voluntary
- Subject's may withdraw from the project for any reason (or no reason at all), at any time, without penalty of any sort, or loss of benefit to which he she would otherwise be entitled
- Subjects were informed and explained about the right to 'withdrawal of participation' while obtaining consent (Annexure D).
- The data collected on the participant to the point withdrawal remains a part of study database

Appartus

1. Plinth
2. Inspiratory muscle training device
3. Pressure biofeedback device
4. Numerical pain rating scale
5. Measuring tape
6. Data sheet

Procedure

Ethical committee clearance was taken for the study

- A written consent was taken from every subjectand the entire procedure was explained to the patient in a language understood by the patient.
- The subjects were divided into two groups by randomization: Group A (n=31) and Group B (n=31)
- Group A was to continue with the inspiratory muscle training exercises with core strengthening exercises and Group B received the core strengthening exercises for three times a week
- Single - blinding was maintained throughout the process by blinding the subject to the treatment Numerical Pain Rating Scale, Pressure Biofeedback and Modified Schobar's test were conducted pre and post intervention.

Group A training: (Core strengthening with Inspiratory Muscle Training)

1. Inspiratory muscle training

Position of participant: Upright sitting in chair with back support

The pressure threshold device is set at a resistance level of -2 or -4 cm H20 in respect with the average baseline MIP of the participant. The device was placed in his/her hands. Mouthpiece was placed in mouth making a good airtight seal. Breathe out as far as you can and take a forceful breath in through your mouth while expanding your chest. Breathe out slowly with minimal effort. 3 sets of 5 repetitions [6] were performed for 3 days in a week with a 1-2-minute rest in between sets.

Progression: A load increment of -2 to -4cm H20 over the period of 6 weeks was done [11]. The load and number of breaths were documented.

Fig 1

2. Diaphragmatic breathing exercise

Position of participant: Upright sitting in chair with back support Shoulder rolls or shoulder shrugs were performed to relax the muscles before performing the actual diaphragmatic breathing technique. Participant's hand(s) were then placed over the rectus abdominis just below the anterior costal margin. Participant was instructed to breathe in slowly and deeply through the nose. By keeping the shoulders relaxed and upper chest quiet, allow the abdomen to rise slightly. Relax and exhale slowly through the mouth [12]. Participants were asked to practice this, three or four times and then rest and were advised to avoid hyperventilation. If the participant had difficulty using the diaphragm during inspiration, then he/she would inhale several times in succession through the nose by using a sniffing action. This action was found to usually facilitate the diaphragm. Participant were taught to self-monitor this sequence, by placing his or her own hand below the anterior costal margin and feel the movement. It was ensured that the participant's hand rises slightly during inspiration and lowers during expiration [15].

Participants were asked to perform this diaphragmatic breathing for 15 minutes with appropriate breaks after every 6-8 breaths alternatively three times a week.

Along with this the subject performed the core strengthening protocol described below

Group B: (Core Strengthening Exercises)

- Warm up (10-15 mins)

- Patient position hook lying (knees 90). Place pressure cuff under lumbar spine and inflate to 40 mmHg. Begin each exercise with drawing in maneuver to activate core muscles. Determine level at which patient can maintain pressure constant (stable pelvis) while performing either A, B, or C limb load activity.
- **Level 1:** core activation- draw in and hold for 10 seconds
- **Level 2:** Opposite LE on mat; bent leg fall out.
- **Level 3:** (A, B, C) Opposite LE is on table
- **Level 4:** (A, B, C) Hold opposite LE at 90^0 of hip flexion with UE
- **Level 5:** (A, B, C) Hold opposite LE at 90^0 of hip flexion (no UE assistance)
- **Level 6:** (A, B, C) Bilateral LE movement
- Cool down (10-15 min)

Fig 2

Fig 3

Fig 4

Fig 5

Outcome Measures

1. NPRS (Numerical Pain Rating Scale)

It is 11-point numeric scale. Data obtained is easily documented, interpretable and meet regulatory requirements for pain assessment and documentation. Reliability is 0.92 [14].

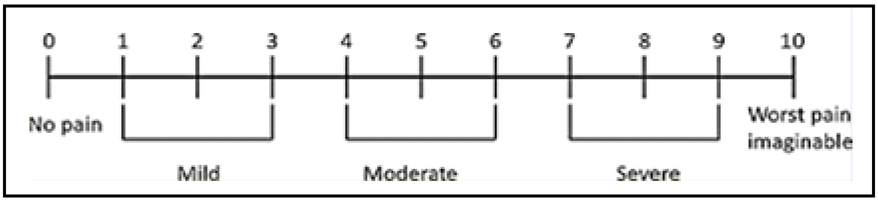

Fig 6

2. Pressure Biofeedback

Pressure biofeedback is a tool designed to facilitate muscle re-education by detecting movement of the lumbar spine associated with a deep abdominal contraction in relation to an air-filled reservoir. (15)

Procedure

Patient position-Supine, hook lying.
Place the three-chamber pressure cell under the lumbar spine horizontally across low back area.
Position the spine in neutral.
Inflate the pressure cell to a baseline of 40mm Hg.
Draw in the abdominal wall without moving the spine or pelvis.
There is an increase in the pressure from 40mm Hg.
Pressure should remain at 40mm Hg +/- 10mm Hg while performing the loading exercises.

Fig 7

3. Modified Schober's test

Modified Schober's Test (interrater (r=0.96) and intra-rater (r=0.94) reliability) [18] The subject standing erect, knees extended, arms relaxed at the sides and body weight centered. Marks on the skin to be made using a pen. The first mark at the lumbosacral junction, as indicated by the posterior superior iliac spines; a second mark was made 10 cm above and a third mark made 5 cm below the lumbosacral junction. The subject then was asked to bend forward as far as possible until the onset of the pain and the new distance between the second and third marks to be measured. Similarly, the distance between the superior and inferior marks were measured as the subject extended the spine as far as possible. The initial length (15 cm) was subtracted from the final length of trunk flexion to obtain the extent of trunk flexion, while the final length of the trunk extension was subtracted from the initial length (15 cm) to obtain the extent of trunk extension.

Fig 8

Conclusion

In the present study core strengthening with inspiratory muscle training and core strengthening both were effective in reducing pain and improving strength and range of motion after completing the treatment protocols. But the improvement in extension range of motion is more in core strengthening group when compared with core strengthening with inspiratory muscle training group. Thus, the null hypothesis which states that "Core strengthening with inspiratory muscle training is not effective in improving pain, strength and range of motion in chronic low back pain individuals at the end of 6 weeks." is rejected.

References

1. Smith MD, Russell A, Hodges PW. Disorders of breathing and continence have a stronger association with back pain than obesity and physical activity. Australian Journal of Physiotherapy.,2006:52(1):11-6.
2. Smith M, Coppieters MW, Hodges PW. Effect of experimentally induced low back pain on postural sway with breathing. Experimental brain research.,2005:166(1):109-17.
3. Jafari H, Courtois I, Van den Bergh O, Vlaeyen JW, Van Diest I. Pain and respiration: a systematic review. Pain.,2017:158(6):995-1006.
4. Roussel N, Nijs J, Truijen S, Vervecken L, Mottram S, Stassijns G. Altered breathing patterns during lumbopelvic motor control tests in chronic low back pain: a case–control study. European Spine Journal.,2009:18(7):1066-73.
5. Janssens L, Brumagne S, Polspoel K, Troosters T, McConnell A. The effect of inspiratory muscles fatigue on postural control in people with and without recurrent low back pain. Spine.,2010:35(10):1088-94.
6. Chaitow L. Breathing pattern disorders, motor control, and low back pain. Journal of osteopathic medicine.,2004:7(1):33-40.
7. AllisonG, MarshallR, SingerK. EMG signal amplitude normalisation technique in stretch-shortening cycle movements. Journal of Electromyography and Kinesiology,1993:3:236-244.
8. Kim E, Lee H. The effects of deep abdominal muscle strengthening exercises on respiratory function and lumbar stability. Journal of physical therapy science.,2013:25(6):663-5.
9. Obayashi H, Urabe Y, Yamanaka Y, Okuma R. Effects of respiratory-muscle exercise on spinal curvature. Journal of sport rehabilitation.,2012:21(1):63-8.
10. Gopaladhas S, Panigrah A, Chinnavan E, Ragupath R. Effectiveness of resisted abdominal exercise versus resisted diaphragmatic breathing exercise on cardio vascular endurance in sports men. International Journal of Medical Research & Health Sciences.,2014:3(4):785-9.
11. Hodges PW, Eriksson AE, Shirley D, *et al*.: Intra-abdominal pressure increases stiffness of the lumbar spine. J Biomech,2005:38:1873-1880.
12. Romer LM, McConnell AK, Jones DA. Effects of inspiratory muscle training upon recovery time during high intensity, repetitive sprint activity. Int J Sports Med.,2002:23:353-360
13. Kisner C, Colby LA. Therapeutic Exercise Foundations and Technique. Philadelphia: F. A. Davis Company; 2007. Chapter 25, Management of Pulmonary Conditions, (5), 851-882.
14. Stephanie J Enright, Viswanathan B Unninathan, Clare Heward, Louise Withnall, David H Davies: Effect of High-Intensity Inspiratory Muscle Training on Lung Volumes, Diaphragm Thickness, and Exercise Capacity in Subjects Who Are Healthy. Phys Ther.,2006:86(3):345-54.
15. van Adrichem JAM van der Korst JK. Assessment of the flexibility of the lumbar spine. Scandinavian Journal of Rheumatology,1973:2:87-91.
16. Lee HY, Cheon SH, Yong MS. Effect of diaphragm breathing exercise applied on the basis of overload principle. Journal of physical therapy science.,2017:29(6):1054-6.
17. Finta R, Nagy E, Bender T. The effect of diaphragm training on lumbar stabilizer muscles: a new concept for improving segmental stability in the case of low back pain. Journal of pain research.,2018:11:3031.
18. Battié M C, Bigos S J, Sheehy A. Spinal flexibility and individual factors that influence it. PhysTher.,1987:67(5):653-658.
19. Leanne NC, Warren T J. Current standards for measuring spinal range of motion for impairment. J Chiropr Med.,2003:2(1):8-12.
20. Brilla LR, Kauffman TH. Effect of Inspiratory Muscle Training and Core Exercise Training on Core Functional Tests. Journal of Professional Exercise Physiology., 2014, 17(3).
21. Cho HY, Kim EH, Kim J. Effects of the CORE exercise program on pain and active range of motion in patients with chronic low back pain. Journal of physical therapy science.,2014:26(8):1237-40.
22. Yang EJ, Park WB, Shin HI, Lim JY. The effect of back school integrated with core strengthening in patients with chronic low-back pain. American journal of physical medicine & rehabilitation.,2010:89(9):744-54.
23. Bhadauria EA, Gurudut P. Comparative effectiveness of lumbar stabilization, dynamic strengthening, and Pilates on chronic low back pain: randomized clinical trial. Journal of exercise rehabilitation.,2017:13(4):477.
24. Janssens L, McConnell AK, Pijnenburg M, Claeys K, Goossens N, Lysens R, *et al*. Inspiratory muscle training affects proprioceptive use and low back pain. Medicine & science in sports & exercise.,2015:47(1):12-9.

25. Lamberg EM, Hagins M. The effects of low back pain on natural breath control during a lowering task. Eur J Appl Physiol.,2012:112(10):3519-24
26. Balagué F, Mannion AF, Pellisé F, Cedraschi C. Non-specific low back pain. Lancet,2012:379:482-491.
27. Biering-Sørensen F. A prospective study of low back pain in a general population. I. Occurrence, recurrence and aetiology. Scand J Rehabil Med,1983:15:71-79.
28. Black LF, Hyatt RE. Maximal respiratory pressures: normal values and relationship to age and sex. Am Rev Respir Dis.,1969:99(5):696-702.
29. Borghi-Silva A, Oliveira CC, Carrascosa C, *et al*. Respiratory muscle unloading improves leg muscle oxygenation during exercise in patients with COPD. Thorax.,2008:63(10):910.
30. Hides JA, Jull GA, Richardson CA: Long-term effects of specific stabilizing exercises for first-episode low back pain. Spine, 2001, 2.
31. Kumar SP: Efficacy of segmental stabilization exercise for lumbar segmental instability in patients with mechanical low back pain: a randomized placebo controlled crossover study. N Am J Med Sci,2011:3:456-461.
32. Waddell G: 1987 Volvo award in clinical sciences. A new clinical model for the treatment of low-back pain. Spine,1987:12:632-44.
33. Staal JB, Hlobil H, van Tulder MW, *et al*: Occupational health guidelines for the management of low back pain: An international comparison. Occup Environ Med,2003:60:618-26.
34. Al-Bilbeisi F, Mc CF. Diaphragm recruitment during nonrespiratory activities. American Journal of Respiratory Critical Care Medicine,2000:162:456-459.
35. Axler CT, McGill SM. Low back loads over a variety of abdominal exercises: searching for the safest abdominal challenge. Medicine and Science in Sports and Exercise,1997:29:804-811.