EFFECT OF ABDOMINAL DRAWING-IN MANEUVER ALONG WITH RESISTED ANKLE DORSI-FLEXION TO ACTIVATE TRANSVERSE ABDOMINIS MUSCLE IN CHRONIC NON-SPECIFIC LOW BACK PAIN

EFECTUL MANEVREI DE VACUUM ABDOMINAL ASOCIATĂ CU DORSIFLEXIA CU REZISTENȚĂ PENTRU ACTIVAREA MUȘCHIULUI TRANSVERS ABDOMINAL ÎN DUREREA NESPECIFICĂ LOMBARĂ CRONICĂ

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Keywords: abdominal draw-in maneuver, irradiation, transverse abdominis, chronic non-specific low back pain, pressure biofeedback unit

Abstract

Introduction. Chronic non-specific low back pain (CNSLBP) is a disorder of frequently unknown etiology. Impairments in motor control (MC) have been frequently associated with CNSLBP disorder. The abdominal draw-in maneuver (ADIM) is commonly used during core stabilization techniques to restore neuromuscular control.

Scope. This study was done to investigate effectiveness of ADIM along with resisted ankle dorsiflexion (RADF) on changes in activation score of transverse abdominis (TrA) muscle using pressure biofeedback unit (PBU) in CNSLBP patients. It was a single blind randomized controlled trial.

Method. Sixty subjects with CNSLBP were randomly assigned into two groups. The subjects in Group-A (experimental group) performed ADIM along with RADF, and the subjects in Group-B (control group) performed ADIM alone. The activation score of TrA, pain and back related disability; were measured by PBU, Numeric Pain Rating scale (NPRS) and Roland-Morris disability questionnaire (RMDQ) respectively.

Resuls. Activation score of TrA, NPRS and RMDQ showed significant improvement in experimental group ($p<0.05$) than control group.

Conclusion. The result of the study suggests the use of ADIM along with RADF for effective management of CNSLBP patients to restore neuromuscular control.

Cuvinte cheie: tehnica de vacuum abdominal, iradiere, transvers abdominal, durere croică lombară nespecifică,unitate de biofeedback presor

Rezumat

Introducere. Durerea cronică lombară nespecifică (CNSLBP) este o afecțiune cu etiologie frecvent necunoscută. Tulburări ale controlului motor motor (MC) au fost associate frecvent cu CNSLBP.Manevra de vacuum abdominal (ADIM) se folosește adesea în tehnica de stabilizare a musculaturii posturale pentru retaurarea controlului neuromuscular.

Scop. Acest studiu are ca scop investigarea eficienței ADIM combinată cu dorsiflexia cu rezistență (RADF) în modificarea gradului de activare a transversului abdominal (TrA), folosind unitatea de biofeedback presor (PBU) la pacienții cu CNSLBP. Este vorba despre un studiu randomizat.

Metodă. Șaizeci de subiecți cu CNSLBP au fost împărțiți aleator în două grupuri. SUbiecții din grupul A (grupul experimental) au efectuat ADIM asociat cu RADF, iar suniceții din grupul B (grupul de control) a efectuat doar ADIM. Scorul de activare al TrA, durerea și disabilitatea lombară asociată au fost evaluate cu ajutorul PBU, Scala Numerică de evaluare a durerii (NPRS) și chestionarul Roland-Morris de evaluare a disabilității (RMDQ).

Rezultate. Scorul de activare al TrA,NPRS și RMDQ au arătat îmbunătățiri semnificative la grupul experimental ($p<0.05$) față de grupul de control.

Concluzii. Rezultatele studiului sugerează căfolosirea ADIM asociată cu RADF sunt eficiente în managementul durerii la pacienții cu CNSLBP și pentru restabilirea controlului neuromuscular.

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Introduction

Low back pain is one of the main causes of disability and despite its high prevalence the source of pain is not established in the majority of cases and the term "non-specific low back pain" is used. [1]About 90% of the patients with low back pain will receive the diagnosis 'non-specific low back pain' (NSLBP). [2]A term that signifies that no specific pathology or disease e.g., infection, tumor, osteoporosis, fracture, structural deformity etc exists. Although pain improves rapidly in the first month with a typical episode of NSLBP, low levels of pain may continue for many months. [3]

One factor that has been proposed as important in genesis and persistence of NSLBP is stability and control of spine. Studies of individuals with LBP have identified impairments in the control of deep trunk muscles [e.g., TrA and multifidus (MF)] responsible for maintaining the stability of spine. [4]These muscles could be dysfunctional in back pain patients.

The local muscles may not be able to maintain prolonged or sustained muscle contraction in order to protect continuously any unstable spinal segments, which could leave the LBP patient vulnerable to persistent strain and pain. [5]Panjabi reported evidences of lumbar instability, low muscular strength and endurance among subjects with LBP. Instability could be a result of tissue damage, making the segment more difficult to stabilize, low muscular control, and is usually a combination of all three. These three components are interdependent and one system could compensate for deficits in another. [6]Richardson *et al* reported that abdominal exercises were appropriate as trunk stabilization exercises that correct neutral spinal postures in response to body rotations caused by external force, since these exercises reduce the contraction of the rectus abdominis and cause the co-contraction of the external oblique, internal oblique and the transversus abdominis muscle. Methods of trunk stabilization includes, increasing the resistance and the number of the exercisesincluding abdominal bracing, curl-ups, lateral bridges, wall squats and stabilization exercises using a ball; increasing the instability of the bearing surface using foam-rollers, balance boards, or Swiss-balls; and increasing the intensity of exercises. [7,8,9]Evidence on the conservative management of LBP suggests that the restoration of neuromuscular control in the TrA muscle, together with minimal contraction of other superficial internal and external abdominal oblique muscles, is essential for effective treatment during the early stages of rehabilitation. [10]

The ADIMis commonly used as core stabilization technique to restore neuromuscular control. ADIM in particular, is more effective than the use of general core stabilization techniques in improving the cross-sectional area of the TrA muscles. [11]One important mechanism by which core stabilization exercise increases the neuromuscular function of the TrA and associated lumbar spinal stability is neuromechanical stiffening of the thoracolumbar fascia (TLF). [12]. The synergistic contraction of the TrA and posterior fibers of the internal oblique (IO) increases the postero-lateral lumbar tension on the TLF that connects to the spinous and transverse processes of the lumbar spine.

The irradiation technique, which emphasizes the important contribution of the relatively stronger distal muscle group by increasing the number of potential motor-unit recruitment in muscles involved or weakened. [13,14,15]Possibly, irradiation technique may stimulate the, deep TrA muscles selectively through RADF when used in combination of with the ADIM and thus enhancing lumbar spinal stability. When ADIM is performed, the activated TrA draws the abdominal wall inward whileconcurrently forcing the viscera upward into the diaphragm and downward into the pelvic floor. Co-activation of the TrA and IO (TrA/IO) together with the TLF generates intra-abdominal pressure, which transforms the abdomen into a mechanically rigid cylinder, providing spinal stability. [16]

RADFis used to augment the TrA/IO via co-contraction for improving the selective activation of deep core muscles. Chon *et al* reported that co-activation of the ankle dorsiflexors and rectus femoris (RF) muscles effectively augmented the selective activation of the TrA muscle, as demonstrated by increased mean EMG amplitude of the TrA/IO muscles after the

RADF. [13] Also evidence is there that core stabilization exercises can contribute to deep abdominal contraction to improve TrA muscle activation in normal healthy individual. [13]Chon SC, You JH and Saliba SAdemonstrated that a cocontraction of the ankle dorsiflexors with ADIM training might result in a thickness change in the TrA muscle and associated pain management in patients with CNSLBP. [17]

Pourpose

It was hypothesized that the selective increase in activation score of TrA muscle using PBU would be greater in the experimental group (which performed both the ADIM and RADF) compared with the control group (which performed the ADIM alone).

Matherial and Methods

Participants

Table 1: Demographic data of participants (n=60), expressed as mean (standard deviation)

	Experimental (n=30)	Control (n=30)
Age (years)	28.7 (6.924)	28.7 (5.535)
Males	15	16
Females	15	14

Over 4 months (December 2013 to March 2015) 60 male and female individuals with CNSLBP were included in the study based on the inclusion criteria: (a) Age group 18-42 years; (b) CNSLBP (>3 months); (c) Both males and females. Participants were excluded if they have: (a) lumbar injury; (b)inability to contract the abdominal muscles; (c) pressure reduction of <2 mmHg; (d) prolapsed disk, spondylolisthesis, fracture involving spine etc.

The sample size calculated was 26 subjects per group based on a power of 80% at α=0.05 to detect large differences in effect size between the groups. However, 30 subjects per group were recruited to compensate for drop-outs. There wereno drop-outs in this study. Prospective random sampling was used in the study. The consent was taken from every subject and the study was approved by institutional ethical committee. Table-1 presents the demographic characteristics of the participants.

Procedure:

The baseline data werecollectedprior to the intervention. TrA activation measuredby PBU, Pain by NPRS and disability by the RMDQ; and then participants underwent for training program for 5-days per week for 2 weeks.

Measurement of the baseline data:

ADIM Test: All participants received basic information about the function of the TrA muscle, as well as about the procedure of testing and training the TrA muscle contraction. All subjects were previously instructed to fast for 2 hours prior to testing (including water), empty the bladder immediately before the tests and not performabdominal exercises prior to the tests.

- Starting position: Participants were positioned in a prone position on a hard surface, with the lower limbs positioned with the feet off the plinth and arms beside the trunk. The inflatable bag from the PBU was placed between the anterior superior iliac spine and the navel. Before starting the contractions, the bag was inflated to a pressure of 70 mmHg with the valve closed. To avoid muscle substitution activation patterns and ensure measurement consistency, subjects were instructed to inhale and then exhale just prior to performing the ADIM.

- Patients were requested to perform TrA muscle contractions with the following verbal commands standardized by the examiner: "Draw in your abdomen without moving the spine or pelvis" and maintain these contractions for 10 seconds. According to the manufacturer of the PBU, the ability to contract the TrA muscle results in a pressure reduction from 4 to 10 mmHg over 10 seconds, which is recorded by PBU. [18] Activation score is amount of pressure level the subject is able to achieve.
- After the baseline scores were recorded; all subjects received standardized instructions and training on technique of performing the ADIM before the actual intervention was started.

Intervention:

Both groups performed an PBU-guided (visual feedback) ADIM for 10 repetitions per day, 5 days per week over a 2 week period, with RADF added in the experimental group. The success of ADIM was assessed by monitoring activation score of TrA. Present study was limited in the sense that irradiation was not evaluated by monitoring the recruitment sequence of activation of the tibialis anterior, rectus femoris and TrA muscles of the right lower extremity by real time EMG.

On the first day of intervention subjects were asked to adopt a crook lying position. A PBU (Stabilizer) was placedbeneath their 5^{th}lumbar vertebrae to monitor lumbar movement during the measurement of abdominal drawing-in maneuver performance. Then patient were asked to hold the dial of PBU in their hand. Subjects were instructed to use the visual feedback provided by the analog gauge of the PBU in order to maintain the determined target pressure during the abdominal draw-in and subjects were verbally cued to draw-in their abdominal wall, with the intention to move their navel toward their low back and asked to maintain 40 mmHg pressure without contracting upper abdomen and gluteal region or spine, while maintaining a neutral pelvic position in attempt to keep the target pressure range (40 to 70 mmHg).Subjects were then asked to dorsal flex their ankle joint against the resistance [with 50% maximal voluntary isometric contraction (MVIC) of the tibialis anterior] provided by a Strap band and hold this position for approximately 10 seconds and repeat it for 10 times. [13] In control groupthe procedure remained same excluding RADF. Subjects were again tested in prone position after 2 weeks of intervention period as described for baseline data for both the groups.

Figure-2. Baseline /after 2-weeks post-treatment measurement being taken in Prone Lying position.

Figure-3. TrA training in crook lying position

Figure-4. TrA co-activation along with RADF.

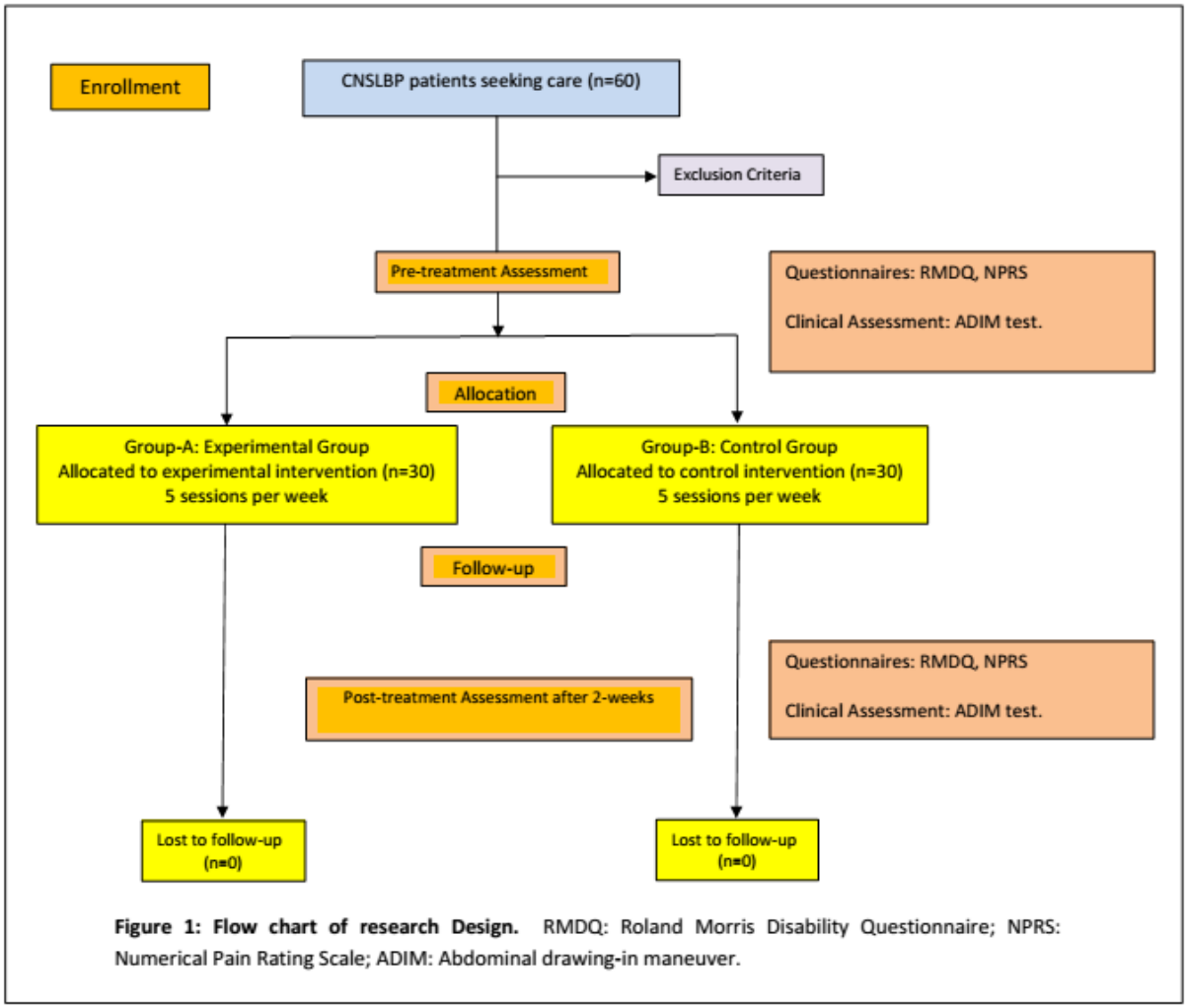

Figure 1: Flow chart of research Design. RMDQ: Roland Morris Disability Questionnaire; NPRS: Numerical Pain Rating Scale; ADIM: Abdominal drawing-in maneuver.

Statistical analysis

Between and within group comparisons were done using Mann-Whitney U test and Wilcoxon Signed rank test (Non-parametric tests) respectively. Statistical significance was set at $p<0.05$ for all statistical analyses and Statistical Package for Social Sciences version 20.0 (SPSS, IBM Company, USA) was used.

Results

The present study included participants (n=60) with mean age 28.7 ±6.24. The table- 1 & 2 show the pre- and post- comparison; and between group comparison for the measurement variables ADIM, NPRS and RMDQ.

Table-1: Pre- and post- comparison

Variables	Experimental group		Z-value	P-value	Control group		Z-value	P-value
	Mean	SD			Mean	SD		
ADIM Pre	68.16	1.26			68.30	1.70		
ADIM Post	65.93	1.20	-5.062	.000*	68.10	1.80	-2.121	0.34
NPRS Pre	5.73	.907			5.53	.90		
NPRS Post	2.76	1.27	-4.832	.000*	5.33	1.12	-1.890	0.59
RMDQ Pre	6.66	2.13			4.70	1.84		
RMDQ Post	3.00	2.31	-4.812	.000*	4.67	1.76	-1.000	.317

* Significant difference $p<0.05$

Table-2: Between group comparison

Variables	Experimental group		Control group		Z-value	P-value
	Mean	SD	Mean	SD		
ADIM Pre	68.16	1.26	68.30	1.70	-.893	.372
ADIM Post	65.93	1.20	68.10	1.80	-4.592	.000*
NPRS Pre	5.73	.907	5.53	.900	-.722	.470
NPRS Post	2.76	1.27	5.33	1.12	-5.773	.000*
RMDQ Pre	6.66	2.13	4.70	1.84	-3.418	.001
RMDQ Post	3.00	2.31	4.67	1.76	-3.061	.002*

* Significant difference $p<0.05$

Discussion

The present study showed marked improvement in activation of TrA, reduction in pain and disability score in experimental group than control group.A study conducted on chronic low back patients by O'Sullivan P *et al* also reported specific training of the deep abdominal muscles with co-contraction of lumbar multifidus showed a statistically significant reduction in pain intensity and functional disability levels. [19]

The present study used PBU which can be applied easily and is cost effective than ultrasound imagining because a study by Hides JA *et al* showedreliability of abdominal musculature measurementsfor recapturing the image and repetition across days ranged from low to high. [20].

The present study also supports the observations ofUrquhart DMet al. (2005), which states that inward movement of the lower abdominal wall in supine produces the most independent activity of TrA relative to the other abdominal muscles, recruitment varies between regions of TrA, and observation of abdominal and lumbopelvic motion may assist in evaluation of exercise performance. [21] This study also confirms that the TrA is invariably the first muscle that is active during movement of a lower limb following contralateral weight shifting and the CNS initiates contraction of the abdominal muscles and the multifidus in a feed-forward manner in advance of the prime mover of the lower limbwhich is in agreement with the study done by Hodges PW and Richardson CA.[22]

Findings of the present study also suggest that the ADIM along with RADF stimulates the selective recruitment of the TrA. A study by Chul Chon S.et al on healthy population andanother study by Chon SC, You JHand Saliba SA on LBP patients indicated that the combination of the ADIM and RADF was more effective in improving selective recruitment of the TrA muscle than the ADIM alone. [13,17] Moreover Wenlan Chai, So Hee Lee and Yu Hyung Park in their study also showed that abdominal muscle contraction exercises with Ankle Dorsiflexion in patients with LBP had an influence on abdominal muscle thickness and strength. [23]

However a study conductedby Gorbet Nathaniel et al(2010) between healthy and non-symptomatic LBP patients found no significant differences betweenactivation ratios of the two groups during either exercise and TrA activation during the ADIM was higher than the quadrupedexercise. [24]

Conclusion

It is observed that there is additive effect of RADF in selectively stimulating the activation of TrA muscle using PBU. This helps in reduction of pain andin reducing disability in CNSLBP population. Use of PBU enhances the activation of TrA because of visual feedback it provides to the participants.

Limitations

This study had a short follow-up period. Hence, this study should be conducted with longer follow-up period to see long term results.

Conflict of Interest: None.

Authors' Contribution:

SKD performed review of literature and collection of data; BD drafted the manuscript, designed and coordinated the study; TRA performed the statistical analysis, interpretation of data and review of manuscript.

Acknowledgements

We deeply thank Dr. M. T. Rangwala (Director, Sarvajanik College of Physiotherapy, Surat), Dr. Vaibhav Shah, Dr. Preety Thakkar, Dr. Hena Patel for their support and all the participants of the study for their cooperation.

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