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Effect of clamshell exercise on postpartum lumbo-pelvic stability and low back pain: a randomized controlled trial

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Abstract:

Background: Compensatory changes that occur during pregnancy affect the core muscle's function and balance, resulting in low back pain (LBP). Clamshell exercise, as a core stability exercise, targets the hip abductor muscles that are key muscles in hip stability and mobility. **Purpose:** This study aimed to determine the effect of clamshell exercise on lumbo-pelvic stability in LBP. **Participants and methods**: This randomized controlled trial was conducted on 40 females with postpartum LBP & pelvic instability, selected from outpatient clinic of specialist obstetrics and gynecology hospital in Port Said. Their age ranged from 25-35 years, and their body mass index (BMI) ranged from 25-30 kg/m^2. They were randomized into two equal groups; the control group A (n=20), performed abdominal bracing maneuver 3 times per week for 6 weeks, and the study group B (n=20), performed clamshell exercises 3 times per week for 6 weeks in addition to abdominal bracing maneuver as group A. The outcome measures were the visual analogue scale (VAS) for assessing LBP severity, Oswestry disability index (ODI) for assessing functional disability and quality of life, universal goniometry and special tests (dip test- runner pose test - single leg squat test) for lumbo-pelvic stability. **Results:** Within groups, there was a statistically significant difference ($P \leq 0.05$) when comparing pre-to-post study results in both groups, while no statistically significant difference was found between groups. **Conclusion:** clamshell exercises added to abdominal bracing improved lumbo-pelvic stability, decreased LBP and improved functional disability in postpartum women, with no difference between both intervention on any of the variables.

Keywords: Low Back Pain, Clamshell Exercise, Postpartum Women, Oswestry Disability Index.

INTRODUCTION

During pregnancy, the growing uterus causes significant changes in the musculoskeletal, mechanical, hormonal, and vascular systems of the body. Hormonal changes together with weight gain result into a series of changes in the musculoskeletal system. To counteract altered center of gravity, an exaggeration in the lumbar lordosis is developed, with both anterior neck flexion and downward shoulder movement. As the body adapts, the anterior stabilizers weaken due to physiological rectus abdominis muscles' separation, while the new center of gravity causes the lumbar stabilizing muscles to work more to keep a steady posture [1, 2].

These changes negatively affect the function of core muscles, causing LBP. Moreover, because of relaxin and progesterone hormones, alongside pregnancy mechanical effects, joint laxity becomes greater in preparation for childbirth [2]. This instability of the lumbo-pelvic region indicates reduced passive stability system efficiency, which must be compensated by the dynamic stability to guard against pain [3]. Besides, postpartum women (up to 6 months post-delivery) experience greater fatigability of the lumbo-pelvic stabilizing muscles [4].

LBP is one of the common problems in women that become more intense after delivery either with cesarean section or normal vaginal delivery. The postpartum backache prevalence among women delivered with cesarean section is 56.67%, compared to women delivered with normal vaginal delivery, which is 33.33% [5].

Management of LBP includes both pharmacological and non-pharmacological interventions. However, the main components of LBP treatment include kinesio taping, acupressure [6] dry cupping therapy at acupoint BL23 [7], spinal mobilization [8], pelvic floor muscle exercises, stabilizing exercises [9], taping [10], and transcutaneous electric nerve stimulation [11].

Core represents lumbo-pelvic-hip complex, including the muscular box with the diaphragm, abdominal, gluteal, para spinal, and the pelvic floor muscles. These muscles work as spinopelvic dynamic stabilizers. A defect in these muscles could result in spinal mechanical instability [3]. Core stabilization is an integration of passive, active, and neural control subsystems, which are coordinated by neuromuscular control for dynamic stabilization [12]. Core stability training can positively affect the motor recovery of trunk and lower extremity, hip muscle strength, gait speed, functional ability and activities of daily living [13, 14].

Abdominal bracing exercise, a technique that aids lumber spine stability, is defined as a co-contraction of both superficial and deep abdominal muscles [15, 16]. It is considered an effective exercise technique that is often recommended in rehabilitation and fitness programs to prevent or reduce diastasis of the rectus abdominis muscle in the postpartum women [17].

The clamshell exercise is a core stability exercise that is intended to target the hip abductors, more specifically the gluteus Medius, while diminishing the tensor fascia latae activity [18, 19] and improve activity of the hip extensors and abdominal muscles in patients with LBP [20]. The clamshell exercise, by selectively strengthening muscles required to maintain standing posture, can improve trunk control, reduce sway and improve weight distribution and increase balance ability [21].

Although previous studies have examined the importance of targeted exercises like clamshells in helping stroke patients regain vital motor functions and balance. [21], research is lacking in terms of its effectiveness on postpartum LBP and lumbo-pelvic stability. Thus, was the aim of the present study to hypothesize that clamshell exercise would impact both trunk control and balance?.

MATERIALS AND METHODS

Participants and recruitment

Fifty postpartum women with LBP were initially recruited for the study, using flyers and direct interviews, from the outpatient clinic of specialist obstetrics and gynecology hospital in Port Said. Women were selected using convenience sampling from those suffering from postpartum LBP and lumbo-pelvic instability who delivered by vaginal or cesarean delivery. They were included if their ages ranged from 25-35 years and their BMI from 25-30 kg/m2. Women were ineligible to participate if they had spinal and/or lower limb deformity, osteosarcoma, bad general health, mental disorders, or performed any physical exercise at the time of the study [3].

Participants were randomly assigned using a computer-generated sequence created with Randomizer.org to provide codes for women. The codes were then included in opaque envelopes opened by an independent research assistant to ensure random assignment of women to groups. They were randomly assigned into two equal groups.

Assessment procedure

The study outcomes involved lumbo-pelvic stability, evaluated by goniometer and three special tests, as the primary outcome, and both pain intensity and functional disability, measured by visual analogue scale (VAS) and Oswestry disability index (ODI), respectively, as secondary outcomes.

For assessing back pain intensity, VAS was used for all females in both groups (A&B) before and after the study. It consists of a 10 cm line anchored with “no pain” on the left end and “extreme pain” on the right end. VAS is a valid tool for pain assessment [22], with high test-retest reliability (ICC= 0.90). It was proved suitable for use in clinical practice [23].

For evaluating lumbo-pelvic stability, universal goniometer and three special tests were used for all females in both groups (A&B). The goniometer has shown good test-retest reliability (ICC = 0.95; $p < 0.05$) [24]. Special tests that were done for the dominant side; the dip test, the runner pose test [25], and the single leg squat test [26], have been shown to be reliable.

Regarding functional disability related to back pain, ODI was used for all females in both groups (A&B). The ODI questionnaire which evaluate the impact of daily activates is a reliable and valid tool suitable for measuring disability in patients with LBP, which consists of ten evaluating items concerning pain, personal care, lifting, traveling, setting, standing, and walking abilities, social life, and sleep [27].

Treatment interventions

All women in both groups (A&B) performed abdominal bracing exercise 3 times/ week for six weeks. Each woman was asked to walk 10 meters with abdominal contraction, in a state as if someone was about to strike the stomach, while breathing naturally. To minimize muscle fatigue, women were given a 1-minute rest time after walking 10 meters and returning to the origin starting position. After completing the 10 meters for three times, women were allowed to rest for 3 minutes [28].

Women in the study group were instructed to perform clamshell exercie clamshell exercises 3 times per week for 6 weeks in addition to abdominal bracing maneuver. Each woman was positioned in the side lying, with the pelvis and the spine in neutral position, the hips bent at 45° and the knees flexed to 90°. The top knee was abducted as far as possible, while keeping the heels together [29]. The position was maintained for 5 seconds in the abduction and then returned to the starting position. The exercise was done bilaterally and repeated 10 times, with rest for 1 minute between sets to minimize muscle fatigue [21].

Sample size and statistical analysis

Sample size calculation was done considering lumbo-pelvic stability the primary outcome [30], with 80% power considered at $\alpha = 0.05$, two measurements, for 2 groups and effect size of 0.52 using F-test MANOVA for within and between interaction effects. The minimal sample size was identified as 32 women, adding 8 (25%) women for drop out, so total sample size required was 40 women, 20 in each group. Sample size calculation was done utilizing specific software (G*Power, version 3.0.10).

Data was analyzed using statistical packages for the social sciences (SPSS) (version 20 for Windows; SPSS Inc., Chicago, Illinois, USA). Shapiro-Wilk test was used for testing normality of data distribution. Descriptive data were expressed as mean ± standard deviation (SD), median (IR) and number (%) whenever applicable. Unpaired t-test and chi square were used to compare between-groups subject characteristics. MANOVA was conducted for comparing within and between groups' effects for parametric variables (lumbo-pelvic stability) and Wilcoxon and Mann-Whitney tests for non-parametric variables (VAS, special tests and functional disability). P value ≤ 0.05 was considered significant.

RESULTS

Out of 50 women selected, 10 were excluded (six of them did not meet the inclusion criteria, and 4 women refused to participate). Only 40 met the requirements for incorporation, completed the assessment and treatment procedures and final analysis, (Fig.1).

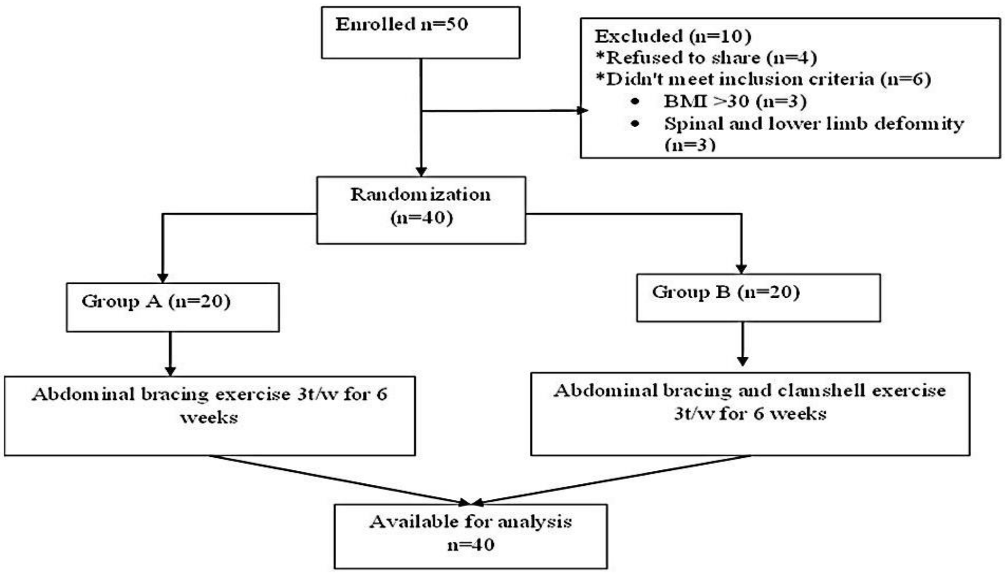

Fig. (1): Flow chart of study participants.

Concerning the basic characteristics of the enrolled women, as presented in (Table 1), there were no statistically significant differences ($P > 0.05$) between women in both groups.

Table (1): Demographic data of women in both groups (A&B) (n=40).

Basic criteria	Group A	Group B	t-value	p-value
	Mean ± SD			
Age (years)	28±3	28.8±3.2	-0.82	0.4
Weight (kg	75.2±10.9	78.9±11.6	-0.09	0.9
Height (cm)	162.8±7.5	163±5.9	-1.04	0.3
BMI (kg/m²)	28.2±2.6	29.4±3.6	-1.27	0.2
Number of deliveries	**Number (%)**			
Once	13 (65%)	13 (65%)		
Twice	3 (15%)	5 (25%)	χ^2 = 1.7	0.637
≥ Three times	4 (20%)	2 (10%)		

Data is expressed as mean ± standard deviation and number (%), χ^2: chi square

As presented in table 2, both control and study groups showed a statistically significant post treatment improvement in lumbo-pelvic stability, measured by the goniometer. Stability improved by 14% and 17.4% in the control and study groups, respectively with no statistically significant difference between both groups. The results of the special tests post-intervention were estimated using a t-test, single leg squat test significantly improved in both groups with the percentage of women achieving good ratings increased from 45% to 85% in the control group and from 25% to 95% in the study group, with no difference between both groups post-intervention. Dip test ability improved to 100% (n=40) of women achieving good ratings in both groups post treatment, when compared to a pre-treatment baseline of 55%. For the last test (runner pose), scores also increased in both groups, from 5% to 40% in the control group and 5% to 50% in the study group.

For pain scores, there was a statistically significant reduction of 40% in the control group A and 45% in study group B, with no difference between both groups. Regarding disability scores, within group post-intervention results showed an improvement of 62.5% and 57% for the control and study groups, respectively, with no difference between groups (Table 2).

Table (2): Pairwise comparison of dependent variables in both groups (n=40)

Measured variables	Group A	Group B	P-value (between groups)
Lumbo-pelvic stability	**Mean ± SD**		
Goniometer measurement (degree)			
Pre-treatment	41.3 ± 12.3	41.4 ± 17	0.985
Post-treatment	35.5 ± 13.7	34.2 ± 15	0.825
%of change	14%	17.4%	
P-value	0.001*	0.001*	
Special tests	**Number (%)**		
Single leg squat			
Pre-treatment			
Good	9 (45)	5 (25)	0.320
Poor	11 (55)	15 (75)	
Post-treatment			
Good	17 (85)	19 (95)	0.605
Poor	3 (15)	1 (5)	
P-value (chi square test)	0.019*	0.001*	
Runner-pose test			
Pre-treatment			
Good	1(5)	1 (5)	1.000
Poor	19 (95)	19 (95)	
Post-treatment			
Good	8 (40)	10 (50)	0.751
Poor	12 (60)	10 (50)	
P-value (chi square test)	0.020*	0.003*	
Pain (cm)	**Median (IR)**		
Pre-treatment	5 (4-6)	5.5 (4-7)	0.417
Post-treatment	3 (2-4.7)	3 (2-5)	0.793

% of change	40%	45%	
P-value (Wilcoxon test)	0.002*	0.001*	
ODI (%)			
Pre-treatment	16 (12.5-22)	21 (16-26)	0.077
Post-treatment	6 (4-12)	9 (4.5-13.5)	0.307
% of change	62.5%	57%	
P-value (Wilcoxon test)	0.001*	0.001*	

SD: standard deviation, *: significant, IR: interquartile range, *: significant with P value < 0.05.

ODI: Oswestry disability index.

DISCUSSION

LBP is a frequently reported chronic condition among postpartum women. It results in discomfort in the lower back that may radiate the hips, legs, and buttocks [31]. Improving core muscle strength and neuromuscular control is widely recognized as a primary strategy to alleviate LBP and improve functional performance [32, 33].

This study was designed to evaluate the effect of abdominal bracing added to clamshell exercises on lumbo-pelvic stability and LBP in postpartum women. The present study revealed significant improvement in all study variables in both groups post treatment with no significant difference between both groups.

The present study revealed significant improvements in lumbo-pelvic stability, functional disability scores, and pain intensity in both the control and study groups. Also, better performances in functional tests were noticed in both groups, without statistically significant difference between groups.

Lumbo pelvic stability

The findings of the control group, who performed abdominal bracing revealed increased stability indicated by goniometer assessment and performance in the functional tests. Abdominal bracing was proved to improve the stability of lumbo-pelvic complex by engaging the trunk muscles and creating intra-abdominal pressure. This prevents excessive pelvic and lumbar movement. A study done by Park et al. [21] and Aleksiev et al. [35] stated that adding abdominal bracing to spine stability exercises significantly improved spinal extensor strength, discomfort, and function in individuals with chronic LBP compared to performing stabilization exercises only, especially at greater degrees of spinal flexion [34, 35].

This could be explained by the ability of abdominal bracing to increase trunk rigidity and support, reducing compensatory lumbar motion and mechanical load on the spine. Also, this type of exercise helps stabilize the core, permitting more efficient hip function and reducing lumbar compensatory movements [36].

Moreover, abdominal bracing helps improve the performance of functional tests by keeping the trunk rigidity and inhibiting unwanted spino-pelvic movements during dynamic lower limb exercises. Improved trunk stability allows for greater control of the pelvis and lumbar spine, indicated by increased rates of achieving good performance observed on post-intervention results of the control group [37].

In the study group, who performed clamshell exercises added to abdominal bracing, there was a statistically significant improvement in lumbopelvic stability post intervention. This could be attributed to the effect of clamshell exercises added to abdominal bracing on gluteal muscles that are crucial for pelvic stability as well as hip mobility. This explanation could be supported by the fact that individuals complaining of LBP commonly have weakened gluteal muscles, resulting in poor pelvic control and lumbar compensation [38, 39].

Based on the known biomechanical relationship between hip mobility, hip stability, and lumbar spine, when hip motion is restricted or hip muscles are weak, the lumbar spine compensates with abnormal movement, increasing stress and risk of pain. Clamshell exercise was found to enhance hip mobility and strengthen the gluteus Medius and maximus, allowing for more uniform force distribution and reducing the lumbar load [40].

Similarly, clamshell exercises were found to improve functional movements by enhancing hip abductor strength and neuromuscular control, which both are required for pelvic stability during single-leg and dynamic tasks. Strengthening the gluteus Medius was reported to reduce common compensatory movements in cases with LBP in the form of pelvic drop and lateral trunk lean. That could help maintain proper alignment during movement [40, 41].

Pain severity and functional disability

Considering the control group, recent studies have shown that combining abdominal bracing with exercises for spinal stability leads to better reductions in pain and disability than performing stabilization exercises alone. A possible cause is greater mechanical stability, higher spinal extensor strength, and improved neuromuscular control that eventually lessen abnormal spinal motion and pain. Studies have also shown that regular exercising together with abdominal bracing are useful in avoiding recurrence and lowering the frequency and duration of LBP [42, 43].

For the study group receiving clamshell exercises added to abdominal bracing, the mechanism behind pain relief and improving functional abilities includes boosting gluteus Medius strength and reducing compensatory lumbar motions and mechanical strain. Clamshell exercises reduce aberrant lumbar loading and increase function by restoring hip strength and pelvic alignment [38, 40, 41].

According to the current study findings, clamshell exercises added to abdominal bracing could address LBP and lumbo-pelvic instability in distinct ways. For instance, abdominal bracing improves core stability and inhibits compensatory lumbar movement, whereas clamshell exercises directly increase hip stability and mobility. This combined strategy promotes adequate lumbo-pelvic function and effective LBP treatment..

Conclusion

Based on the study results, it could be concluded that clamshell exercises added to abdominal bracing could improve lumbo-pelvic stability, decreased LBP intensity and improved functional disability in women with postpartum LBP and lumbo-pelvic instability. Nevertheless, no intervention was found to be superior to the other regarding any of the measured outcomes.

Abbreviations:

BMI: Body mass index.
ICC: Intraclass correlation coefficient.
IR: Interquartile range
LBP: Low back pain.
ODI: Oswestry disability index.
SD: Stander deviation.
SPSS: Statistical package for social sciences.
VAS: Visual analogue scale.

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