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Effect of Ultrasound Cavitation on lumbar hyperlordosis in Obese Postnatal Women with Diastasis Recti: A randomized controlled trial

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Abstract

Objective: *This study was conducted to determine the effect of ultrasound cavitation (UC) on lumbar hyperlordosis in obese postnatal women with diastasis recti.*

Subjects and Methods: *Sixty obese multiparous women with diastasis rectus abdominis (DRA), their ages ranged from 25 to 35 years, their BMI was more than 30 Kg/ m^2. All women had lumbar hyper lordosis, and their mode of delivery was normal vaginal delivery. All women were divided randomly into two equal groups (A & B). Each group consist of 30 women, Group A (control group) treated by low caloric diet regimen only (1600-2000 Kcal/ day) designed by nutritionist throughout the whole treatment program for two months. Group B (study group) treated by ultrasound cavitation on the abdominal area for 30 minutes, twice weekly for two months in addition to low caloric diet regimen for two months. The lumbar lordotic angle was measured using the spinal mouse before and after two months of treatment for each woman in both groups (A & B).*

Results*: Within groups, there was statistically significant improvement post-treatment versus pre-treatment in lumbar lordotic angle) ($p < 0.05$), between groups; pre-treatment, there was no significant difference between both groups (A & B) in lumbar lordotic angle. While, post treatment, there was a significant difference between both groups (A & B) in lumbar lordotic angle (more decrease in group B) .*

Conclusion: *Using UC on the abdominal area was effective on reducing lumbar hyper lordosis in obese postnatal women with diastasis recti.*

Keywords: *Ultrasound cavitation - Diastasis recti – lumbar hyperlordosis - Postnatal women.*

1. Introduction

The postnatal period is the time after childbirth, it is so critical to the health and survival of the mother and her newborn [1]. During this period, mothers often overlook their own issues leading to persistent and recurring challenges [2]. One of the most common challenges that appear during late pregnancy and could persist into the postpartum period is the rectus diastasis abdominis (RDA) [3]. RDA causes many postnatal musculoskeletal problems that stress the spine and lumbo pelvic region, leading to chronic low back pain [4]. Among postpartum women with diastasis recti, 31.5% were primiparous versus 68.5% multiparous, indicating a higher prevalence with multiple births [3]. RDA is defined as linea alba (LA) widening and rectus abdominis muscle separation by over 2 cm at the midline [5]. Diagnostic ultrasonography could be used to measure the RDA [6]. Pregnancy hormones like relaxin, progesterone, and estrogen combined with uterine enlargement can overstretch abdominal muscles, facilitating diastasis recti emergence [7]. DRA alters abdominal/pelvic muscle angles and reduces their function in maintaining lumbopelvic stability. This may potentially lead to pelvic and spinal injuries [5] [7] [8]. Lumbar hyperlordosis is from the serious complications of untreated RDA postpartum, as RD affects the stabilization of the trunk and pelvis, potentially compromises posture and increases discomfort in the lumbo-pelvic and hip regions [9] [10]. RDA could lead to lumbar hyperlordosis as the baby grows inside the uterus and the maternal rib cage expands anteriorly and laterally, so rectus abdominis muscle elongate. It leads to anterior pelvic tilt and exaggerated lumbar hyperlordosis to compensate for this weakness anteriorly [11]. Another explanation is the hormonal induced laxity of ligaments during pregnancy, which could exacerbates the issue of lumbar hyperlordosis [9]. Foetal macrosomia, polyhydramnios and obese moms are very common factors developing RDA [3]. Carrying excess abdominal fats could increase separation of the linea alba (LA) through exerting pressure against the LA similar to pressure generated by a growing pregnant uterus and increasing the chance of developing RDA and its subsequent complications [11]. Therefore, it is significant to focus on reducing abdominal obesity to create a well-organized intervention program to treatment RDA and its subsequent health complications. There are so many noninvasive physical therapy modalities could be used to reduce abdominal obesity, such as: Cryotherapy, radiofrequency and ultrasound cavitation (UC) [12]. UC is one of the non-invasive safe techniques used to reduce abdominal fats and waist circumference (WC), besides improving the appearance of body shape in a simple and a safe manner [13]. UC in lipolysis targets a depth of 1.5 cm to break down fats. Following the breakdown, triglycerides are released into the interstitial space and transported to the hepatobiliary system through the lymphatic drainage [14]. Endogenous lipases metabolize each triglyceride into glycerol and three molecules of FFAs. Glycerol, being water-soluble, is absorbed into the circulatory system for energy recycling. FFAs, being hydrophobic, bind to transport proteins, primarily albumin and then conveyed to the liver for processing as other fatty acids [14]. So, this study aimed to investigate the effect of ultrasound cavitation on lumbar hyperlordosis in obese postnatal women with diastasis recti.

Materials and methods

The study was designed as a randomized controlled trial with two groups pre-test post-test design. Participants were randomly chosen from outpatient clinic of obstetrics and gynaecology department, El Minya University Hospital, in El Minya. The study's protocol was explained in detail to each woman and informed consent was obtained prior to participation. This work adhered to the principles outlined in the Declaration of Helsinki for the ethical conduct of research regarding human subjects. It was carried out from June 2023 till October 2023.

Participants

Sixty obese multiparous women diagnosed with DRA more than 2.5 cm and less than 4 cm in supra umbilical region and with lumbar hyper lordosis were selected randomly from outpatient clinic of obstetrics and gynaecology department, El Minya University Hospital, in El Minya, Egypt. Females

included in the study were between the ages 25- 35 years, with BMI more than 30 Kg/ m^2, from 2: 5 months postnatal and their mode of delivery was normal vaginal delivery. Females excluded from this study if they had previous caesarean section, previous abdominal and back operation, spinal disorders, abdominal skin diseases, serious diseases such as heart disease, uncontrolled diabetes, hypertension, liver or renal failure and finally any other contraindication for body sculpting-weight loss.

Randomization

Randomization was done to eliminate the researches' bias; 60 women were randomly divided into two equal groups (control group and study group) through computer generated numbers using SPSS for windows version 23 (USA). Cards were put in sealed envelopes. The participants were allocated to their groups according to the cards chosen by an external blinded researcher who opened the closed envelopes; Inside each envelope, a letter was enclosed to specify whether the participant would be allocated to the control or study group.

Interventions

Group (A) (control group) consisted of thirty obese women with postnatal diastasis recti, were treated by low caloric diet regimen only (1600: 2000 Kcal/ day) designed by nutritionist throughout the whole treatment program for two months, whereas group (B) (study group) consisted of thirty obese women with postnatal diastasis recti, were treated by ultrasound cavitation on the abdominal area for 30 minutes, twice per week for two months in conjunction with low caloric diet regimen (1600: 2000 Kcal/ day) for two months.

Low caloric diet regimen:

All women in both groups (A & B) received strict instructions to adhere to a low-calorie diet regimen (1600: 2000 Kcal/ day). It was used for weight reduction or at least weight maintenance throughout the treatment period for 8 weeks [15].

Ultrasound cavitation:

Ultrasound cavitation, Dae Yang, Mabel 6, made in Korea, was used to reduce abdominal subcutaneous fat thickness of all women in group B only. Each woman was asked to assume supine lying position. The anterior abdominal wall's skin was sterilized with alcohol divided vertically into 2 segments. Subsequently, a conducting medium, in the form of gel, was applied to the ultrasound device's cavitation head. The device was then switched on, and the intensity was set. The cavitation head was moved very slowly in a small circular vertical rhythmic motion on each abdominal segment for 15 minutes with total duration treatment session on the abdominal area 30 minutes applied twice per week for 8 weeks. After finishing the UC, the skin was cleaned with cotton [16].

Outcome measures

Lumbar lordotic angle:

The spinal mouse (MEDIMOUSE) IDIAG M360 pro, pc-Software, 7.4.0., serial number: *112D2A24*, connected to a computer device, made in Switzerland) was used to measure lumbar lordotic angle. Spinal mouse is recommended for both research and clinical patient follow-ups as a method that safely, accurately and quickly assess the spinal curvatures. It is also effortless to operate without any resultant side effects [17]. The device measured the lumbar lordotic angle from the standing position for all women in both groups (A & B) before and after treatment.

The spinal mouse is a hand-held accelerometer-based system (electronic goniometer) with small wheels that could glide along the spinous processes from C7 to S3. It is used to objectively measure the sagittal plane of spinal curvature such as: Thoracic kyphosis through generating positive angular values and lumbar lordosis through generating negative angular values. In this study, the lumbar lordotic angle from T12 to S1 from the standing position was the main outcome measure [18].

Prior to assessment data of all women as name, date of birth, weight, height, etc., were recorded on the computer software [19]. During measurements, all women were with pants or skirts only, leaving bras unfastened to facilitate access to the para-spinal region. For accurate assessment all women were

asked to stand erect without shoes and with arms hanging freely beside the body. They were also advised to focus on a vertical column of numbers affixed to the wall, concentrating on the number at their eye level until the scans were completed [18].

The spinal processes of the vertebrae from C7 (starting point) to S3 (ending point, which is at the top of the anal crease) were palpated and marked [18]. During the recording, the two rolling wheels remained in full contact with the marked spinous processes and were moved slowly over them. The lumbar lordotic angle was automatically measured and displayed as negative values on the device screen. It was also denoted whether the condition had a normal, hyper lordotic, or flattened lumbar curve in a detailed report [19].

Statistical analysis

Results were presented as mean ± standard deviation. To assess the distribution of pre-treatment data, a test of normality, specifically the Kolmogorov-Smirnov test, was conducted. Comparison between normally distributed data (variables) in the two groups was conducted through unpaired t test. Analysis of covariance (ANCOVA) test was utilized to compare the pre-treatment values between the two groups, as well as the post-treatment values while controlling for the pre-treatment baselines. To compare pre-treatment and post-treatment data within each group, a paired t-test was used. Statistical Package for Social Sciences (SPSS) computer program (version 19 windows) was utilized to analyse the data. P value ≤ 0.05 was considered significant.

Results:

Table (1): Comparison of subject characteristics between group A and B:

Items	Group A	Group B	Comparison	
	Mean ± SD	Mean ± SD	t-value	P-value
Age (yrs.)	30.07 ± 2.82	30.80 ± 2.22	-1.120	0.267 (NS)
Weight (Kg)	84.40 ± 6.88	82.88 ± 7.52	0.815	0.418 (NS)
Height (m)	1.59 ± 0.03	1.60 ± 0.06	-0.487	0.629 (NS)
BMI (Kg/ m2)	33.29 ± 3.00	32.40 ± 2.11	1.320	0.193 (NS)

Data are expressed as mean ± SD, NS= p> 0.05= not significant.

Table (1) represents mean ±SD of the postnatal women's baseline characteristics in diet and UC plus diet groups as well as, comparison between groups before treatment, there was no statistically significant difference in the mean value of age, weight, height and BMI between the two groups.

Table (2): Lumbar lordotic angle mean scores within and between group A and B:

	Group A (n= 30)	Group B (n= 30)	F value	P value
Pre-treatment	-50.13 ± 3.61°	-50.90 ± 3.99°	0.609	0.438 (NS)
Post-treatment	-47.53 ± 5.00°	-44.97 ± 5.40°	11.016	0.002 (S)
Mean difference	-2.60°	-5.93°		
% change	5.19 ↓↓	11.65 ↓↓		
t value	-5.302	-7.007		
p value	0.001 (S)	0.001 (S)		

* Significant values, data are expressed as mean ± SD, F value= ANCOVA test; t value= paired t test, NS= p> 0.05= not significant; S= p≤ 0.05= significant.

Results of this study as shown in table (2), within groups; there was a statistically significant decrease in the mean value lumbar lordotic angle measured at post treatment when compared with its corresponding value measured at pretreatment in both groups (A &B).

Between groups, pretreatment, there was no significant difference between both groups (A &B) in the mean value of lumbar lordotic angle. While post treatment, there was a statistically significant difference between both groups (A&B) in the mean value of lumbar lordotic angle (in favor of group B).

Discussion

Diastasis recti abdominis refers to both recti muscle separation laterally. This is associated with linea alba tissue widening and abdominal wall protrusion [20]. Postpartum DRA can reduce tension in the elastic LA, impairing abdominal force transmission across the midline. Consequently, this can result in weaker abdominal muscles, less support for the lower back and disruption of the balance of muscles in the lower back [21]. This may lead to anterior pelvic tilt, the lumbar spine to curve more and subsequent suffering from low back pain [21]. Subjects with higher BMIs often exhibit weakened abdominal muscles mainly the rectus abdominis, which can significantly contribute to DRA development. As the accumulated fats in their abdominal cavities increase the intra-abdominal pressure, this can further push both recti apart and worsen the separation [22]. Results of this study found that, between groups; Pre-treatment, there was no significant difference between both groups (A & B) in the lumbar lordotic angle. While, post treatment, there was significant difference between both groups (A & B) in the lumbar lordotic angle (more decrease in group B that received UC. Our results agreed with Yalfani et al., [9] who stated that abdominal obesity is one of the predisposing factors increasing the RD in postnatal women through putting extra pressure against the LA. Therefore, reducing abdominal obesity could improve RDA and lumbar hyperlordosis in such cases**.** Regarding the influence of low-caloric diet on body weight and abdominal obesity, our results were in agreement with Suyardi et al., [23] who confirmed that balanced low-caloric diet has shown to be effective in reducing body weight and waist to hip ratio through decreasing body fat mass. Regarding the mechanism of action of ultrasound cavitation on abdominal obesity, our study agreed with Mahgoub and El-desoky, [24] who found that ultrasound cavitation surplus body fat by generating microbubbles which breakdown fat cells. They designed a study on obese subjects of both sexes to compare between the effect of cavitation and abdominal exercises. The group treated by ultrasound cavitation (39: 41) KHz, for 40 minutes, had a significant reduction of waist circumference (WC) with a percentage of improvement (8.92%) than the group treated by abdominal exercises with a percentage of improvement (4.73%). Current results are supported by Mekawy and Omar, [25] who reported that ultrasound cavitation leads to a significant modification of the pattern of fat distribution, especially at the abdominal level. As the group treated by ultrasonic cavitation in addition to exercise and hypocaloric diet, had a greater reduction of body weight and waist/hip ratio after 4 months, compared to the group treated by exercise and hypo caloric diet only ($P<0.001$). Additionally, our findings are consistent with those of Moreno-Moraga et al. [26] who confirmed that transdermal focused ultrasound could be deemed as a safe, painless, and non-invasive method for reducing unwanted fat deposits. Following three liporeductive cavitation treatments, there was a mean reduction in fat thickness of 2.28±0.80 cm, coupled with an average decrease in waist circumference of 3.95±1.99 cm with no observed harmful impacts. Regarding the effect of UC on lumbar hyper lordosis, our results aligned with vijayakumar et al., [27] who confirmed that high BMI coupled with sedentary habits and a lack of physical activity in obese individuals play a key role in developing lumbar hyperlordosis and excessive anterior pelvic tilting. Therefore, early diagnosis followed by the appropriate physical therapy interventions could correct the deformity and treat the problem. In contrast, our findings disagreed with Kiedrowicz et al., [28] who stated that radiofrequency was more effective than UC in reducing waist circumference when both devices were applied over 60 females suffering from abdominal obesity.

Limitations

There were some limitations. The main limitation lies in the study's relatively short duration. There are more objective methods available for the assessment of lumbar lordotic angle: such as: X rays, therefore the accuracy of measurement may be flawed.

Conclusion

Eight weeks of using UC on the abdominal area was effective on reducing lumbar hyper lordosis in obese postnatal women with diastasis recti.

Author contributions

The authors listed contributed substantially to the intellectual content of this work and have approved the final version for publication.

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Declaration of conflicting interests
The author(s) have no conflict of interest to declare.
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