Abdominal Muscles Exercise Program and/or Electrical Stimulation in Postnatal Diastasis Recti

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ABSTRACT

The purpose of this study was to investigate and compare between the effect of abdominal muscles exercise program and/or faradic electrical stimulation on pulmonary ventilation functions and intra-recti distance in women had diastasis recti postnatally. Thirty multiparous women (2 to 3 times) had diastasis recti (separation between 2 recti was > 25 mm or more) after 2 months of normal vaginal delivery participated in the study. They were divided randomly into equal three groups. The first group performed a regular abdominal muscles exercise program for 30 minutes/day. The 2nd group received faradic stimulation program for 30 minutes/session, while, the 3rd group performed abdominal muscles exercise program and faradic electrical stimulation for 60 minutes/day. All methods of treatment were given for 3 times/week for 8 weeks. Assessments were performed through measuring intra-recti distance and pulmonary ventilation functions which included maximum voluntary ventilation (MVV) and forced vital capacity (FVC) before and after treatment for all groups. The results of this study revealed highly significant decrease (P< 0.001) in intra-recti distance in group 3 than group 1 or group 2. While it showed significant improvement (P< 0.029 & P< 0.03) respectively in MVV & FVC measurements in group 3 than the other 2 groups. Accordingly, it could be concluded that application of faradic stimulation together with abdominal muscles exercise program improved pulmonary ventilation functions (MVV and FVC) and decreased intra-recti distance in women had diastasis recti postnatally than application of each method of treatment alone.

Key words: *Abdominal muscles exercise program, faradic electrical stimulation, pulmonary ventilation functions, intra-recti distance.*

INTRODUCTION

During pregnancy the female body undergoes many hormonal and anatomic changes that affect muscloskeletal system. These changes may cause various musculoskeletal complaints, predisposing to injury or alter the cours of the preexisting aliments[3,4].

No doubt that, the abdominal muscles suffers a lot during pregnancy due to severely overstretching of their muscle fibers around the growing uterus. For this reason, they usually seem flat, flabby and very weak immediately after delivery[10]. Because of this, spinal stability is extensively affected by the lengthening of abdominal muscles and the consequential changes in their ability to generate tension[9,11]. In which stretched and weakened abdominal muscles will not be able to support the back properly and this of course may cause severe backache[10,13].

Diastasis recti occurs commonly in pregnancy and its incidence rates of more than 67%[20] if the separation (gap) between both recti exceed 25 mm (2.5 fingers) and it is greater in multiparous than primiparous women, that takes 3-6 months after delivery to return to the pre-pregnant state when there is a good planned postnatal exercise program[24].

All the abdominal muscles have an insertion in the median plane of the linea alba so, the presence of the diastasis recti indicates a number of changes affecting the integrity of the abdominal wall[25]. Because of the absence of stable instertion for abdominal muscles, which influences the inter-relation ship between attachment and muscle fiber direction. So that, these changes in the angle of insertion of the abdominal muscles may influence the muscle's line of action[8,17] and subsequently their functional capabilities that resulted in decreased their ability to stabilize the pelvis. Such inadequacies could lead to muscle imbalance, inefficiency in the movement, changes in the posture and the development of low back pain[14]. The severe cases of diastasis recti may progress to complete umbilical hernia[16]. Specialized abdominal muscles exercise program must be given for these cases as trunk rotation and side binding should be delayed until the size of the gap has been reduced as these movements may increase the gap. Static abdominal exercise as well as pelvic tilting exercises and electrical stimulation may be performed safely for such women[24].

Many authors have postulated that exercises included curl up could strength the upper portion of these muscles[2] and exercises involved straight leg raising and posterior pelvic tilt could influence strength in their lower portions, while other noting that trunk and/or raising lower limbs exercise create similar action potential within each portions of the rectus abdominis muscles[1].

Hartsell and Karmer (1992)[12] confirmed that faradic stimulation activates an extra flow of motor signals traveling form the CNS to the muscles to cause them to contract (exercise), but it is not to be used as an alternative to natural exercise. It is used an adjunct to natural exercise or when the use of natural exercise is impractical.

Freidhelm (2002)[8] differenctiated between the effect of voluntary and electrical stimulated contraction of large group of muscles, where voluntary contraction cause asynchronous depolarization through intermittent contractions that cause low firing rate with rapid fatigue, in the other hand, electrical contraction cause synchronous depolarization through constant contractions (fixed frequency of firing) that cause firing of all motor neurons with delay fatigue appearance[22].

Electrical muscle stimulation was used to activate and maintain exercise in both skeletal, visceral and cardiac muscle[5,23].

The purpose of this study was designed to investigate and compare between the effect of abdominal muscles exercise program and / or faradic electrical stimulation on pulmonary ventilation functions and intra-recti distance in women had diastasis recti postnatally.

SUBJECTS, MATERIALS AND METHODS

Subjects

Thirty multiparous women (2 to 3 times) had diastasis recti were selected form Kasr Aini Hospital after 2 months of normal vaginal delivery and their age ranged from 20-28 years old, body mass index not exceed 29kg/m^2.

All women were free from any musculoskeletal disorders, no previous

abdominal operation and experienced normal vaginal delivery without any postpartum complications and had diastasis recti in which the separation between the 2 recti was more than 25 mm.

Women were divided randomly into equal three groups (10 each). The first group performed a regular abdominal muscles exercise program for 30 minutes / day, 3 times/week for 8 weeks. The second group received faradic stimulation program for 30 minutes/ session, 3 times/week for 8 weeks. While, the third group performed abdominal muscles exercise and faradic electrical stimulation program for 60 minutes/session, 3 times/ week for 8 weeks.

Instrumentations

1- Weight and height scale to measure weight and height of each woman and calculate the body mass index.

$$\text{Body mass index} = \frac{Weight(Kg)}{Height(m^2)}$$

2- Hand held electronic spirometer which is an accurate unit with private mouth piece for each woman included in this study, to measure pulmonary ventilation functions that mainly include Forced Vital Capacity (FVC) and Maximum Voluntary Ventilation (MVV) before and after treatment.

3- Dial calipers was used for measuring inter-recti distance before and after treatment.

4- Low frequency current device (Gymna, Model 800), portable electrical nerve stimulating apparatus to stimulate anterior wall abdominal muscles with frequency: 50-100 Hz, pulse width: 0.2 Msec, duration: 30 minutes and intensity: below the perception level to produce a comfortable mild parathesia (tingling) sensations without visible muscle contractions.

5- Plinth for performing exercise and application of faradic stimulation.

6- Stop watch to determine the session time.

Procedures

a) Measurement of the intra-recti distance:

I palpated the medial edge of the recti muscle borders and placed the dial calipers perpendicular to the recti borders just above the umbilicus by 4.5 cm while the woman was in crock lying position, then asked the woman to raise her head until the scapulae lifted the plinth at this point reading was taken for the distance between two recti. Three trials were taken for each assessment and the mean was recorded. The distance between two recti should exceed 25 mm to confirm diastasis recti before starting the suggested program and reevaluated after the end of treatment (8 weeks).

b) Exercise descriptions

- Static abdominal exercises for 10 repetitions through contracting abdominal muscles in from crock lying position and pressing lumbar region down on the plinth while, I placed my hands one above the abdominal wall at the waist line and the other below her lumbar region.
- Trunk curl-up form crock lying position, the woman raised her neck and trunk to the point where the scapulae were lifted from the plinth while curling the rib cage toward the pelvis and hold for 2 seconds in this position and repeated for 10 repetitions.
- Posterior pelvic tilt: from crock lying position, each woman was instructed to contract gluti, abdominal muscles and press lumbar region down on the plinth, hold for 2 seconds in this position and repeated for 10 repetitions.
- Unilateral straight leg raising: from half crock lying position (in which one lower limb was in extension and other limb was

flexed hip, knee and foot was rested on the plinth) each woman was instructed to raise her straight leg up 30 cm off the plinth and hold for 2 seconds in this position and repeated for 10 repetition then, the other leg performed the same task after that.

- Double straight leg raising: from supine lying position, each woman was instructed to raise both legs up as possible as she can but not more than 25cm off the plinth and hold for 2 seconds in this position and repeated this task 10 repetitions.
- Tupler technique: from crock lying position, the woman was instructed to cross her hands at the waist and guide the recti muscles toward the midline to stabilize them, take in deep breathing, while she slowly expire, perform pelvic floor contraction and raise her head off the bed. Then , slowly return to starting position as she breathes in. this was repeated 10 repetition.
- This exercise program was repeated to equal 30 minutes/session. Three times/ week for eight weeks.

c) Faradic stimulation: from relaxed supine lying position, application of low frequency current (50-100Hz) was performed for 30 minutes/session, day after day for 8 weeks. By using four electrodes applied 2 cm para median, 2 electrodes above the umbilicus and other 2 electrodes below it, the intensity increased gradually according to the woman tolerance.

d) Measurement of pulmonary ventilation function tests throughout electronic spirometer including maximum voluntary ventilation (MVV) and forced vital capacity (FVC). They were measured before and after treatment for the three groups. The measurement was done through:

- Placing a new sheet of chart papter on the spirometer's revolving cylinder and adjust the pen tip to write on the chart paper.
- Putting the woman in comfortable sitting position with loosen any tight clothing.
- Showing the proper chin neck position to the woman, chin should be slightly elevated and the neck slightly extended. This was maintained throughout the forced expiratory procedures.
- Putting a clean own woman mouth piece on the valve at the end of spirometer tubing.
- Learning the woman how to relax and regularly breathe through the mouth piece before starting the test.
- Placing nose clips that should always be warm.
- Switching on the apparatus and waiting for a minute, pressing the button menu and record the personal data including age, weight and height after each item press enter.
- Placing the mouth piece, lips should be sealed tingly and the tongue should not stick out into the mouth piece.
- Pressing the button of forced expiratory volume and asking the woman after deep inspiration to expire forcefully and rapidly as much as possible through the mouth piece then pressing print of data and graph, repeating this procedure 3 times then have the best of these 3 records.
- Pressing the button of maximum voluntary ventilation and asking the woman to breathe in/out of the lung as fast as possible for at least 6 seconds through the mouth piece then pressing print of date and graph, repeating this procedures 3 times then having the best one.

- Assessment of ventilatory functions was based on comparing a subject test results against the reference or predicted values.

Data analysis

The mean and SD were calculated for each group t-test was performed to compare between pre and post treatment measures in each group.

ANOVA test was used to determine any significant differences among all groups. The level of significance was (P< 0.05).

RESULTS

The results of this study revealed that:

- There were non significant difference (P> 0.05) between all groups in age, body mass index and parity (Table 1).
- Intra – recti distance showed significant decrease (P<0.01 and P< 0.05) respectively in group (1) and (2) while, it showed highly significant decrease (P< 0.001) in group (3) between before and after treatment (Table 2 & Figure 1).
- MVV showed highly significant increase in all groups (P< 0.003, P<0.005 and P< 0.001) respectively between before and after treatment (Table 3 & Figure 2).
- Also, FVC showed highly significant improvement in all groups when comparing before and after treatment (P< 0.002, P< 0.005 and P< 0.001) respectively (Table 4 & Figure 3).
- Comparison of three groups together after treatment, there were non significant difference (P> 0.026, P> 0.05 & P> 0.587) between group (1) and (2) respectively in intra-recti distance, MVV and FVC. While, there were highly significant improvement (P< 0.001) in inter-recti distance in group (3) than group (1) or (2).
- The differences were significant improvement (P< 0.029 & P< 0.03) respectively in MVV & FVC in group (3) than group (1) or (2).

Table (1): Physical characteristics of the 3 groups.

Groups	Age (years)	BMI(Kg/m^2)	Parity (No.)	
	Mean ± SD	Mean ± SD	2 times	3 times
Group (1)	23.76 ± 2.52	27.16 ± 2.51	4	6
Group (2)	22.91 ± 2.39	27.33 ± 1.96	5	5
Group (3)	23.08 ± 2.67	27.08 ± 1.72	7	3

Table (2): Intra-recti Distance (mm) of all groups before and after Treatment.

Groups	Intra-recti distance (mm)			
	Before treatment	After treatment	t-value	P-value
Group (1)	47.78 ± 8.89	28.35 ± 3.40	6.390	P<0.01
Group (2)	46.55 ± 7.56	30.25 ± 2.49	1.032	P<0.05
Group (3)	45.72 ± 8.67	24.52 ± 1.43	21.320	P<0.001

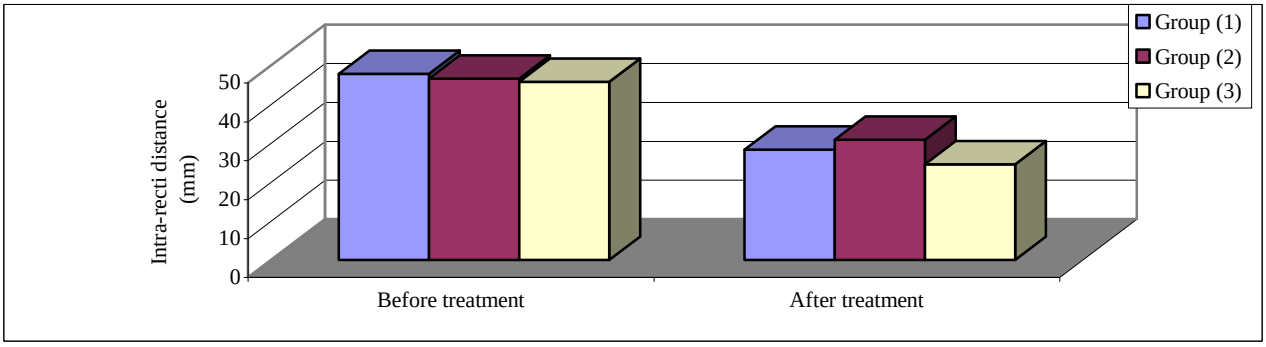

Fig. (1): Intra – recti Distance of the three groups before and after Treatment.

Table (3): The Mean Values of MVV of all groups before and after Treatment.

Groups	MVV (L/min)			
	Before treatment	After treatment	t-value	P-value
Group (1)	70.133 ± 6.780	103.333 ± 6.640	- 11.830	P<0.003
Group (2)	70.00 ± 7.319	94.666 ± 9.53	- 11.760	P< 0.005
Group (3)	70.22 ± 6.88	108.250 ± 7.79	-10.940	P<0.001

Table (4): The Mean Values of FVC of all groups before and after Treatment.

Groups	FVC (liter)			
	Before treatment	After treatment	t-value	P-value
Group (1)	3.19 ± 0.469	4.284 ± 0.536	6.390	P<0.002
Group (2)	3.141 ± 0.927	3.574 ± 0.403	4.720	P<0.005
Group (3)	3.820 ± 0.340	4.983 ± 0.450	5.885	P<0.001

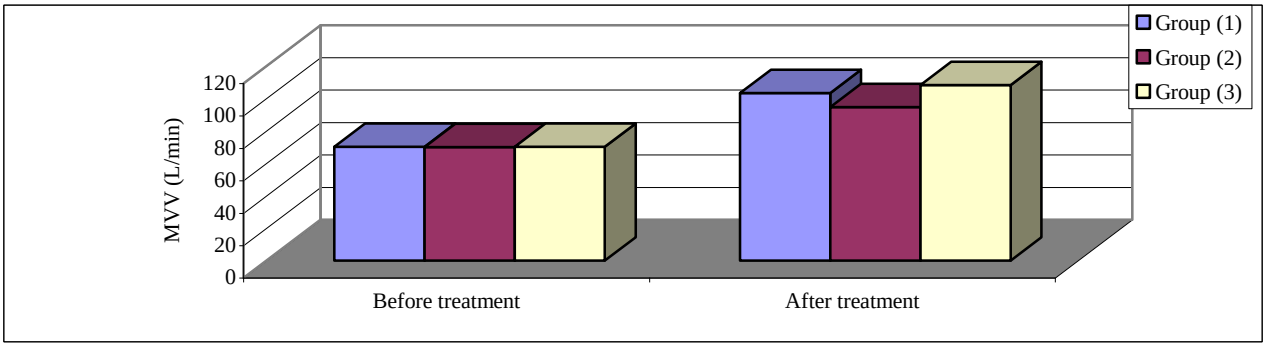

Fig. (2): Mean Values of MVV of all groups before and after Treatment.

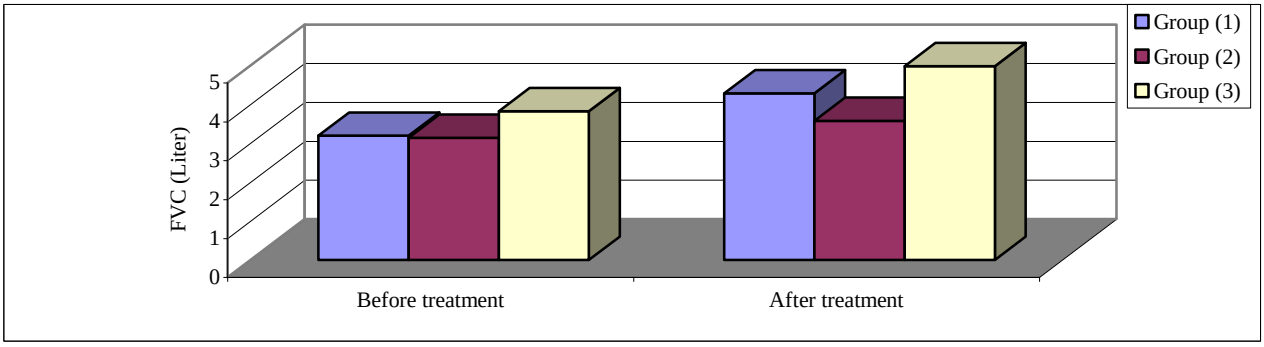

Fig. (3): Mean values of FVC of all groups before and after Treatment.

DISCUSSION

This study was conducted to investigate and compare between the effect of abdominal muscles exercise program and/or faradic electrical stimulation on pulmonary ventilation functions and intra-recti distance in postnatal women with diastasis recti.

The results of the present study demonstrated that there were highly significant decrease in intra-recti distance in the all groups when comparing between before and after receiving each method of treatment within each group. But, the most effective improvements were seen in exercise and electrically stimulated group than exercise group or electrically stimulated group after treatment. Also, there were significant improvement ($P< 0.029$ & $P< 0.03$) respectively in MVV & FVC measurement in group 3 than other groups.

In fact abdominal muscles play an important role in normal quiet inspiration and forced expiration. So, its affection causes real respiratory problems[6]. That led to the importance of strengthening abdominal muscles in cases of diastasis recti to reach acceptable level of ventilatory functions[10].

Lenderman and Ramshaw, (2005)[16] confirmed that diastasis recti causes drop in intra abdominal pressure that promote lateral retraction of abdominal content and wider muscle disinsertion. So, it causes several complications for respiratory mechanics and muscle functions. Respiratory process requires adequate co-ordination between chest wall, diaphragm and abdominal wall.

When there is dropping in intra abdominal pressure, the diaphragmatic movement decreases so normal resistance and support offered by abdominal viscera to the inferior diaphragmatic surface is reduced, that increases need of accessory muscles of respiration[15].

In the present study, we tried to improve the abdominal muscles strength through abdominal muscles exercise program, faradic stimulation or both together which 1ed to improvement in pulmonary ventilation functions (MVV& FVC) and decrease the intra – recti distance in postnatal women had diastasis recti.

There were highly significant improvements in abdominal muscles strength in all groups but the most effective method was abdominal muscles exercise plus faradic stimulation as exercise today is an integral part of normal life for all women. There are many health benefits for women who exercise regularly and in moderation. Exercise improved cardiovascular status, increased

bone mineral content and improved muscle strength[21].

Many authors have postulated that abdominal muscles exercise included curl up could strength the upper portion of rectus diastasis ,while other exercise involved straight leg raising and posterior pelvic tilt could influence strength of the lower portions[19].

Some investigators have evaluated exercise training programs, while others have focused on the relationship between voluntary and electrically stimulated muscular contraction intensities[6]. When using electrical stimulation for augmentation of muscle strength the criteria describing electrical stimulation intensity, frequency and electrode placement have varied widely. The mechanisms for muscle strengthening using an electrically induced muscle contraction is the same as that of a voluntary muscle contraction by substantially increasing the muscle functional load and is only dependent on the load at the tendon[7].

Hartsell and Karmer (1992)[12] confirmed that electrical nerve stimulation activates an extra flow of motor signals traveling form CNS to the muscles to cause them to contract (exercise), but it is not to be used as an alternative to natural exercise, but as an adjunct to natural exercise or when the use of natural exercise is impractical.

Eventually, abdominal muscles exercises with electrical stimulation are effective in ventilatory function improvement during postnatal period in women suffering from diastasis recti via their effect on strengthening abdominal muscles.

Accordingly, it could be concluded that application of faradic stimulation together with abdominal muscles exercise program improved pulmonary ventilation records (MVV & FVC) and decreased intra-recti distance in postnatal diastasis recti women than application of each method of treatment alone.

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الملخص العربي

برنامج تقوية عضلات البطن مع أو مقابل التنبيه الكهربي في حالات التباعد بين عضلتي البطن الطوليتان بعد الولادة الطبيعية

إن الهدف من هذه الدراسة هو معرفة ومقارنة تأثير برنامج تقوية عضلات البطن مع أو مقابل التنبيه الكهربي علي وظائف التهوية الرئوية ومقدار التباعد بين عضلتي البطن الطوليتان في السيدات اللاتي يعانين من التباعد بين عضلتي البطن الطوليتان بعد الولادة الطبيعية . شاركت في هذه الدراسة 30 سيدة متعددة الولادة (2-3 مرات) كن يعانين من تباعد عضلتي البطن الطوليتان (أكثر من 25 مم) بعد شهران من الولادة الطبيعية . وقد تم تقسيمهن ألي 3 مجموعات متساوية ، المجموعة الأولي شاركت في برنامج منتظم لتقوية عضلات البطن والمجموعة الثانية عولجت باستخدام التنبيه الكهربي لعضلات البطن أما المجموعة الثالثة عولجت بالاثنان معا 3 مرات أسبوعيا لمدة 8 أسابيع وقد تم التقييم عن طريق قياس وظائف التهوية الرئوية ومقدار التباعد بين عضلتي البطن الطوليتان قبل وبعد الانتهاء من العلاج . وقد أظهرت النتائج وجود انخفاض ذات دلالة إحصائية عالية في مقدار التباعد بين عضلتي البطن الطوليتان وأيضا تحسن ذو دلالة إحصائية في وظائف التهوية الرئوية في المجموعة الثالثة عن المجموعة الأولي أو الثانية . ومن هنا يمكن أن نستنتج أن تطبيق برنامج تقوية عضلات البطن والتنبيه الكهربي معا كان أفضل من تطبيق وسيلة منهما علي حدا لتحسين وظائف التهوية الرئوية وتقليل التباعد بين عضلتي البطن الطوليتان في السيدات اللاتي يعانين من التباعد بين عضلتي البطن الطوليتان في فترة ما بعد الولادة الطبيعية .

الكلمات الدالة : برنامج تقوية عضلات البطن ، التنبيه الكهربي ، وظائف التهوية الرئوية ، مقدار التباعد بين عضلتي البطن الطوليتان .