Effect of Abdominal Versus Pelvic Floor Muscles Exercises on Vaginal and Leak Point Pressures in Mild Stress Urinary Incontinence in Obese Women

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Abstract: Objective: To compare the benefits of 12 weeks abdominal and pelvic floor muscles (PFM) strength training for mild stress urinary incontinence (SUI) in obese women. **Design**: A randomized control trial with three months follow up. **Setting**: Bab El Sharia University Hospital. **Subjects**: Thirty female obese patients with mild SUI. **Intervention**: Abdominal exercises (Abd. ex's) group (n=15) received specific exercises for transversus abdominis and internal obliqus muscles. Whereas, pelvic floor exercises (PF ex's) group (n=15) received pelvic floor exercises. **Main outcome measures**: Vaginal pressure, leak point pressure (LPP) and waist hip ratio (WHR) were measured for both groups at three intervals (baseline, 12 weeks of intervention and 3months follow up i.e. 24 weeks from the start of the study). **Results**: Both abdominal and pelvic floor groups showed a significant increase in vaginal pressure after 12 weeks of intervention ($p < 0.0001$ and $p < 0.021$, respectively) and at follow up ($p < 0.0001$ and $p < 0.009$, respectively) compared to baseline. This effect was greater for Abd. ex's group at 12 weeks ($p < 0.041$) and at follow up ($p < 0.022$) when compared with PF ex's group. Also, both abdominal and pelvic floor groups showed a significant increase in LPP after 12 weeks of treatment ($p < 0.001$ and $p < 0.008$, respectively) and at follow up ($p < 0.0001$ and $p < 0.007$, respectively) compared to baseline; there were no significant differences between the two groups at these time points. **Conclusion**: Overall, the results of this study suggest that 12 weeks of abdominal muscles strengthening training has superior effects compared to pelvic floor strength training for mild SUI in obese patients.
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1. Introduction

Stress urinary incontinence (SUI) is urodynamically proved as involuntary loss of urine occurs following a sudden rise in the intra-abdominal pressure caused by coughing, sneezing, straining, laughing or other physical activities, when the intravesical pressure exceeds the maximum urethral pressure in the absence of detrusor contraction [1, 2]. SUI is the most common type of urinary incontinence in women with risk factors includes advancing age, childbirth, smoking, chronic bronchitis, and obesity [3].

There are many methods to diagnose SUI. Leak point pressure (LPP) testing originated from extensive video urodynamic studies done over many years in a board cross-section of patients including those with idiopathic incontinence, stress incontinence and neurogenic conditions [4]. In addition, the perineometer, through a compressible vaginal catheter that is connected to a manometer, measures the increase of intravaginal pressure that is produced by the contraction of pelvic floor muscle [5].

Obesity has often been suggested as a risk factor for urinary incontinence. There are several mechanical and physiologic reasons why an increased body mass index (BMI) may be associated with, if not causative of, urinary incontinence [6]. Each 5-unit increase in BMI associated with a 60% to100% increased risk of daily incontinence [7]. So, there is a strong association between increasing weight and SUI as there is higher resting intra-abdominal and intravesical pressures in obese individuals [8]. Increased intra-abdominal pressures adversely stress the pelvic floor in addition to affect the neuromuscular function of the genitourinary tract [9].

The increase in intravesical pressure created by a rising BMI may reduce the continence gradient between the urethra and the bladder. In this situation, the magnitude of increased intra-abdominal pressure necessary to force urine through the urethra is reduced because the static pressure within the bladder is higher [10]. These higher pressures could expose the pelvic-floor muscles to a state of chronic stress, and place chronic stretch on the pudendal nerve [11].

Pelvic floor exercises [12, 13] are advised as a first line of treatment for female SUI. These exercises advocated to strength weak perineal and pelvic floor muscles but their success depend on high level of patients' motivation and compliance with an individual exercise program [14].

Contraction of the abdominal muscles may provide an efficient mechanism with which contraction of the pelvic floor muscles is initiated, particularly for patients who have difficulty in learning to contract those muscles, however the use of abdominal muscles training to rehabilitate pelvic floor muscles may be useful in treating SUI [15]. **Madill and McLean** [16] found that deep abdominal muscle contraction increased intra-vaginal pressure. Moreover, pelvic floor muscles act as part of an integrated abdominal-pelvic unite, under control of central nervous system programming that ensures appropriate timing of automatic responses to any change in trunk postures and trunk muscles activity [17]. The close association between the pelvic floor muscles and abdominal muscles comes from **Power** [18], who described a direct continuation of puborectalis with rectus abdominis in an imperfectly developed fetus [19].

Some studies indicated that abdominal activity and pelvic floor muscles contraction are a normal response to each other. The response of the abdominal muscles to voluntary contraction of the pelvic floor muscles showed greater electromyography (EMG) activity amplitude of transversus abdominis than that of rectus abdominis and obliquus externus abdominis when the spine was positioned in extension [20]**.** When specific isometric abdominal contractions were performed in lying position, pelvic floor contraction EMG activity increased. Also, urethral pressure increases with voluntary pelvic floor muscles contraction and isometric abdominal muscles holds [21, 22].

So far, only one randomized control trial has addressed the effect of abdominal muscle training on SUI. The results showed that additional training of the transversus abdominis (TrA) after pelvic floor muscle training (PFMT) and neuromuscular stimulation did not provide incremental improvement of SUI [23]. However, the coactivation and coordination of the TrA and PFM was not the target.

According to the previously mentioned facts, we encouraged to make an attempt to compare the response when training each of abdominal and pelvic floor muscles separately for mild SUI in obese women.

2. Patients and Methods

Thirty female patients were diagnosed with mild SUI. The diagnosis made via history taking, vaginal examination & Urodynamics study. The patients were referred from the gynecological and urological outpatients' clinics at Bab El Sharia University Hospital. The ethical committee in the hospital approved the study. Inclusion criteria were: age 30-40 years, parity ≤ 3 times, BMI 30-34 Kg/ m^2, and waist\hip ratio ≥ 0.8. Demographic data are summarized in table1. The exclusion criteria were pregnancy, lower urinary tract infections, neurological problems, pelvic tumor, diabetes, smoking, chronic chest diseases as well as, other types of urinary incontinence, and any medications or medical\surgical interventions for SUI.

All patients gave a written consent to participate in the study and were provided with a full explanation of the treatment protocol.

Assessment procedures

Patients were assessed at three time points: baseline, following 12 weeks of exercise intervention and then after 24 weeks from the beginning of the study as follow-up. Outcome measures were as follows:

Perineometer (Peritron 9300; Cardio Design Pty Ltd Australia) assess vaginal pressure as a marker of pelvic floor muscle strength. During assessment, the patients were asked to strongly squeeze, lift and maintain hold (as long as possible) on the vaginal probe of the perineometer. In addition, the patients taught not to involve rectus abdominus or the gluteal muscles at all during assessment. The examiner observed the cranial movement of the perineum through the slight anterior tilt of the sensor (towards the anus) and recorded of the readings over the monitor. This maneuver was repeated three times per session and the mean of vaginal pressure was calculated

Urodynamics studies were performed after the approval of ethical committee by using a Merkur 2000 in order to confirm the diagnosis of SUI and also to measure valsalva LPP.

Weight/height scale measurements were used to calculate the BMI, in order to confirm the degree of the patient's obesity. This was done only one time at baseline assessment.

Tape measurement was used to calculate waist/ hip ratio (which must be ≥ 0.8) at baseline assessment. The normal value is 0.7 for women [24].

Procedures

Eligible patients were randomly allocated into two groups by using simple random method. Concealed papers picked by a third parity to pick patient's name for each group at a time. By the end, there were two groups abdominal exercises (Abd. ex's) group (n=15) underwent abdominal muscles exercise strength training program specifically for TrA and internal oblique muscles [19]; and pelvic floor exercises (PF ex's) group (n=15) underwent pelvic floor muscles strength training program. The intervention was applied at the physiotherapy outpatient clinic in an isolated and secured place. Both groups trained for 12 weeks with frequency 3sessions/week (see Appendix for details).

All patients received the standard treatment for SUI and obesity including education,

advice and dietary modification in form of 1200 Kcals\ day divided into 3 main meals and 2 snacks in addition to counseling and diet modification every week during the intervention. Both groups were asked to continue their own program plus the dietary modification after the intervention until they reassessed after 3 months. Statistical analysis, applied the central limit theory that assuming large sample. Statistical comparisons within each group were made using paired t-test for pre and post treatment measurement variables. Comparisons between groups were made using unpaired t-test. The P-value was set at 5% level.

3. Results

Thirty female patients were recruited and randomized into two groups (Abd. ex's & PF ex's). There were no differences at the baseline between the groups in the age, weight, height and BMI as presented in table1.

Vaginal pressure, there were no significant differences between the groups at baseline. Both groups (Abd. ex's & PF ex's) showed a significant increase in vaginal pressure after 12 weeks of treatment ($p < 0.0001$ and $p < 0.021$ respectively) and after 24weeks ($p < 0.0001$and $p < 0.009$ respectively) compared to baseline, table2. When comparing both groups, the increased vaginal pressure was greater in Abd. ex's group than PF ex's group at 12 weeks ($p < 0.041$) and after 24 weeks ($p < 0.022$), Fig.1. The improvement percentages after 12 & 24 weeks were 15.620% &18.02%, respectively in Abd. ex's group, while in PF ex's group were 4.6% and 5.96% respectively.

Leak Point Pressure, there were no significant differences between the groups at baseline. Both groups (Abd. ex's & PF ex's) showed a highly significant increase after 12 weeks of treatment ($p < 0.001$ and $p < 0.008$, respectively) and after 24weeks ($p < 0.0001$ and $p < 0.007$, respectively) compared to baseline(Table3). Comparing both groups, there were no significant differences at 12 weeks ($p < 0.205$) & 24 weeks ($p < 0.058$), Fig.2. The improvement percentages after 12 & 24 weeks were 16 % and 16.83 %, respectively in Abd. ex's group. While there were (9.07% &7.66% respectively) in PF ex's group.

Waist/hip ratio, there were no significant differences between the groups at baseline. Both groups (Abd. ex's & PF ex's) showed a significant decrease in WHR after 12 weeks & after 24weeks compared to baseline Abd. ex's group: $p < 0.0001$ & $p < 0.0001$; and PF ex's group: $p < 0.021$ & $p < 0.006$, respectively(Table 4). In comparison of both groups, there were no significant differences at 12 weeks ($p < 0.095$) & 24 weeks ($p < 0.069$), Fig.3.

Table1 The demographic data of subjects in both groups.

	Groups	Range		Mean	SD	t-value	P- value
		Min.	Max.				
Age (Yrs)	Abd ex's group	35	45	39.87	3.54	0.11	0.92
	PF ex's group	35	45	39.74	3.64		
Weight (Kgs)	Abd ex's group	72	97	84.94	7.35	0.99	0.34
	PF ex's group	70	98	82.80	8.10		
Height (Cm)	Abd ex's group	153	174	162.27	7.86	1.04	0.32
	PF ex's group	152	173	160.20	7.36		
BMI (Kg/m^2)	Abd ex's group	30.72	33.75	32.23	0.93	0.12	0.91
	PF ex's group	31.11	33.75	32.20	0.83		

Table 2. The mean difference values of the vaginal pressure at baseline, post 12 & 24 weeks in both groups.

		Mean difference	S.D.	t-value	P-value	significance
Abd ex's group	Baseline Post 1	-7.80	5.89	-5.12	0.0001	Significant
	Baseline Post 2	-9.00	5.65	-6.16	0.0001	Significant
	Post1 Post 2	-1.20	3.50	-1.32	0.207	Non significant
PF ex's group	Baseline Post 1	-2.33	3.47	-2.59	0.021	Significant
	Baseline Post 2	-3.00	3.82	-3.04	0.009	Significant
	Post1 Post 2	-0.66	1.04	-2.46	0.027	Significant

Key S.D. = standard deviation Post 1= 12 weeks Post 2= 24 weeks

Table 3. The mean difference values of the LPP at baseline, post 12 & 24 weeks in both groups.

		Mean difference	S.D.	t-value	P-value	significance
Abd ex's group	Baseline Post 1	-12.80	11.44	-4.33	0.001	Significant
	Baseline Post 2	-13.46	9.87	-5.28	0.0001	Significant
	Post1 Post 2	-0.66	2.69	-0.96	0.353	Non significant
PF ex's group	Baseline Post 1	-7.26	9.18	-3.06	0.008	Significant
	Baseline Post 2	-6.13	7.47	-3.18	0.007	Significant
	Post1 Post 2	-1.13	5.01	0.87	0.396	Non significant

Table 4. The mean difference values of the WHR at baseline, post 12 & 24 weeks of in both groups.

		Mean difference	S.D.	t-value	P-value	significance
Abd ex's group	Baseline Post 1	0.048	0.037	4.990	0.0001	Significant
	Baseline Post 2	0.052	0.035	5.674	0.0001	Significant
	Post1 Post 2	0.003	0.024	0.529	0.605	Significant
PF ex's group	Baseline Post 1	0.018	0.026	2.60	0.021	Significant
	Baseline Post 2	0.022	0.027	3.238	0.006	Significant
	Post1 Post 2	0.004	0.013	1.38	0.187	Non significant

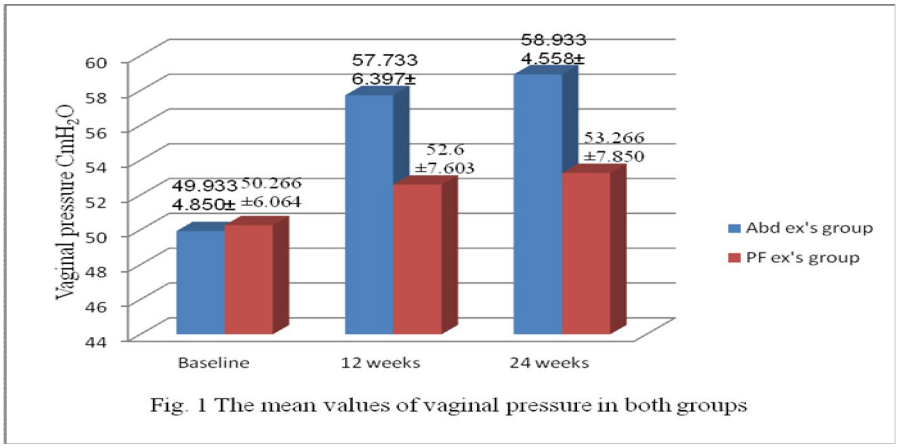

Fig. 1 The mean values of vaginal pressure in both groups

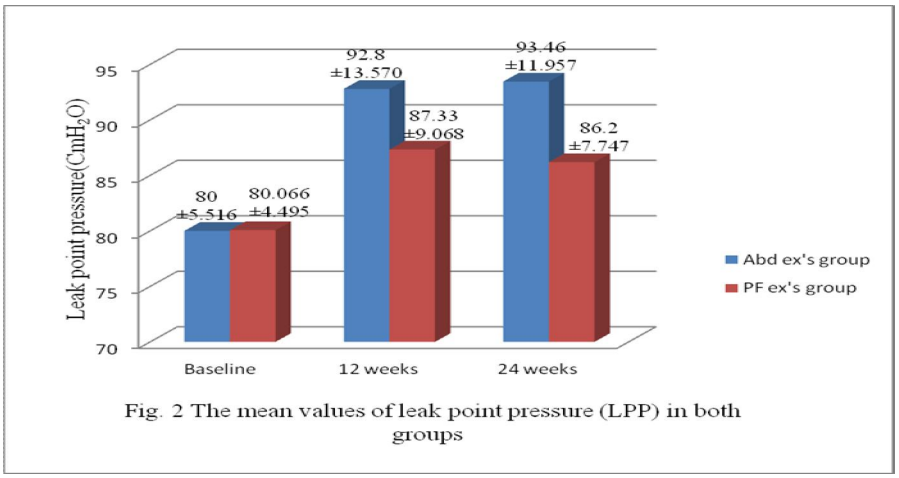

Fig. 2 The mean values of leak point pressure (LPP) in both groups

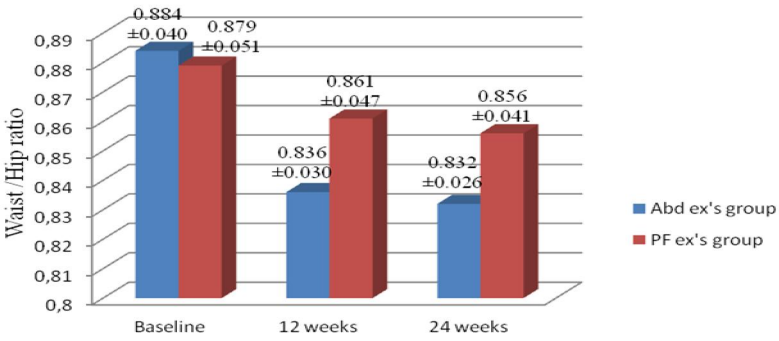

Fig. 3 The mean values of waist /hip ratio (WHR) in both groups

Appendix

Stage	Exercise program	Exercise description
Group (A)	Transversus abdominal muscles exercises	Patients were in crock lying position and were asked to contract statically their abdominal muscles strongly**.** This done for 15 repetitions each one consisted of contraction for 10 sec. followed by relaxation for 20 sec., after 15 repetitions, they were rested for 5 min**.** Then repeat the consequence again for two sets of 15 repetitions. Instructions: the patient's hands over the abdomen to feel its tension. The pelvis and spinal movements were prevented
	Internal obliqus muscles (lateral trunk flexion) exercises	Patients were in crock lying position and were asked to contract statically their abdominal muscles strongly, then try to touch with their tips of the fingers the farthest point of their legs for 15 repetitions each one consisted of contraction for 10 sec. followed by relaxation for 20 sec., after 15 repetitions, they were rested for 5 min. Then repeat the same procedures for the other leg.
Group (B)	pelvic floor muscles exercises	1) **First step for pubovaginalis**:- Patients were asked to contract the anterior fibers of pubococygeus muscle 15 repetitions each one consisted of contraction and squeezing for 10 sec., followed by relaxation for 20 sec., after 15 repetitions, they were rested for 5 min. Perineal palpation was done during the exercise to assure the cranial movement of the perineum.
		2) Second step for puborectalis:- Patients were asked to contract the posterior fibers of pubococygeus muscle 15 repetitions each one consisted of contraction and squeezing for 10 sec., followed by relaxation for 20 sec., after 15 repetitions, they were rested for 5 min. The therapist tips of fingers were around the anus to assure contraction of puborectalis as lifting of the anus up and detect any substitution of gluteus maximums muscles.
		3) Third step for pubo cocygeus as a whole:- Patients were asked to contract the anterior and posterior fibers of pubococygeus muscle 15 repetitions each one consisted of contraction and squeezing for 10 sec., followed by relaxation for 20 sec. Palpation as step 2 was done in addition to verbal instruction to assure raising of the perineum.
Home routine both groups (A&B)		*All patients were given a record for the home routine of exercises. It was done four times per day on the other days of usual exercises in their group, as following: - At early morning before getting from bed from crock lying position. - At afternoon from sitting and standing positions. - At evening from sitting and standing positions. - At night at bed time from crock lying position

4. Discussion

The results of this study suggested that 12 weeks of specific abdominal muscles training showed benefits more than pelvic floor training in improving vaginal pressure and leak point pressure

which indirect positively affect mild SUI in obese patients.

One of our weaknesses is that, BMI assessment was not done post intervention and at the follow up. Furthermore, we relied only on objectives assessments without accounting episodes of leakage or self reported questionnaire.

Regarding the effect of the abdominal muscles exercises on the function of the pelvic floor muscles in mild SUI, to the best of our knowledge, there is no study tested the effect of the abdominal muscles training alone in comparison to the pelvic floor muscles for SUI. But there are many studies supporting the relation between these two groups of muscles. A recent study done by Hung *et al.* [25], who found that 4-months period intervention by retraining diaphragmatic, deep abdominal and pelvic floor muscles (PFM) coordinated function could improve symptoms and quality of life in women with SUI or mixed urinary incontinence (MUI).

WHR had a significant decrease after 12 &24 weeks compared to the baseline in both groups. This can be explained as central adiposity increases the intra-abdominal and bladder pressure and urethral mobility so; weight reduction by changes in dietary intake and physical activity may reduce forces on the bladder and pelvic floor, thus reducing incontinence [26].

In the current study, there were a significant improvements (vaginal pressure, LPP and WHR) obtained after 12 weeks of intervention either abdominal or pelvic floor exercises for obese women with SUI. This is broadly in line with current consensus in muscle physiology that improvements in strength can be observed after 8 weeks of training [27]. Furthermore, even if pelvic floor or abdominal muscles are severely and recently affected as in cases of persistent postnatal stress urinary incontinence, 8 weeks of pelvic floor or pelvic floor plus abdominal training are sufficient to improve pelvic floor strength [23].

Awareness of pelvic floor muscles contraction is individually different and may require the utilization of different techniques. The improvement obtained in Abd. ex's group can be explained as the abdominal muscles act indirectly to activate the pelvic floor muscles and maintain its coordination, support, endurance and strength [15]. In addition, Thompson *et al.* [28] found abdominal muscles were more active than pelvic floor muscle in symptomatic women, and suggested careful monitoring of this phenomenon when teaching pelvic floor muscle contractions. Furthermore, there is more than preliminary evidence that exercises for transversus abdominis and the obliqus internus when recruited lead to activation of the pelvic floor muscle. This was the essential concept behind the regimen of exercises in Abd. ex's group of this study [20,22].

Both abdominal and pelvic floor muscles are affecting each other. This was obvious when healthy subjects co-contracted pelvic floor during low abdominal hollowing in four-point kneeling results in greater increase in transversus abdominis thickness [29]. Furthermore, there was an increase in thickness of the transversus abdominis and internal obliqus muscles during pelvic floor muscle (PFM) contraction showing a co-contraction of the abdominals during PFM contraction both in women with and without SUI [30]. In contrast, EMG biofeedback over abdominal muscles was used for patients suffering from SUI who asked to minimize the abdominal muscles contraction during pelvic floor exercises. It seems that using biofeedback provides no difference between both groups [31]. In addition, Bo [32] concluded that instruction to contract the pelvic floor muscles produces a more effective pelvic floor muscle contraction than instruction to perform a transversus abdominis muscle contraction.

The effectiveness of pelvic floor muscles training for SUI as in PF ex's group can be explained that the pelvic floor contraction enhances closure of the urethra. With this closure, pressure in the urethra is elevated and leakage is avoided. Contraction also helps to maintain urethral position during intra-abdominal pressure increase [33].

The results obtained in PF ex's group are supported by many studies which had shown the effects of pelvic floor exercises as elevation of the bladder neck, increased pelvic floor contraction pressure [34,35], and decrease in volume of leaked urine [36]. Pelvic floor exercises are superior for treating SUI compared with electrical stimulation, biofeedback, vaginal cones, and no treatment [37]. Pelvic floor exercises have a long term benefit for patients after vaginal and cesarean birth [38]. Furthermore, the benefits of pelvic floor exercises can be maintained for up to 5 years even with a reduction in frequency of exercise to as little as one session/week [39].

Finally, we recommend for further studies using another methods of assessment e.g. one pad test. In addition, compare the abdominal versus the pelvic floor exercises in normally weight females with SUI or MUI.

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