Effect of abdominal versus pelvic floor muscle exercises in obese Egyptian women with mild stress urinary incontinence: A randomised controlled trial

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Abstract

The aim of this study was to compare the benefits of a 12-week abdominal and pelvic floor muscle strength training programme for the treatment of mild stress urinary incontinence (SUI) in obese women. Thirty obese female patients with mild SUI were randomly divided into two groups: the abdominal exercise (ABD) group and the pelvic floor exercise (PF) group. The participants were evaluated for vaginal pressure, leak point pressure (LPP) and waist–hip ratio (WHR) before, immediately after and at a 12-week follow-up after the termination of treatment. The ABD group showed a significant increase in vaginal pressure immediately after the intervention and at follow-up (\(p < 0.001\)), while the PF group showed no significant change in this variable. The ABD group also showed a significant increase in LPP after 12 weeks of treatment (\(p = 0.008\)), while the PF group demonstrated no significant change in the same variable (\(p = 0.030\)). At 24 weeks, the LPP remained significantly different from the baseline only for the ABD group (\(p = 0.005\)). The results showed that the 12-week abdominal muscle strength training programme is superior to pelvic floor strength training for the treatment of mild SUI in obese patients.

Introduction

Stress urinary incontinence (SUI) involves an involuntary loss of urine that occurs following a sudden rise in intra-abdominal pressure caused by coughing, sneezing,
straining, laughing or other physical activities. It happens 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 including advancement in age, childbirth, smoking, chronic bronchitis, and obesity [3].

There are many methods to diagnose SUI. One of them is leak point pressure (LPP) testing, which is originated from extensive video urodynamic studies carried out over many years in a wide variety of patients including those with idiopathic incontinence, stress incontinence and neurogenie conditions [4]. In addition, the perineometer, via a compressible vaginal catheter that is connected to a manometer, measures the increase of intravaginal pressure that is produced by contraction of the pelvic floor muscles [5].

Obesity has often been suggested as a risk factor for urinary incontinence. Each 5 kg/m² increase in body mass index (BMI) is associated with a 60–100% increased risk of daily incontinence [6]. There are several mechanical and physiological reasons why an increased BMI may be associated with, if not causative of, urinary incontinence [7]. The strong association between increasing weight and SUI may be related to the higher resting intra-abdominal and intravesical pressures in obese individuals [8]. Increased intra-abdominal pressures adversely stress the pelvic floor and affect the neuromuscular function of the genitourinary tract [9].

The increase in intravesical pressure associated with a rise in 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 a chronic stretch on the pudendal nerve [11].

Pelvic floor exercises [12,13] are advised as a first line of treatment for women with SUI. These exercises are designed to strengthen weak perineal and pelvic floor muscles, but their success highly depends on patients’ motivation level and compliance with the exercises [14].

Contraction of the abdominal muscles may provide an efficient mechanism by which contraction of the pelvic floor muscles is initiated, particularly for patients who have difficulty in learning how to contract those muscles. However, the use of abdominal muscle training to rehabilitate the pelvic floor muscles may be useful in treating SUI [15]. Madill and McLean [16] found that deep abdominal muscle contraction increased intravaginal pressure. Moreover, the pelvic floor muscles act as part of an integrated abdominopelvic unit. The central nervous system ensures appropriate timing of the pelvic floor muscle, automatic response to any change in trunk posture and trunk muscle activity [17]. Power [18] has proposed that there is a close association between the pelvic floor muscles and abdominal muscles, which may originate from a direct continuation of puborectalis with rectus abdominis in an imperfectly developed foetus.

Some studies [19–21] have indicated that abdominal activity and pelvic floor muscle contraction are a normal response to each other. The response of the abdominal muscles to voluntary contraction of the pelvic floor muscles showed a greater amplitude of electromyographic (EMG) activity in transversus abdominis than rectus abdominis and obliquus externus abdominis when the spine was positioned in extension [19]. When specific isometric abdominal contractions were performed in the supine position, EMG activity in the pelvic floor muscle contraction increased. In addition, urethral pressure increased with voluntary pelvic floor muscle contraction and isometric abdominal muscle holds [20,21].

So far, only one randomised controlled trial has addressed the effect of abdominal muscle training on SUI. The results showed that additional training of transversus abdominis after pelvic floor muscle training and neuromuscular stimulation did not provide any incremental improvement in SUI. However, the coactivation and coordination of transversus abdominis and the pelvic floor muscles was not targeted [22].

In this randomised controlled trial, we compared the response to abdominal muscle training with pelvic floor muscle training for the treatment of mild SUI in obese women.

Methods

Subjects

Obese women with mild SUI were studied. The diagnosis of mild SUI was made via history-taking, vaginal examination and urodynamic study. The patients were referred from the gynaecological and urological outpatient’s clinics at Bab El Sharia University Hospital. The hospital’s ethical committee approved the study. The inclusion criteria were: age = 30–40 years, parity ≤ 3, BMI 30–34 kg/m² and waist–hip ratio ≥ 0.8. The exclusion criteria were pregnancy, lower urinary tract infection, neurological problems, pelvic tumour, diabetes, smoking, chronic chest diseases, the presence of other types of urinary incontinence and use of any medications or medical/surgical interventions for SUI.

Thirty patients fulfilled the eligibility criteria and were enrolled in the study (Fig. 1). Their demographic data are summarised in Table 1. All patients gave their written consent before participating in the study, and were provided with a full explanation of the treatment protocol. All procedures were performed in accordance with the Declaration of Helsinki.

Outcome assessments

Patients were assessed at three time points: baseline, 12 weeks following exercise intervention, and then 24 weeks after the beginning of the study as a follow-up (i.e., 12 weeks after the termination of treatment). The assessors were blinded to group assignment at all time points. Outcome measures used were as follows.

A perineometer (Peritron 9300; Cardio Design Pty Ltd, Oakleigh, VIC, Australia) was used to assess vaginal pressure as a marker of pelvic floor muscle strength. During assessment, patients were asked to strongly squeeze, lift, and maintain hold (as long as possible to produce their
maximum effort) on the vaginal probe of the perineometer. In addition, the patients were taught not to involve rectus abdominis or the gluteal muscles during the assessment. The examiner observed the cranial movement of the perineum through the slight anterior tilt of the sensor (toward the anus) and recorded the readings over the monitor. This manoeuvre was repeated three times per session and the mean vaginal pressure (cmH$_2$O) was

**Table 1** Demographic data of subjects

| Group    | Range          | Mean | Standard deviation | t value | p     |
|----------|----------------|------|--------------------|---------|-------|
|          | Minimum - Maximum |      |                    |         |       |
| Age (y)  | ABD 35 - 45 | 39.9 | 3.5                | 0.113   | 0.922 |
|          | PF 35 - 45  | 39.7 | 3.6                |         |       |
| Weight (kg) | ABD 72 - 97 | 84.9 | 7.4                | 0.990   | 0.341 |
|          | PF 70 - 98  | 82.8 | 8.1                |         |       |
| Height (cm) | ABD 153 - 174 | 162.3 | 7.9           | 1.042   | 0.324 |
|          | PF 152 - 173 | 160.2 | 7.4              |         |       |
| Body mass index (kg/m$^2$) | ABD 30.7 - 33.8 | 32.2 | 0.9           | 0.124   | 0.914 |
|          | PF 31.1 - 33.8 | 32.2 | 0.8            |         |       |

$ABD = $ abdominal exercise; $PF = $ pelvic floor exercise.
calculated. In addition, the perineometer was used as adjunct biofeedback in the pelvic floor muscle group while they were performing the exercises.

Urodynamic studies were performed using a Merkur 2000 urodynamic system (supplied with puller, EMG preamplifier and electrical roller pump) (Wiest Uropower Ltd., Potsdam, Germany) in order to confirm the diagnosis of SUI and also to measure Valsalva LPP (in cmH2O).

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

Tape measurement was used to calculate the waist–hip ratio (which had to be ≥ 0.8) at the baseline assessment. The normal value for women is 0.7 [23].

Intervention

Eligible patients were randomly allocated into either the abdominal exercise (ABD) group or the pelvic floor muscle exercise (PF) group using a simple randomisation method in which papers with concealed names were picked by a third party to select the patients for each group. The ABD group (n = 15) underwent an abdominal muscle exercise strength training programme specifically for the transversus abdominis and obliquus internus muscles [24], whereas the PF group (n = 15) underwent a pelvic floor muscle strength training programme. The intervention was applied in an isolated and secured location within the physiotherapy outpatient clinic. Both groups underwent three treatment sessions per week for 12 consecutive weeks (see the Appendix for details).

All patients received the standard treatment for SUI and obesity, including patient education (e.g., the appropriate way of doing the exercises, the amount and timing of fluid intake per day, and the voiding frequency), and dietary modification in the form of an intake of 1200 kcal/d divided into three main meals and two snacks. The actual treatment was terminated at 12 weeks. The patients in both groups were encouraged to continue their own programme plus dietary modifications until they were reassessed at week 24.

Statistical analysis

SPSS 14.0 for windows Integrated Student Version (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. An unpaired t test was used to compare the variables between the two groups at baseline. To assess the treatment effect, a 2 × 3 analysis of variance (ANOVA) test (between-subject factor: group; within-subject factor: time) was used, followed by a post-hoc t test analysis to assess the time effect. Comparisons between groups at each time point were made using unpaired t tests. Bonferroni correction was used, with the alpha value adjusted to 0.017 for the post-hoc comparisons.

Results

There were no statistically significant differences between the ABD and PF groups in terms of age, weight, height or BMI, as shown in Table 1.

Vaginal pressure

There was no significant difference (p = 0.902) in vaginal pressure between the two groups at baseline. ANOVA revealed a significant group × time interaction effect (F = 7.083, p = 0.001). The ABD group showed a significant increase in vaginal pressure at 12 and 24 weeks (p < 0.001) compared with baseline, by 15.6% and 18.0%, respectively. In contrast, the PF group showed no significant change over time (p > 0.05) (Table 2).

Leak point pressure

There was no significant difference (p = 0.951) in LPP between the two groups at baseline. There was a statistically significant group × time interaction (F = 10.832, p < 0.001). A significant increase in LPP was observed after 12 weeks of treatment in the ABD group (by 16.0%, p = 0.008), but not in the PF group (by 9.1%, p = 0.030). At 24 weeks, the LPP remained significantly different compared with baseline (p = 0.005) in the ABD group, but not in the PF group (p = 0.083) (Table 2). Between-group comparisons, however, showed no significant differences at 12 weeks (p = 0.210) or 24 weeks (p = 0.058).

Waist–hip ratio

There was no significant difference (p = 0.892) between the groups at baseline. There was a statistically significant group × time interaction effect (F = 7.351, p = 0.001).

Table 2  Outcome measures at baseline, and 12 and 24 weeks post-treatment in the two groups

| Outcome               | ABD group         | PF group          |
|-----------------------|-------------------|-------------------|
|                       | Baseline | 12 weeks | 24 weeks | Baseline | 12 weeks | 24 weeks |
| Vaginal pressure (cmH2O) | 49.93 ± 4.85 | 57.73 ± 6.39* | 58.93 ± 4.56* | 50.26 ± 6.06 | 52.60 ± 7.60 | 53.26 ± 7.85 |
| LPP (cmH2O)            | 80.00 ± 5.52 | 92.80 ± 13.57* | 93.46 ± 11.96* | 78.00 ± 4.49 | 87.33 ± 9.07 | 86.20 ± 7.75 |
| WHR                   | 0.89 ± 0.04 | 0.84 ± 0.03* | 0.83 ± 0.03* | 0.88 ± 0.05 | 0.86 ± 0.05 | 0.86 ± 0.04 |

Data are presented as means ± SD unless otherwise indicated.
ABD = abdominal exercise; LPP = leak point pressure; PF = pelvic floor exercise; WHR = waist–hip ratio.
*Statistically significant difference (p < 0.017).
Only the ABD group showed a significant change at 12 and 24 weeks ($p < 0.001$) (Table 2).

Discussion

In the current study, there were significant improvements (vaginal pressure, LPP and waist–hip ratio) obtained after 12 weeks of intervention in the ABD group. The PF group, in contrast, did not show a significant improvement in vaginal pressure and waist–hip ratio. The evidence obtained from this study thus indicates that the ABD programme seems to be more beneficial among obese patients with mild SUI.

Regarding the effect of the abdominal muscle exercises on the function of the pelvic floor muscles in mild SUI, there are no studies to test the effect of abdominal muscle training alone in comparison to pelvic floor muscle training for SUI. A recent study by Hung et al. [25] found that a 4-month intervention of retraining the coordinated function of the diaphragmatic, deep abdominal and pelvic floor muscle could improve the symptoms and quality of life in women with SUI or mixed urinary incontinence.

Waist–hip ratio showed a significant reduction after 12 and 24 weeks compared with baseline in the ABD group, but not in the PF group. Central adiposity increases intra-abdominal and bladder pressure, and urethral mobility. Therefore, weight reduction achieved by changes in dietary intake and physical activity may reduce forces on the bladder and pelvic floor, thus reducing incontinence [26].

This study showed that an improvement in vaginal pressure and LPP can be obtained in 12 weeks. This is broadly in line with the current consensus in muscle physiology that improvements in strength can be observed after 8 weeks of training [27]. Furthermore, even if the pelvic floor or abdominal muscles are severely and recently affected, as in cases of persistent postnatal SUI, 8 weeks of pelvic floor or pelvic floor plus abdominal training are sufficient to improve pelvic floor strength [23].

Awareness of pelvic floor muscle contraction is individually different and may require the utilisation of different techniques. The improvement obtained in the ABD group may be explained by the fact that the abdominal muscles act indirectly to activate the pelvic floor muscles and maintain their coordination, support, endurance, and strength [15]. Thompson et al [28] found that the abdominal muscles were more active than the pelvic floor muscles in symptomatic women, and suggested careful monitoring of this phenomenon when teaching pelvic floor muscle contractions. Previous studies have also demonstrated that recruitment of the transversus abdominis and obliquus internus muscles during abdominal exercises would lead to activation of the pelvic floor musculature [19,21]. This was the essential concept behind the regimen of exercises used in the ABD group in the current study.

The abdominal and pelvic floor muscles could affect each other. This was obvious when healthy subjects co-contracted the pelvic floor muscles during low abdominal hollowing in four-point kneeling, which would then result in an increase in thickness of transversus abdominis [29].

There was also an increase in thickness of the transversus abdominis and obliquus internus muscles during pelvic floor muscle contraction both in women with and without SUI [30]. In contrast, EMG biofeedback over the abdominal muscles was used for patients suffering from SUI who were asked to minimise abdominal muscle contraction during pelvic floor exercises. It seems that the use of biofeedback did not lead to any difference between the two groups [31]. In addition, Bo et al [32] concluded that instructions to contract the pelvic floor muscles produced a more effective pelvic floor muscle contraction than instructions to perform a transversus abdominis muscle contraction.

Pelvic floor muscle exercises are thought to be beneficial for treating SUI as 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 increases [33]. Several studies have shown that pelvic floor exercises can produce effects such 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 caesarean birth [38]. 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 per week [39]. However, the PF group only showed a some increase in LPP after 12 weeks of treatment that did not quite reach statistical significance. Although the majority claimed that they continued to perform pelvic floor muscle training after 12 weeks, the effect on LPP was not further enhanced at 24 weeks. These findings thus raise concerns about the efficacy of pelvic floor muscle training [40].

Vaginal pressure and waist–hip ratio showed no significant improvement in the PF group. This may be related to the difficulty of performing the exercises and the lack of awareness of the pelvic floor contraction.

Limitations of the study

One of the weaknesses of the study is that BMI assessment was not done post-intervention and at follow-up. Pelvic floor muscle training was carried out without using vaginal cones as biofeedback. Furthermore, we did not measure the actual episodes of leakage. For further research, we recommend using other methods of assessment (e.g. a 1-hour pad test). Further study should also compare abdominal with pelvic floor exercises in women of normal weight with SUI or mixed urinary incontinence.

Conclusion

This study showed that 12 weeks of specific abdominal exercises resulted in more improvement in vaginal pressure and LPP over pelvic floor exercises.
Appendix

| Stage                      | Exercise programme                                                                 | Exercise description                                                                                                                                 |
|----------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Abdominal exercise group (ABD) | Transversus abdominis muscle exercises                                               | Patients were in the crook lying position and were asked to strongly and statically contract their abdominal muscles. Fifteen repetitions were carried out; each one consisting of contraction for 10 s followed by relaxation for 20 s. After 15 repetitions, patients rested for 5 min. The sequence was then repeated for two sets of 15 repetitions. Therapist: the patient's hands over the abdomen to feel the tension. Pelvic and spinal movements were prevented. |
| Pelvic floor exercise group (PF) | Pelvic floor muscle exercises (using the Perineometer as an adjunct)              | Patients were asked to contract the anterior fibres of pubococcygeus for 15 repetitions consisting of contraction and squeezing for 10 s followed by relaxation for 20 s. After 15 repetitions, patients rested for 5 min. Perineal palpation was carried out during the exercise to ensure cranial movement of the perineum. **First step for pubovaginalis:** Patients were in the crook lying position and were asked to strongly and statically contract their abdominal muscles and then try to touch the furthest point of their legs with their fingertips for 15 repetitions consisting of contraction for 10 s followed by relaxation for 20 s. After 15 repetitions, patients rested for 5 min. The sequence was then repeated on the other leg. **Second step for puborectalis:** Patients were asked to contract the posterior fibres of pubococcygeus for 15 repetitions consisting of contraction and squeezing for 10 s followed by relaxation for 20 s. After 15 repetitions, patients rested for 5 min. The therapist’s fingertips were placed around the anus to ensure contraction of puborectalis and detect any substitution of the gluteus maximus muscles. **Third step for pubococcygeus as a whole:** Patients were asked to contract the anterior and posterior fibres of pubococcygeus for 15 repetitions consisting of contraction and squeezing for 10 s followed by relaxation for 20 s. Palpation, as for Step 2, was carried out in addition to verbal instruction to ensure raising of the perineum. |

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