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Effect of structured pelvic floor muscle training on pelvic floor muscle contraction and treatment of pelvic organ prolapse in postpartum women: ultrasound and clinical evaluations

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Abstract

Objectives The purpose of this study is to examine the impact of structured pelvic floor muscle training (PFMT) on pelvic floor muscle (PFM) contraction and the treatment of pelvic organ prolapse (POP) in postpartum women.

Methods Sixty patients who volunteered for a PFMT assessment at 6–8 weeks after delivery were included in this retrospective analysis. For 5 weeks, all patients had structured PFMT, which included supervised daily pelvic muscle contractions, biofeedback therapy, and electrical stimulation. The main outcomes were POP stage assessed by POP quantification (POP-Q), pelvic organ position and hiatus area (HA) assessed by transperineal ultrasound, PFM contraction assessed by Modified Oxford scale (MOS), surface electromyography (EMG), and sensation of PFM graded using visual analog scale (VAS).

Results Structured PFMT was associated with better POP-Q scores in Aa, Ba, C, and D (p values were 0.01, 0.001, 0.017, and 0.001 separately). The bladder neck at rest and maximum Valsalva, the cervix position and HA at maximum Valsalva in transperineal ultrasound were significantly better than before (p values were 0.031, <0.001, 0.043, and <0.001 separately). PFM contraction assessed by MOS, EMG, and PFM VAS score were significantly improved (all p values were <0.001). However, no significant improvement was observed in POP-Q stage.

Conclusions Structured PFMT can increase PFM function in postpartum women but cannot modify the POP-Q stage. Transperineal ultrasonography is a useful method for evaluating therapy efficacy objectively. More randomized controlled trials are needed before definitive conclusions can be drawn about the effect of structured PFMT on POP in postpartum women.

Keywords Postpartum · Pelvic floor muscle training · Pelvic floor organ prolapse · Transperineal ultrasound

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Introduction

Pelvic organ prolapse (POP), a common gynecological disorder, can impair women's quality of life by causing discomfort and problems with urination, intercourse, and defecation [1–3]. The main triggering factors include pregnancy and vaginal delivery. According to estimates, vaginal birth, and pregnancy account for 75% of POP instances [4]. The pressure of the levator ani and intra-abdominal muscles rises during pregnancy and vaginal birth, compressing the pelvic floor tissue and relaxing the pelvic floor support, leading to bladder, bowel, or uterus descent into the vagina [5, 6]. In addition, pregnancy-related changes in estrogen and progesterone levels decrease the collagen metabolism of the pelvic connective tissue and impact the supportive role of the pelvic floor structure [7]. According to reports, POP is diagnosed in up to 50% of parous women [8], and the prevalence of POP stage ≥ II at 3–6 months after delivery ranges from 18 to 56% [9]. Therefore, early nonsurgical postpartum prevention and treatment are required.

Pelvic floor muscle training (PFMT), also known as Kegel's exercise, is a set of intentional pelvic floor muscle (PFM) contractions. It was first proposed by Kegel in 1936 for treating and preventing female urine and fecal incontinence [10]. In contemporary clinical practice, PFMT has been updated. It includes several therapeutic techniques (called structured PFMT), such as electrical stimulation and daily voluntary PFM contractions combined with or without biofeedback therapy.

Several randomized controlled trials have shown that PFMT leads to a small, but probably important, reduction in prolapse symptoms in women of all ages who had stage I–III prolapse [11]. Furthermore, a study found that supervised Kegel exercise with biofeedback is more effective in reducing stress urinary incontinence (SUI) than unsupervised Kegel's exercises [12]. These findings indicate that structured PFMT (with biofeedback) has the potential to improve PFM strength and postpartum POP. The aim of this study was to evaluate the efficacy of structural PFMT initiated in the early postpartum period for pelvic floor function in postpartum women by objective evaluation methods.

Materials and methods

The study was approved by the hospital ethics committee, and all patients provided written informed consent. A total of 60 patients who volunteered for a PFM assessment at 6–8 weeks postpartum in our hospital between November 2018 and November 2020 were enrolled in this retrospective study. A diagram of the overall study design is shown in Fig. 1.

Participants with levator ani muscle (LAM) avulsion and levator co-activation were excluded [13]. General clinical data were collected by a questionnaire, including age, height, weight, body mass index (BMI), delivery mode, neonatal birth weight, and symptoms of postpartum.

All patients were given structured PMFT, including Kegel's exercise, electrical stimulation, and biofeedback therapy. All patients were encouraged to perform daily Kegel's exercise three times a day at home, one time consisting of 10–15 contractions. The contraction lasted for no less than 6 s each time, then they relaxed for 10–20 s and repeated. Electrical stimulation and biofeedback therapy were given twice a week for 5 weeks. The pelvic floor rehabilitation instrument (SA980X Nanjing Vishee Technology Co., Ltd., China) was used to treat patients with electrical stimulation and biofeedback technology. Patients were in the lithotomy position. The therapist slowly inserts the vaginal electrode probe into the vagina and places the electrodes as parallel to the left and right vaginal walls as possible. Adjust parameters according to individual conditions of subjects. The range of current intensity was 10–30 mA, the frequency was 30–40 Hz, and wave width was 200–500 μs. It was better for patients to feel passive pelvic floor contraction and no pain. Instruct subjects to actively cooperate and train PFM according to the images and instructions on the instrument screen. In the biofeedback, during the intermittent period, the woman fully relaxed the PFM as much as possible, when the voltage screen was lower than the baseline, the instrument gave

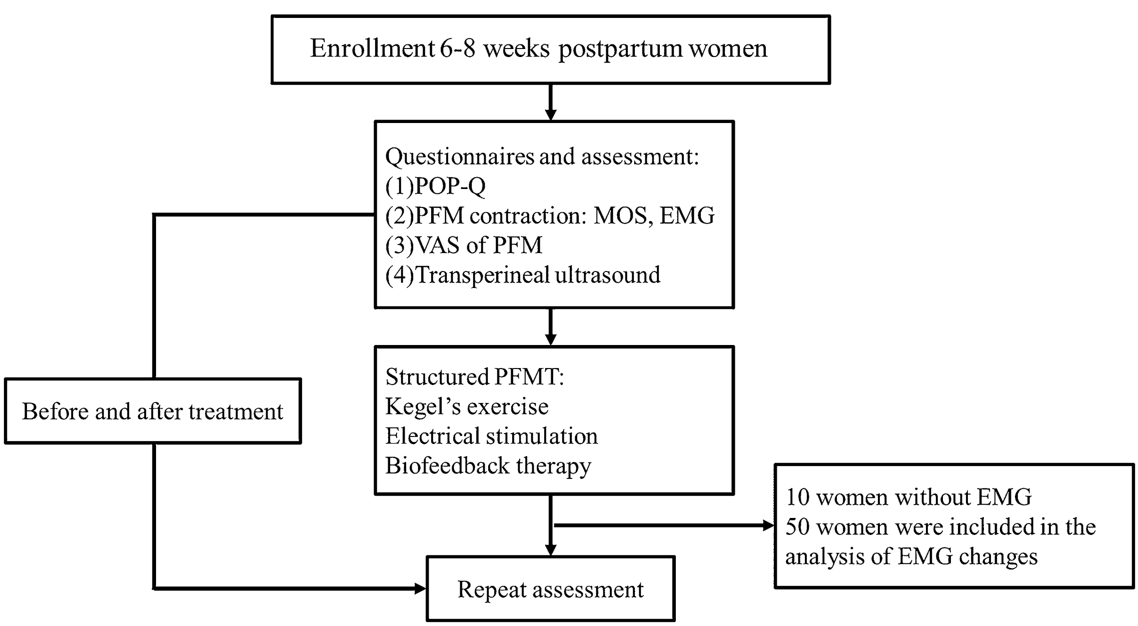

Fig. 1 Diagram of patient evaluation and treatment

instructions to the woman to do rapid contraction, and then entered the intermittent period, repeated the action. Each biofeedback treatment lasted 20 min.

At the beginning of treatment, patients with poor PFM contraction may actively contract their abdominal muscles to increase abdominal pressure to meet the standard contraction curve, which can affect the PFM strength grading and pelvic floor EMG results. All subjects received individual guidance and ability assessment to achieve the correct PFM contraction.

Primary outcomes were POP-Q stage, transperineal ultrasound, PFM contraction, and visual analog scale (VAS) of LAM.

POP-Q

POP will be staged according to the POP-Q staging system of the International Continence Society (ICS) [14]. The POP-Q point of organ descent was measured relative to the hymen during the maximum Valsalva maneuver with the woman in the lithotomy position.

PFM contraction and VAS score

Assessment of PFM contraction by digital palpation was performed using two fingers at the level of the LAM, approximately 4 cm into the vagina. The contraction was assessed using the six-point Modified Oxford scale (MOS), which ranges from 0 (no contraction) to 5 (strong contraction). The EMG was performed using an instrument (SA980X Nanjing Vishee Technology Co., Ltd., China) to record the signals of electromyographic activity on the surface of the PFM during the pre-resting phase, the assessment phase of the fast muscles (class II muscles), the assessment phase of the slow muscles (class I muscles), and the post-resting phase. In addition, quantify the values of the muscle voltages of the different muscle fibers. The scale of VAS had marking every inch from 0 to 10 and 0 represented no pain and 10 represented extreme pain.

Transperineal ultrasound

Transperineal ultrasound was performed by a radiologist with more than 5 years of experience in sonography of obstetrics and gynecology, especially on the pelvic floor, using Voluson GE E8 (GE Healthcare, Zipf, Austria) with a 4–8-MHz curved-array transducer. The patients were in the lithotomy position with an empty bladder (< 50 ml). The distance of the bladder neck, cervix, and rectal ampulla from the reference line were measured on the rest and the maximum Valsalva. The horizontal line of reference is placed through the inferior margin of the symphysis pubis. The levator hiatus area (HA) was assessed on an axial view of the levator hiatus by 3-dimensional transperineal ultrasound.

Statistical analyses

Data were analyzed using SPSS, version 15. Quantitative data were expressed as means ± standard deviations (SD) and were compared using Student's t-test and Wilcoxon signed-rank test. Ranked data were expressed as numbers and percentages and were compared using the Wilcoxon rank-sum test. A probability value of $p < 0.05$ was used to denote statistical significance.

Results

Baseline demographic and clinical data are shown in Table 1. Of these, 10 women did not have EMG, so 50 women were analyzed for EMG changes before and after treatment (Table 2).

Compared with the baseline examination (Table 3), details of POP-Q points: Aa, Ba, C, D, and gh were statistically significantly better. In transperineal ultrasound, the position at rest of the bladder neck (23.52 mm vs 24.67 mm; $p = 0.031$) and maximum Valsalva maneuver of the bladder (3.3 mm vs 6.75 mm; $p < 0.001$), cervix (20.18 mm vs 21.95 mm; $p = 0.043$), and HA (18.04 cm^2 vs 16.19 cm^2; $p < 0.001$) were significantly better than the baseline. In addition, bladder neck descent distance (rest position-valsalva position) (20.2 mm vs 18.16 mm; $p = 0.006$) was significantly better than the baseline. PFM contraction assessed by vaginal palpation (MOS I, 1.88 vs 3.52; $p < 0.001$; II, 2.1 vs 3.74; $p < 0.001$) and surface EMG of class II muscle

Table 1 Demographic characteristics of patients

Characteristic	*n* (60)
Age (year)	31.02 ± 3.60
Weight (kg)	60.64 ± 10.74
BMI (kg/m^2)	22.96 ± 3.93
Delivery mode	
Eutocia	48 (80%)
Cesarean	12 (20%)
Neonatal birth weight (g)	3234.48 ± 408.23
Symptoms of postpartum	
Stress incontinence	24 (40%)
Dyspareunia	8 (13%)
Urinary infection	14 (23%)
Lumbago and abdominal discomfort	32 (54%)

Means with standard deviations (SD) or frequencies with percentages (%)

PFMT pelvic floor muscle training, *SD* standard deviation

Table 2 EMG changes before and after treatment

EMG index (μV)	Before PFMT	After PEMT	z	p
Before resting period	8.31(4.94)	7.01(4.99)	1.312	0.192
Maximum mean value of class II fast muscle fibers	39.28(14.35)	60.42(24.57)	− 5.252	< 0.001
Average value of class I slow muscle	29.72(27.75)	30.56(9.71)	− 0.204	0.839
After resting period	9.19(5.49)	9.21(6.89)	− 0.021	0.983

Table 3 Point values (cm) for POP and transperineal ultrasound measurement

	Before PFMT	After PEMT	z	p
POP-Q				
Aa	− 1.89 ± 0.725	− 2.03 ± 0.851	− 2.583	0.01
Ba	− 1.892 ± 0.725	− 2.108 ± 0.611	− 3.299	0.001
Ap	− 2.767 ± 0.406	− 2.608 ± 1.312	− 0.303	0.762
Bp	− 2.825 ± 0.559	− 2.767 ± 0.362	− 0.303	0.762
C	− 4.833 ± 1.750	− 4.925 ± 2.461	− 2.385	0.017
D	− 6.398 ± 0.730	− 6.575 ± 1.950	− 3.284	0.001
gh	3.325 ± 0.694	3.083 ± 0.612	− 3.349	0.001
pb	3.133 ± 0.610	3.008 ± 0.661	− 0.655	0.513
Tvl	6.5 ± 2.926	6.07 ± 4.133	− 0.8	0.937
Pelvic organ position on US				
Rest (mm)				
Bladder neck	23.52(3.70)	24.67 (3.79)	− 2.154	0.031
Cervix	35.42 (5.38)	35.37 (4.09)	− 0.601	0.548
Rectal ampulla	13.6 (4.09)	13.73 (3.57)	− 0.833	0.405
On maximum Valsalva maneuver (mm)				
Bladder neck	3.3 (10.02)	6.75 (9.00)	− 4.03	< 0.001
Cervix	20.18 (7.31)	21.95 (6.39)	− 2.026	0.043
Rectal ampulla	− 1.57 (8.58)	− 0.53 (7.16)	− 1.197	0.231
Retrovesical angle (RVA)	145.75 (20.36)	144.08 (17.54)	− 1.705	0.088
Urethral rotation angle (URA)	38.83 (15.88)	37.33 (18.19)	− 1.073	0.283
Bladder neck descent (BND)	20.2 (9.30)	18.16 (7.04)	− 2.734	0.006
HA (cm^2)	18.041 (5.25)	16.185 (4.11)	− 4.486	< 0.001
Pelvic floor muscle contraction				
MOS (0–5)				
Class I muscle	1.88	3.52	− 6.281	< 0.001
	5/24/13/10/7/1	0/3/8/15/23/11		
Class II muscle	2.1	3.74	− 5.761	< 0.001
	5/22/11/11/6/5	0/2/9/13/15/21		
VAS				
Right LAM	4.43	1.18	− 5.751	< 0.001
Left LAM	4.28	1.47	− 5.055	< 0.001

(39.28 μV vs 60.42 μV; $p < 0.001$) were significantly better than the baseline. Furthermore, the VAS of LAM (right LAM 4.43 vs 1.18; $p < 0.001$; left LAM 4.28 vs 1.47; $p < 0.001$) was significantly better than the baseline.

Table 4 shows the number of women with POP-Q stage 0, I, or II at baseline and after structured PFMT. None of the participants had POP stage III or IV. We found that the POP-Q stage of 6 patients decreased from II to I, and one

Table 4 POP-Q stage at baseline and after structured PFMT (n, %)

	Before PFMT	After PEMT	z	p
POP-Q stage			− 1.044	0.297
0	5 (8.3)	6 (10)		
I	40 (66.7)	44 (73.3)		
II	15 (25)	10 (16.7)		

patient decreased from I to 0 after structured PFMT. In addition, one patient increased from stage I to II. However, there was no significant difference in POP-Q staging before and after structured PFMT.

Discussion

In this study, we investigated the efficacy of postpartum structured PFMT in the early postpartum period for postpartum women on pelvic floor muscle contraction and treatment of POP. Our findings showed that POP-Q score, the position of the bladder neck and cervix and HA, PFM strength and electrical activity, and PFM VAS score were significantly improved after PFMT. Other recent studies yielded similar results to ours [15–18]. Ana Paula M. Resendeet et al. [15] evaluated the efficacy of PFMT by pop-q, and the results showed that PFMT could improve POP symptoms, quality of life, prolapse severity, and PFM function. Ingeborg Hoff Brækken et al. [16] investigated the morphological and functional changes after PFMT in women with POP. In addition, they found that supervised PFMT can increase muscle volume, close the levator hiatus, shorten muscle length, and elevate the resting position of the bladder and rectum. The difference between our research and these cited studies is that they focus on women with POP stages rather than pregnant women in the early postpartum period.

In addition, several studies have proved that PFMT has some positive effects on reducing symptoms and the severity of prolapse [19–22]. The subjective prolapse symptoms of the patients we included were mild. Moreover, we found that the prolapse severity assessed by objective methods such as ultrasound and POP-Q scores was not completely correlated with patients' subjective symptoms. Therefore, this study is mainly to evaluate the changes by objective indicators.

Our study found that structured PFMT did not significantly improve the POP stage. Similar to our study, a systematic review and meta-analysis of PFMT found that the POP stage will likely not change with postpartum PFMT [23]. Moreover, our study analyzed the changes of some indicator points in POP-Q and found that there was still a statistical difference in Aa, Ba, C, and D. Still, these differences are not enough to cause changes in staging. A prospective study [24] also showed that PFMT combined with biofeedback-electrical stimulation could significantly improve the PFM function of women with PFD but could not improve the POP-Q stage of women with mild POP, which is similar to our study. They analyzed it may be because the treatment time is short, and the improvement of muscle strength is not enough to change the prolapse stage. In addition, we agree with their point of view, but this may require more research to confirm. In our study, one patient has a worse POP stage after structured PFMT than baseline. It may be because, at the first examination, due to the obvious perineal pain after delivery, the patient may not achieve the maximum Valsalva maneuver, resulting in the measurement result being less severe than the actual. After treatment, the patient's pain was significantly reduced, and the Valsalva maneuver could be completed more standardly, so we got a worse POP stage than before.

As a real-time, dynamic, and repeatable examination, ultrasound has been increasingly used by obstetricians and gynecologists to diagnose pelvic floor diseases. It can objectively and visually show the anatomical position of pelvic floor organs. It has also been included in the relevant guidelines for pelvic floor dysfunction in recent years [25, 26]. In this study, we use transperineal ultrasound to assess the improvement in pelvic floor function after structured PFMT. Transperineal ultrasound shows that the bladder neck and cervix position at rest and maximum Valsalva were improved. In addition, the HA at maximum Valsalva was significantly reduced. A prospective cohort study on postpartum women also showed that performing at least three sets of home PFMT daily significantly reduced the HA by 4.43%, consistent with our results [27].

In our study, MOS and EMG were used to evaluate the contraction of PFM, which provided a relatively comprehensive assessment of PFM contraction. MOS showed improvement in class I and II muscles after PFMT. In EMG, only the maximum mean value of class II fast muscle fibers significantly improved after PFMT. However, there is no significant change in the indicators of class I muscle associated with chronic pelvic floor dysfunction, and statistical analysis of a larger sample may be required.

There were some limitations in our study. First, the population sample size was small. Second, this study is retrospective. Only the patients are compared before and after treatment, and the blank control group is not set. In the future study, we will design a large sample randomized controlled trial with a blank control group. Third, this study conducted a course of treatment (twice a week for 5 weeks). The exercise time was relatively short, and the evaluation was performed after the end of a course of treatment. Whether PFMT can effectively improve POP symptoms and quality of life in the long term needs further study.

Conclusions

For postpartum women with POP-Q stage ≤ II, structured PFMT initiated in the early postpartum period is effective for pelvic floor tissue repair. The level of improvement is not enough to change the POP-Q stage. Transperineal ultrasound is an effective tool that can objectively evaluate therapeutic effectiveness. Further randomized controlled trials are needed before definitive conclusions can be drawn about the effect of structured PFMT on POP in postpartum women.

Author contributions HZ: project development, data collection, manuscript writing. X-NL: project development, data collection. L-NL: project development, data collection, and revision of the manuscript for important intellectual content.

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Data availability The data that support the findings of this study are available on request from the corresponding author, upon reasonable request.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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