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Original Article

Efficacy of Kegel exercises combined with electrical stimulation on the restoration of postpartum pelvic floor muscle function

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Abstract: Objective: To investigate the efficacy of Kegel exercises combined with electrical stimulation on the restoration of postpartum pelvic floor muscle (PFM) function. Methods: Data of 120 parturients with full-term singleton pregnancy who delivered vaginally in the Guang'an People's Hospital were retrospectively analyzed, and the study subjects were grouped into a Kegel exercise group (n=40, receiving Kegel exercise alone), an electrical stimulation group (n=40, receiving electrical stimulation alone) and a combined group (n=40, receiving Kegel exercises combined with electrical stimulation) according to the treatments received. All three groups received intervention for 3 months. The overall response rates (ORRs) at 3 months, changes in PFM strength and vaginal pressure during treatment, the scores of International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF), the incontinence quality of life questionnaire (I-QOL), and the incidence rates of pelvic floor dysfunction (PFD) were evaluated in the three groups. Results: ORR in the combined group (100.00%) was higher than that of the Kegel exercises group (87.50%) and the electrical stimulation group (85.00%) ($P < 0.05$). At 1, 3, and 6 months after intervention, the combined group was superior to the Kegel exercises and the electrical stimulation groups in systolic blood pressure (SBP) of pelvic floor, and the continuous SBP of type I and II muscle fibers ($P < 0.05$). After 6 months of follow-up, the scores of ICIQ-UI SF and I-QOL in the combined group were higher than those in the Kegel exercises and electrical stimulation groups ($P < 0.05$). The score of satisfaction in the combined group was higher than in Kegel exercises and electrical stimulation groups ($P < 0.05$). Conclusion: Kegel exercises combined with electrical stimulation have a good therapeutic effect on postpartum pelvic floor dysfunction, which can markedly improve PFM strength and vaginal pressure.

Keywords: Kegel exercises, electrical stimulation, pelvic floor muscle, restoration of function, efficacy

Introduction

Pregnancy and childbirth are one of the main factors leading to pelvic floor dysfunction (PFD) [1, 2].

PFD is one of the five major chronic diseases that seriously endanger women's health. PFD-related symptoms include pelvic organ prolapse, stress urinary incontinence (SUI), and chronic pelvic pain. An investigation of 19,024 women with SUI in China exhibited that the incidence of SUI was as high as 30.9% [3]. Other studies have suggested that the incidence of maternal SUI is about 38% at 8 weeks after delivery and 42% during pregnancy [4, 5]. At present, surgical treatment and non-surgical treatment are the main interventions for PFD in women. Surgical treatment is mainly to change the anatomic structures of patients or for transvaginal mesh implantation, but it has the disadvantages of high recurrence rate, high cost, and easy infection [6]. Non-surgical treatment mainly includes medication, physical rehabilitation, electrical stimulation, and biofeedback, which has been widely recognized by patients [7].

At present, although there are many clinical studies on rehabilitation therapy of pelvic floor muscles (PFMs), there are still few studies on the combination of electrical stimulation and Kegel exercises in the puerpera [8]. Kegel exer-

cise is a therapeutic measure to improve the function of PFMs through active PFM exercise [9]. This therapy was first introduced in 1970 by Dr. Arnold Kegel who invented it as a method to practice the contractility of pubococcygeal muscle. At present, this therapy has been proved to be applicable to routine PFM exercise of postpartum women, and has good effect in improving various urinary incontinence, vaginitis and puerperal symptoms. A study on 91 patients with PFD found that Kegel rehabilitation training was helpful to improve the clinical symptoms of patients [10]. So far, Kegel exercises have been extensively implemented in many countries and proven effective in improving pelvic floor function in parturients [11]. Electrical stimulation involves the application of electrical currents of different frequencies to stimulate the damaged PFMs and make them contract regularly, a form of passively exercise, thereby strengthening the entire PFMs and ultimately enhancing muscle strength [12]. A controlled study on 100 parturients showed that electrical stimulation could promote passive contraction of muscles and restore proprioception of class I and class II pelvic floor contraction [13]; with additional biofeedback therapy, patients could learn to contract the perineum, exercise class I and class II pelvic floor muscle strength, and correct deviated contraction methods under the guidance of visual images. In addition, electrical stimulation can also improve neuromuscular excitability and arouses impaired nerves due to compression, so as to promote the recovery of nerve function [12]. Therefore, in this study we investigated the combination of PFM rehabilitation therapy and electrical stimulation, and analyzed the feasibility of the combined treatment through controlled intervention, in order to provide a reference for postpartum rehabilitation of parturients.

Materials and methods

General data

In this retrospective study, a total of 120 parturients with full-term singleton pregnancy who delivered vaginally in the Guang'an People's Hospital were retrospectively selected as the study subjects, and were grouped into a Kegel exercise group (n=40), an electrical stimulation group (n=40) and a combination group (n=40) according to the treatments they received. Kegel exercises group performed Kegel exercises alone, electrical stimulation group was treated with electrical stimulation alone, and the combination group was treated with Kegel exercises combined with electrical stimulation. The study was approved by the Ethics Committee of the Guang'an People's Hospital.

Inclusion criteria: (1) parturients who were aged 20-35 years; (2) primiparas with singleton pregnancy; (3) parturients who underwent vaginal delivery; (4) parturients who were diagnosed with PFD after delivery; (5) parturients with complete clinical data; (6) parturients who underwent Kegel exercises and/or electrical stimulation and did not have contraindications.

Exclusion criteria: (1) parturients with mental disorders; (2) parturients with previous history of PFD; (3) parturients with malignant tumors; (4) parturients with urinary system infection; (5) parturients with previous history of pelvic surgery; (6) parturients with cognitive dysfunction; (7) parturients with vesical fistula or diseases that may affect the investigation results.

Intervention methods

All subjects received one-on-one nursing intervention and health education for postpartum PFM rehabilitation. The health education primarily involved steps, methods, principles and cautions in PFM rehabilitation. Kegel exercises group was treated with Kegel exercises alone, electrical stimulation group was treated with electrical stimulation alone, and the combination group was treated with Kegel exercises combined with electrical stimulation. The specific measures were as follows. (1) Kegel exercises. The subjects were placed in supine position with legs flexed apart. The subjects were asked to inhale and try to contract the anus for about 6-8 s, relax when exhaling, and repeat. The exercises lasted for about 30 min continuously each time, 3 times a day for 3 months. The subjects were informed to avoid involvement of leg and hip muscles during exercises, perform the exercises when sitting or standing upon the mastery of the actions, and gradually extend the duration of contraction and exercises, during which the exercises for intermittent urination (*i.e.*, actively stopping or slowing down the urine stream when urinating) could be performed [14]; (2) PFM biofeedback and electrical

stimulation. The electrodes of the PFM rehabilitation instrument were placed in the vagina of the parturient, and electrical stimulation with high frequency and high current intensity (the current intensity did not exceed 100 mA) was conducted. Each electrical stimulation was performed for 2 s, with an interval of 4 s, and each treatment lasted for 30 min, twice a week, for 3 months. All parturients were followed up by subsequent visit or telephone.

Observational indices and assessment criteria

Primary indicators

Overall response rate (ORR): After 3 months of intervention, PFM strength was measured by hand to evaluate the therapeutic effects on parturients. The specific evaluation methods were as follows. The parturient was placed in a semi-sitting position, with the knees apart. The physician gently pressed the abdomen of the parturient with the left hand, and stretched the middle and index fingers of the right hand into the vagina of the parturient. The parturient contracted the vagina following the physician's instructions. Grade 0 was given if the physician could not perceive muscle contraction; grade 1 was given if the physician could slightly perceive muscle peristalsis or contraction, but such peristalsis or contraction could not be maintained; grade 2 was given if the physician could perceive muscle contraction, which could last for 2 s and be performed twice; grade 3 was given if the muscle contraction could be maintained for 3 s and performed 3 times; grade 4 was given if the muscle contraction could be maintained for 4 s and performed 4 times; grade 5 was given if muscle contraction could be maintained for 5 s and performed 5 times. After 3 months of intervention, elevation of muscle strength level ≥ 2 grades was considered as marked response, elevation by 1 grade was considered as moderate response, and no elevation was considered as no response. The ORR = (number of cases with marked response + number of cases with moderate response)/ total number of cases × 100%.

Vaginal pressure and PFM strength: Before intervention (when the parturients were enrolled and did not receive intervention), after 1 and 3 months of intervention, and after 6 months of follow-up, the changes of the vaginal pressure and PFM strength in the three groups were evaluated. The resting pressure and systolic blood pressure (SBP) of the pelvic floor were measures of vaginal pressure, which were measured using a pelvic floor rehabilitation therapy apparatus (Beijing Hailongma Technology Co., Ltd., Beijing, China). The resting pressure refers to the PFM pressure when the vagina is relaxed, and the SBP of the pelvic floor refers to the difference between maximum SBP and resting pressure when the parturient tries to contract the anus. Types I and II muscle fibers were tested separately to assess PFM strength. Type I muscle fibers were measured using the continuous systolic pressure (*i.e.*, the average of maximum and minimum pressure during contraction of type I muscle fibers minus the resting pressure value) and duration, while type II muscle fibers were measured using the rapid SBP (*i.e.*, the result of the maximum pressure during rapid contraction of type II muscle fibers minus the resting pressure value) and the number of contractions.

Secondary indicators

Scores of international consultation on incontinence questionnaire-urinary incontinence short form (ICIQ-UI SF) and incontinence quality of life questionnaire (I-QOL): Before intervention and at 6 months of follow-up, scores of the ICIQ-UI SF and I-QOL were obtained. ICIQ-UI SF comprises 4 items, namely, the frequency of urinary leakage (0-5 points), amount of urinary leakage (0-6 points), the overall impact of urinary leakage (0-10 points) and self-diagnostic item (no score). The total score of ICIQ-UI SF is the sum of the scores of the first 4 items. A higher score indicates a more serious urinary leakage [15]. I-QOL consists of 22 items, all of which use a five-point Likert-type response scale. The total I-QOL score is 100 points. A higher score indicates a higher quality of life of the subjects [16].

Satisfaction of patients: A self-designed scale was used to evaluate the satisfaction of the three groups of patients after treatment. The full score of the scale was 100 points, and a higher score represented higher satisfaction of the subject.

Statistical analysis: The data analysis was performed using SPSS 22.0. The graphs in this study were plotted using GraphPad Prism.

The Kolmogorov-Smimov test was used to test the normality of quantitative data. Data con-

Table 1. Comparison of general clinical data among the three groups (x±s)/[n (%)]

Data	Kegel exercise group (n=40)	Electrical stimulation group (n=40)	Combination group (n=40)	*F*	*P*
Average age (years)	31.98±4.33	32.01±4.29	31.89±4.11	0.009	0.991
Average weight (kg)	74.29±3.91	74.34±3.89	73.98±4.31	0.093	0.911
Average gestational week (weeks)	38.89±2.32	38.91±2.29	38.79±2.81	0.027	0.973
BMI (kg/m^2)	24.26±3.51	25.16±2.95	24.59±3.65	0.635	0.514
Time from post-delivery to start of treatment (months)	1.56±0.21	1.63±0.15	1.54±0.32	0.223	0.632

Table 2. Comparison of ORRs among the three groups after 3 months of intervention [n (%)]

Group	Number of cases	Marked response	Moderate response	No response	ORR
Kegel exercise group	40	31 (77.50)	4 (10.00)	5 (12.50)	35 (87.50)
Electrical stimulation group	40	30 (75.00)	4 (10.00)	6 (15.00)	34 (85.00)
Combination group	40	35 (87.50)	5 (12.50)	0 (0.00)	40 (100.00)
χ^2	-	-	-	-	6.205
P	-	-	-	-	0.045

ORR: Overall Response Rate.

forming to a normal distribution were described as mean ± standard deviation (SD), and analyzed using independent sample t-test (two groups) or analysis of variance (three or more groups), and SNK test was used for post hoc comparison. The qualitative data were described by n (%), and comparison between groups was analyzed using Chi-square test. $P < 0.05$ indicated a statistical difference.

Results

Comparison of general clinical data

There was no significant difference in the general clinical data (*e.g.*, age, average gestational weak, average weight) among the three groups ($P > 0.05$), so the data were comparable (**Table 1**).

Comparison of clinical efficacies

After 3 months of intervention, the Kegel exercises group had 31 cases with marked response, 4 cases with moderate response and 5 cases with no response, with an ORR of 87.50%. The electrical stimulation group had 30 cases with marked response, 4 cases with moderate response and 6 cases with no response, with an ORR of 85.00%. The combination group had 35 cases with marked response and 5 cases with moderate response, with an ORR of 100.00%. The ORR in the combination group was significantly higher than that in the Kegel exercises and electrical stimulation groups ($P < 0.05$), but there was no difference between the Kegel exercises group and the electrical stimulation group ($P > 0.05$) (**Table 2**).

Changes of vaginal pressure and PFM strength

There were no significant differences in the vaginal pressure and PFM strength among the three groups before intervention ($P > 0.05$). After 1 and 3 months of intervention and after 6 months of follow-up, the resting pressure and the SBP of the pelvic floor in the combination group were markedly higher than those in the Kegel exercise and electrical stimulation groups ($P < 0.05$) (**Figure 1**). The continuous SBP and duration of type I muscle fibers in the combination group were significantly higher than those in the Kegel exercise and electrical stimulation groups ($P < 0.05$) (**Figure 2**). Compared to the Kegel exercise and electrical stimulation groups, the combination group had a higher rapid SBP and greater number of contractions ($P < 0.05$) (**Figure 3**). The vaginal pressure and PFM strength in the three groups were significantly improved after intervention, and the improvement in vaginal pressure and PFM strength in the combination group were more marked than those in the Kegel exercise or electrical stimulation groups, with significant differences ($P < 0.05$).

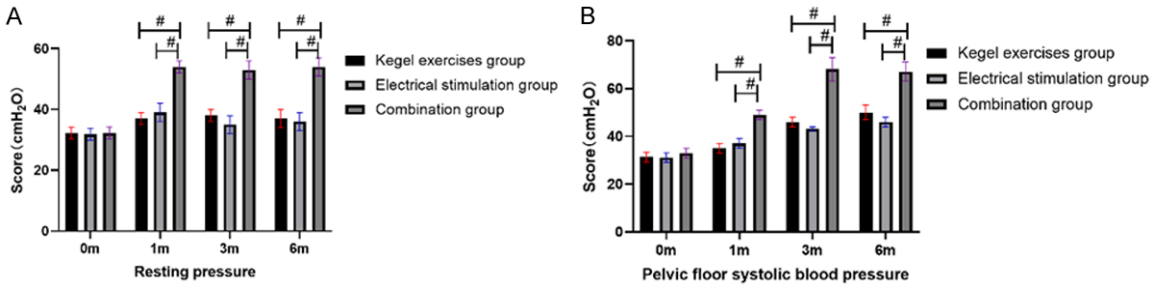

Figure 1. Changes in vaginal pressure in the three groups during intervention. A: Resting pressure. B: Systolic blood pressure of the pelvic floor. $^{\#}P < 0.05$.

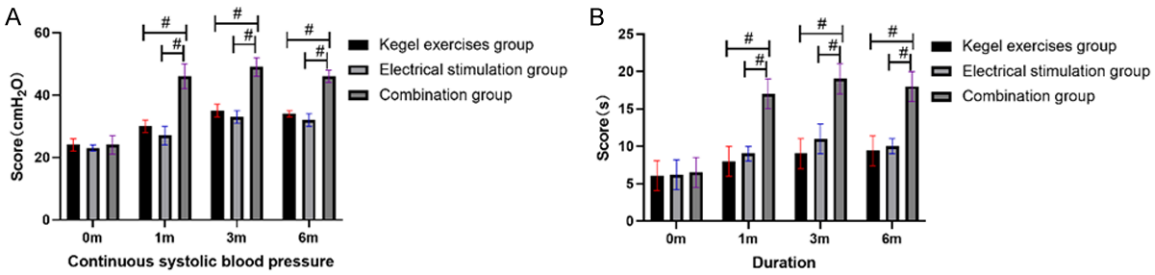

Figure 2. Changes in type I muscle fiber strength in the three groups during the intervention. A: Continuous systolic blood pressure. B: Duration of type I muscle fibers. $^{\#}P < 0.05$.

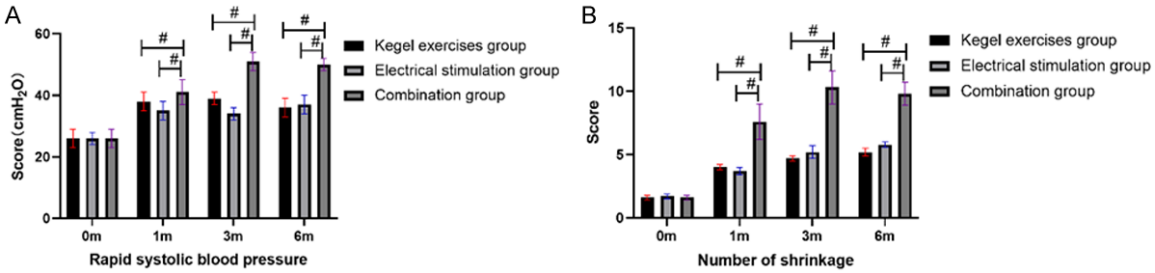

Figure 3. Changes in type II muscle fiber strength in the three groups during intervention. A: Rapid systolic blood pressure. B: Number of contractions. $^{\#}P < 0.05$.

Changes of quality of life

There were no marked differences in the scores of ICIQ-UI SF and I-QOL among the three groups before intervention ($P > 0.05$). After 6 months of follow-up, the ICIQ-UI SF scores in the three groups were lower compared to those before intervention, while the I-QOL scores in the three groups were higher compared to those before intervention ($P < 0.05$). After 6 months of follow-up, ICIQ-UI SF scores in the combination group were lower than those in the Kegel exercise or electrical stimulation groups, while I-QOL scores in the combination group were higher than those in the Kegel exercise or electrical stimulation groups ($P < 0.05$) (**Figure 4**).

Comparison of satisfaction

The score of patient satisfaction was (85.26± 4.21) in the Kegel exercise group, (86.32± 3.65) in the electrical stimulation group, and (92.36±2.15) in the combination group. Patient satisfaction was significantly higher in the combination group than in the electrical stimulation or Kegel exercise groups ($P < 0.05$), but exhibited no significant difference between the Kegel exercise group and the electrical stimulation group ($P > 0.05$).

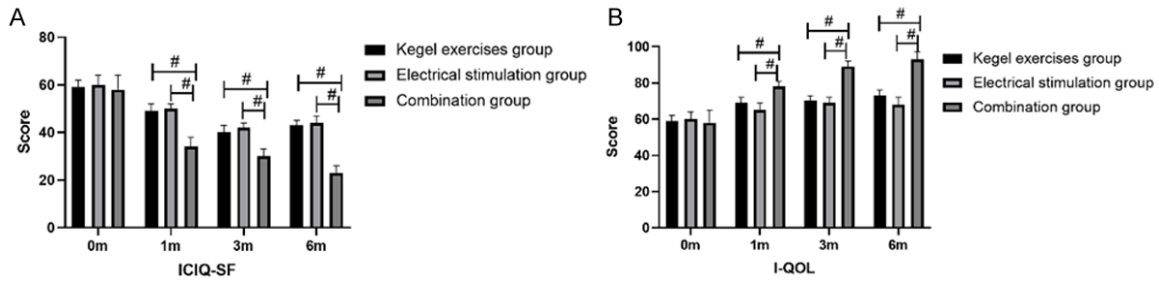

Figure 4. Changes in quality of life in the three groups before intervention and after 6 months of follow-up. A: Scores of International Consultation on Incontinence Questionnaire-Urinary Incontinence Short Form (ICIQ-UI SF). B: Scores of incontinence quality of life questionnaire (I-QOL). $^{\#}P < 0.05$.

Discussion

Pregnancy and childbirth have been shown to be independent risk factors for pelvic floor dysfunction (PFD) [17]. PFD occurs because PFMs are in a state of prolonged high load and traction due to pregnancy, and the fetal head directly compresses the PFMs, inducing muscle fatigue and even atrophy [18]. The sudden rise of high pressure during delivery leads to the excessive traction of the PFMs, resulting in the extreme traction and even tearing of muscle fibers, thus causing irreversible damage to PFM function [18]. An investigation of 1749 primiparas at 12 months after delivery showed that the incidence of postpartum SUI was as high as 47.5% [19]. A study indicated that most parturients who delivered vaginally complained of SUI or other types of urinary incontinence after delivery and had some symptoms (such as vaginal relaxation, frequent urination and constipation), which significantly affect their normal life [20].

Pelvic floor rehabilitation is an important approach to improve the quality of life of parturients. At present, there are few studies on the combination of Kegel exercise and electrical stimulation in the recovery of postpartum PFM function, which restricts the postpartum recovery process of women to a certain extent. This study analyzed the effects of Kegel exercise combined with electrical stimulation on the restoration of postpartum PFM function through grouping and comparison. The results showed that the clinical efficacy of Kegel exercise combined with electrical stimulation was better than that of Kegel exercises alone or electrical stimulation alone. A retrospective study of 100 parturients indicated that the ORR (97.50%) of Kegel exercises combined with electrical stimulation was higher than that (87.50%) of routine postpartum care [21]. A comparative analysis of the rehabilitation effect of Kegel intervention on PFMs of parturients showed that Kegel exercises could accelerate the rehabilitation of PFMs nerve and muscle injury in parturients, and had positive significance for long-term improvement of pelvic floor function in parturients [22]. We believe that Kegel exercise combined with electrical stimulation can effectively improve the PFM function, of which muscle and endurance exercises can drive the movement of muscles around the pelvic floor and expand the blood vessels of PFMs through continuous relaxation and contraction, thereby ameliorating the fluidity and microcirculation of muscle vessels, improving the metabolic rate of muscle tissues, and finally restoring the nerve conduction function and sensitivity of muscle tissues. A previous analysis of electrical stimulation was performed on the improvement in PFM function [23], and the findings showed that electrical stimulation could reduce the threshold value of PFM tissue, effectively restore the conduction function of nerve cells, and make muscle tissue passively contract under electrical stimulation, so as to improve muscle elasticity. Electrical stimulation could also inhibit the secretion of prostaglandin, reduce the permeability of capillaries around the PFM tissues, improve the pathologic state of exudation and edema of PFM, ameliorate the inflammatory changes caused by muscle injury, and finally restore PFM function.

In this study, the changes of vaginal pressure and PFM strength in the three groups were further analyzed, and the results exhibited that the vaginal pressure (vaginal resting pressure,

SBP of the pelvic floor, continuous SBP of type I muscle fibers and rapid SBP of type II muscle fibers) and PFM strength in the three groups were significantly improved during intervention. An investigation of 200 primiparas showed that after Kegel exercise intervention, the normal restoration rate of PFM strength in the observation group (86.0%) receiving Kegel intervention was remarkably higher than that in the control group (56%) receiving conventional intervention [24]. Another study showed that electrical stimulation could improve the PFM fiber strength and increase the duration of contraction [25]. In this study, the effective rate of combined intervention in the combination group reached 100.00%, which was significantly higher than the effect of other studies mentioned above. The reasons may be related to the young age of included parturients, so that they had faster recovery of physical function after delivery. In addition, Kegel exercises are simple and can be performed in an extensive range of scenarios, which enable maternal rehabilitation exercises at any time. Electrical stimulation can be conducted to activate the damaged nerves through stimulating the nerve muscles, which is helpful to accelerate the passive exercises of PFMs. Kegel exercises combined with electrical stimulation exhibit a better efficacy.

Finally, the comparisons of the quality of life and the satisfaction of parturients among the three groups further confirmed the effect of Kegel exercise combined with electrical stimulation on the quality of life and satisfaction of parturients, which may be related to the fact that long-term exercises of PFM function can maximize the restoration of normal function of PFMs and the urinary control ability of parturients.

The limitation of this study is that the influences of the underlying diseases of parturients on the intervention effects were not excluded, which may lead to bias in the results of the study. This is planned to be improved in future studies, and a large sample and multi-center study will be conducted in the later stage to improve the accuracy of the study data.

In summary, Kegel exercise combined with electrical stimulation have a good therapeutic effect on postpartum PFD, which can improve PFM strength and vaginal pressure, and thus improve the quality of life and satisfaction of parturients.

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Disclosure of conflict of interest

None.

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