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Original Article

Clinical effect of electrical stimulation biofeedback therapy combined with pelvic floor functional exercise on postpartum pelvic organ prolapse

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Abstract: Objective: To investigate the clinical effect of electrical stimulation biofeedback therapy combined with pelvic floor functional exercise on postpartum pelvic organ prolapse. Methods: One hundred and four patients with postpartum pelvic organ prolapse were randomly divided into two groups. There were 52 patients in the control group who were given pelvic floor function exercise. Another 52 patients in the study group were given electrical stimulation biofeedback therapy combined with pelvic floor functional exercises. The clinical efficacy, pelvic floor pressure (contraction pressure, resting pressure, contraction duration), improvement of pelvic floor prolapse, pelvic floor surface muscle potential, quality of sex life and quality of life (PFIQ-7 score and PFDI-20 score) were compared between the two groups. Results: After the therapy, the total effective rate of the study group was higher than that of the control group (P<0.05). The contraction pressure, resting pressure and vaginal contraction duration of the two groups all increased, and the indexes of the study group were higher than those of the control group (P<0.05). The pelvic floor prolapse degree of the two groups tended to be 0 degrees and I light, and the improvement of the study group was better than that of the control group (P<0.05). The average and maximum average values of the resting stage, endurance test stage and re-resting stage of the two groups all increased, and the fast muscle contraction time, fast muscle relaxation time and variability value all decreased, and the improvement of the study group was better than that of the control group (P<0.05). The scores of sexual satisfaction, sexual anxiety, sexual communication, sexual reaction, sexual attitude and sexual body image of the two groups all increased, and the scores of the study group were higher than those of the control group (P<0.05). The scores of PFIQ-7 and PFDI-20 in the two groups all decreased, and the scores of the study group were lower than those of the control group (P<0.05). Conclusion: Electrical stimulation biofeedback therapy combined with pelvic floor functional exercise has a noticeable curative effect and can significantly alleviate pelvic floor prolapse and improve the sex life and quality of life of patients.

Keywords: Postpartum pelvic organ prolapse, electrical stimulation biofeedback, pelvic floor functional exercise, pelvic floor pressure, quality of sex life, quality of life

Introduction

Pregnancy and childbirth are the main inducing factors for female pelvic floor dysfunction, of which postpartum pelvic organ prolapse is a common type. Vaginal wall bulge and uterine prolapse are the main manifestations. Patients often have different degrees of urination, defecation and sexual dysfunction. The incidence rate of women over 50 years old is as high as 40% [1]. During pregnancy, on the one hand, the pressure of the abdominal cavity and uterus gradually increases, which compresses the pelvic floor tissue, causes injury and relaxation and reduces urethral closure pressure [2, 3]. On the other hand, during pregnancy, the estrogen and progesterone levels change significantly, weakening pelvic connective tissues' collagen metabolism and affecting the supportive function of the pelvic floor structure [4]. In addition, during childbirth, the extrusion of fetal head on the birth canal damages pelvic floor muscle tissues, which eventually leads to severe complications such as pelvic organ pro-

lapse, resulting in a severe decline of patients' quality of their sex life and quality of life [5, 6].

Pelvic floor functional exercise is a conventional non-surgical treatment with a relaxation exercise method, in genital area. The exercise method also has an excellent therapeutic effect for the whole pelvic floor organ dysfunction related diseases, so it is widely used in the treatment of such things as pelvic organ prolapse, voiding dysfunction and urinary incontinence. Although this method has a certain effect on pelvic floor tissue repair, it is only suitable for patients with mild pelvic organ prolapse. Therefore, it does not apply to all patients [7]. Electrical stimulation biofeedback therapy uses an electrical stimulation instrument by putting electrodes into the vagina through the skin, stimulating pelvic tissue nerves with pulses of current to improve the pelvic system's neuromotor function, and repair symptoms such as vaginal relaxation and prolapse [8]. Recently, there has been a clinical report on the application of electrical stimulation biofeedback therapy combined with pelvic floor functional exercise in patients with postpartum pelvic organ prolapse, showing it can effectively improve the pelvic floor function [9]. Postpartum pelvic organ prolapse can affect patients' sexual function and lead to the decline of life quality. Still, there are few reports on whether this therapy has a beneficial effect on the sexual function and life quality of patients. Given this, in order to treat postpartum pelvic organ prolapse more effectively and help patients improve their quality of sex life and quality of life, this study used electrical stimulation biofeedback therapy combined with pelvic floor function exercise to analyze its application effect in postpartum pelvic organ prolapse. The report is as follows.

Materials and methods

General information

In this prospective study, one hundred and four patients with postpartum pelvic organ prolapse in Shenzhen Hospital, University of Chinese Academy of Sciences (Guangming) from February 2019 to March 2020 were randomly divided into the study group and the control group, with 52 cases in each group. The study was approved by the Ethics Committee of Shenzhen Hospital, University of Chinese Academy of Sciences (Guangming).

Inclusion criteria

The inclusion criteria were: all patients met the diagnostic criteria of pelvic floor organ prolapse in Obstetrics and Gynecology, 8th edition, 2013 [10]; patients were diagnosed as I-II degree using POP-Q grade [11]. All patients gave birth to a full-term singleton baby through vaginal delivery; Patients had clean lochia and no urinary tract infection; patients signed the informed consent; and Patients had normal mental cognition. The exclusion criteria were: patients who were diagnosed as III degree using POP-Q grade; patients who had organic lesions in the genital tract; patients who had a history of pelvic surgery; patients who had a history of macrosomia and multiple births; patients who were complicated with other obstetric complications.

Methods

Control group: Patients were given pelvic floor functional exercises. (1) Kegel bridge exercise. Patients were instructed to empty their bladder before the exercise. They took a supine position, relaxed the body and mind, and bent their legs apart, feeling like pushing the floor when stepping on it. Then, they took a deep breath, tightened the inner thighs and straightened the anus upward. They were asked to adjust the anal contraction according to the breathing rhythm, contract when inhaling and relax when exhaling. The contraction lasted for no less than 3 seconds each time, then they relaxed and repeated. Each Kegel bridge exercise lasted for 20-30 min, three times a day [12]. (2) Vaginal dumbbell training. Patients were asked to put the vaginal dumbbell into the vagina and hold the dumbbell through muscle contraction. At first, patients should use the lightest dumbbell and gradually increase the dumbbell weight according to their vaginal bearing capacity. Each time lasted for 15 min, one time a day.

Study group: Patients were given electrical stimulation and biofeedback therapy in addition to the treatment given in the control group. The pelvic floor rehabilitation instrument (SOKO900 III, Beijing Hailongma Technology Co., Ltd., China) was used to treat the patients with electrical stimulation and biofeedback technology. Patients were asked to take a half lying position and separate their legs. The electromyographic pelvic floor muscle treatment head was put into the vagina, with the initial

current intensity gradually increasing from 0 mA to 60 mA. The frequency was set according to the type of muscle fibers. The initial frequency of type I muscle fibers could be set as 10-35 Hz, and then it could be increased to 35-50 Hz according to the patient's tolerance. The initial frequency of type II muscle fibers could be set as 20-50 Hz, and then it could be expanded to 70-80 Hz according to the patient's tolerance. The pulse width of type I muscle fibers was adjusted to 320-740 us, and the pulse width of type II muscle fibers was adjusted to 20-320 us. According to the type of muscle fibers, high-intensity and coordinated contraction training were carried out. Patients were guided to carry out correct and independent pelvic floor muscle training through feedback information such as a pressure curve and electromyography. Each session lasted for 30 min, two times a week [13].

Criteria for pelvic floor function: Type I muscle fibers: the vaginal contractile muscle strength was not less than 40%, the contraction duration not less than 5 s was grade 5, 4 s was grade 4, 3 s was grade 3, 2 s was grade 2, and 1 s was grade 1. Type II muscle fibers: the vaginal contractile muscle strength was not less than 60%, the vaginal contraction frequency not less than 5 times was grade 5, 4 times was grade 4, 3 times was grade 3, 2 times was grade 2, and 1 time was grade 1. Grade 4 and grade 5 showed normal pelvic floor function.

Outcome measures

Primary outcome measures: (1) Clinical efficacy. The therapeutic effect was evaluated according to the ACOG guidelines [14]. Significantly effective: pelvic floor muscle strength increased by more than three grades compared with before the treatment, vaginal bulge did not occur, and the anterior and posterior vaginal walls were closely attached. Effective: pelvic floor muscle strength increased by less than three grades compared with before the treatment, and vaginal prolapse occurred. Ineffective: the patient's condition did not meet the standard of significantly effective and effective. The total effective rate equaled the effective rate plus the significantly effective rate. (2) Pelvic floor pressure. The resting pressure (no active contraction), contraction pressure (active contraction) and vaginal contraction duration of the two group's pelvic floor muscles were measured by a baroreceptor. (3) Pelvic floor prolapse. The POP-Q method was used to evaluate the pelvic floor prolapse. Stage III: the cervix and uterine body were beyond the hymen. Stage II: the most distal prolapse was located outside the hymen but not beyond. Stage I heavy: the most distal prolapse was less than 10 mm above the level of the hymen. Stage I light: the most distal prolapse was more than 10 mm above the level of the hymen. Stage 0: no prolapse. (4) Pelvic floor surface muscle potential. The pelvic floor surface muscle potential was evaluated by the Glazer pelvic floor surface electromyography. The vaginal electrode was placed into the vagina to record the pelvic floor muscle function at different stages (resting stage, rapid contraction stage, continuous contraction stage, endurance test stage and re-resting stage). The average maximum value, fast muscle contraction time and fast muscle relaxation time were recorded at rapid contraction stage. The average value and variability were recorded at the resting stage and re-resting stage. The overall average value and variability were recorded at the endurance test stage.

Secondary outcome measures: (1) Quality of sex life. The quality of sex life was evaluated by the Pelvic Organ Prolapse/Urinary Incontinence Sexual Questionnaire (PISQ) [15]. The questionnaire contained 32 questions and was divided into six aspects: sexual satisfaction (7 questions), sexual anxiety (7 questions), sexual communication (6 questions), sexual reaction (5 questions), sexual attitude (4 questions) and sexual image (3 questions). Higher scores indicated higher quality of sexual life. (2) Quality of life. The quality of life was evaluated by the Pelvic Floor Impact Questionnaire-Short Form 7 (PFIQ-7) and the Pelvic Floor Distress Inventory (PFDI-20) [16]. The questionnaires included patients' symptoms of bladder, pelvic and intestinal tract within 3 months. The score of each item was 0-4, the score of each column was 0-100, and the total score was 0-300. Lower scores indicated lighter pelvic floor dysfunction and better quality of life.

Statistical methods

SPSS 23.0 software was used to analyze the data. Measurement data in accord with a normal distribution were expressed as mean ± standard deviation ($\bar{x}$ ± sd). Independent-samples t-test and paired-samples t-test were

Table 1. Comparison of general information between two groups ($\bar{x} \pm sd$)

Index	Control group (n=52)	Study group (n=52)	t/χ^2	P
Age (years)	29.6±5.4	28.9±4.8	0.699	0.486
Body mass index (kg/m^2)	22.68±2.08	22.44±2.02	0.597	0.552
Course of disease (d)	25.62±3.61	26.06±3.87	0.600	0.550
Delivery history (n, %)			0.688	0.491
First delivery	19 (36.54)	22 (42.31)		
Second delivery	31 (59.62)	29 (55.77)		
Third delivery	2 (3.85)	1 (1.92)		

Table 2. Comparison of clinical efficacy between two groups (n, %)

Group	Significantly effective	Effective	Ineffective	Total effective rate
Control group (n=52)	18 (34.62)	21 (40.38)	13 (25.00)	39 (75.00)
Study group (n=52)	28 (53.85)	19 (36.54)	5 (9.62)	47 (90.38)
Z/χ^2		2.332		4.300
P		0.020		0.038

used for inter-group comparison and intra-group comparison respectively. Data not accorded with a normal distribution were analyzed by a nonparametric test (Mann-Whitney U test). Enumeration data were expressed by percentages and analyzed by χ^2 test. Ranked data were analyzed by rank sum test. P<0.05 was considered statistically significant.

Results

General information

There was no significant difference in the general data such as age, body mass index, course of disease and delivery history between the two groups (P>0.05). Therefore the the two groups were comparable. See **Table 1**.

Clinical efficacy

The total effective rate of the study group was higher than that of the control group (P<0.05). This revealed that the electrical stimulation biofeedback therapy combined with pelvic floor function exercise improved the clinical treatment efficacy. See **Table 2**.

Pelvic floor pressure

Before the treatment, there was no significant difference in pelvic floor pressure between the two groups (P>0.05). After the treatment, the contraction pressure, resting pressure and vaginal contraction duration of the two groups all increased, and the pelvic floor pressure of the study group was higher than that of the control group (all P<0.05). It was found that the electrical stimulation biofeedback therapy combined with pelvic floor function exercise was more helpful to improve pelvic floor pressure. See **Figure 1**.

Pelvic floor prolapse

Before the treatment, there was no significant difference in pelvic floor prolapse between the two groups (P> 0.05). After the treatment, the degree of pelvic floor prolapse in the two groups tended towards stage 0 and stage I light, and the improvement in the study group was better than that in the control group (P<0.01). It was found that the electrical stimulation biofeedback therapy combined with pelvic floor function exercise was more helpful to improve pelvic floor prolapse. See **Table 3**.

Pelvic floor surface muscle potential

Before the treatment, there was no significant difference between the two groups in pelvic floor surface muscle potential (P>0.05). After the treatment, the average and maximum average values of the resting stage, endurance test stage and re-resting stage in the two groups all increased, and the fast muscle contraction time, fast muscle relaxation time and variability value all decreased, and the improvement of the study group was better than that of the control group (all P<0.05). Therefore the electrical stimulation biofeedback therapy combined with pelvic floor function exercise better promoted the recovery of pelvic floor surface muscle potential. See **Table 4**.

Quality of sex life

Before the treatment, there was no significant difference in the quality of sex life between the two groups (P>0.05). After the treatment, the

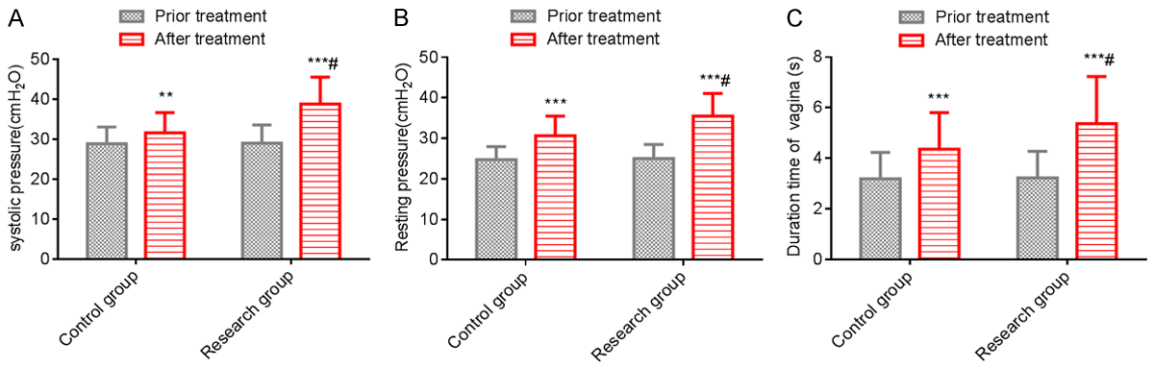

Figure 1. Comparison of pelvic floor pressure between the two groups. A: Contraction pressure; B: Resting pressure; C: Vaginal contraction duration. Compared with the same group before the treatment, $^{**}P<0.01$, $^{***}P<0.001$; compared with the control group after the treatment, $^{\#}P<0.05$.

Table 3. Comparison of pelvic floor prolapse between two groups (n, %)

Index	Control group (n=52)	Study group (n=52)	U	P
Before treatment			0.448	0.654
Stage 0	0 (0.00)	0 (0.00)		
Stage I light	22 (42.31)	24 (46.15)		
Stage I heavy	25 (48.08)	24 (46.15)		
Stage II	5 (9.62)	4 (7.69)		
After treatment			3.314	0.002
Stage 0	17 (32.69)$^{\#\#\#}$	36 (69.23)$^{\#\#\#}$		
Stage I light	21 (40.38)	11 (21.15)		
Stage I heavy	11 (21.15)$^{\#\#\#}$	3 (5.77)$^{\#\#\#}$		
Stage II	3 (5.77)	2 (3.85)		

Note: Compared with the same group before the treatment, $^{\#\#\#}P<0.001$.

scores of sexual satisfaction, sexual anxiety, sexual communication, sexual reaction, sexual attitude and sexual body image in the two groups all increased, and the scores in the study group were higher than those in the control group (all P<0.05). Electrical stimulation biofeedback therapy combined with pelvic floor function exercise better improved the quality of patient's sex life. See **Figure 2**.

Quality of life

Before the treatment, there was no significant difference in the quality of life between the two groups (P>0.05). After the treatment, the PFIQ-7 and PFDI-20 scores of the two groups all decreased, and the scores of the study group was lower than that of the control group (P<0.05). Therefore electrical stimulation biofeedback therapy combined with pelvic floor function exercise better improved patients' quality of life. See **Figure 3**.

Discussion

Pelvic floor functional exercise is mainly performed through conscious contraction of anal, urethral and vaginal muscles to enhance the sensitivity and operational performance of muscles, so as to improve the strength of muscles near the vagina, enhance the support of pelvic tissues and the bladder neck, increase the strength of the urethral sphincter and reduce the internal pelvic pressure [17, 18]. It is easy to learn and has no cost, so most patients easily accept it. Another study pointed out that the effectiveness of adhering to effective pelvic floor function exercise on pelvic organ prolapse can reach 50-70% [19]. On this basis, this study combined with electrical stimulation and biofeedback technology therapy in order to improve the effect of pelvic floor rehabilitation.

The results in this study showed that after treatment, the clinical efficacy of the study group was higher than that of the control group, and the pelvic floor pressure, pelvic floor prolapse and pelvic floor surface muscle potential were better improved, suggesting that pelvic floor functional exercise combined with electrical stimulation biofeedback therapy is beneficial to the improvement of clinical efficacy and pelvic organ prolapse. Zhou Yanna et al. pointed out that after electric stimulation combined with biofeedback pelvic floor muscle training in

Table 4. Comparison of pelvic floor surface muscle potential between two groups ($\bar{x} \pm sd$)

Index			Control group (n=52)	Study group (n=52)	t	P
Resting stage	Average value (μV)	Before treatment	1.86±0.52	1.90±0.56	0.377	0.707
		After treatment	2.08±0.59$^{\#}$	2.41±0.71$^{\#\#\#}$	2.578	0.011
	Variability value (μV)	Before treatment	0.23±0.05	0.24±0.06	0.122	0.904
		After treatment	0.19±0.04$^{\#\#\#}$	0.16±0.04$^{\#\#\#}$	3.824	<0.001
	Maximum average value (μV)	Before treatment	17.68±2.14	18.02±2.36	0.770	0.443
		After treatment	32.51±4.68$^{\#\#\#}$	35.94±5.43$^{\#\#\#}$	3.450	0.001
Continuous contraction stage	Fast muscle contraction time (s)	Before treatment	0.87±0.34	0.89±0.32	0.309	0.758
		After treatment	0.67±0.29$^{\#\#}$	0.54±0.21$^{\#\#\#}$	2.618	0.010
	Fast muscle relaxation time (s)	Before treatment	0.79±0.31	0.81±0.32	0.324	0.747
		After treatment	0.64±0.29$^{\#}$	0.49±0.23$^{\#\#\#}$	3.507	<0.001
Endurance test stage	Average value (μV)	Before treatment	15.36±2.62	15.24±2.51	0.239	0.812
		After treatment	19.16±3.68$^{\#\#\#}$	22.17±3.98$^{\#\#\#}$	4.004	<0.001
	Variability value (μV)	Before treatment	0.32±0.09	0.30±0.08	1.198	0.234
		After treatment	0.25±0.07$^{\#\#\#}$	0.19±0.06$^{\#\#\#}$	4.693	<0.001
Re-resting stage	Average value (μV)	Before treatment	2.60±0.59	2.65±0.61	0.425	0.672
		After treatment	3.01±0.72$^{\#\#\#}$	3.42±0.80$^{\#\#\#}$	2.747	0.007
	Variability value (μV)	Before treatment	0.31±0.09	0.32±0.09	0.567	0.572
		After treatment	0.25±0.09$^{\#\#\#}$	0.18±0.06$^{\#\#\#}$	4.667	<0.001

Note: Compared with the same group before the treatment, $^{\#}$P<0.05, $^{\#\#}$P<0.01, $^{\#\#\#}$P<0.001.

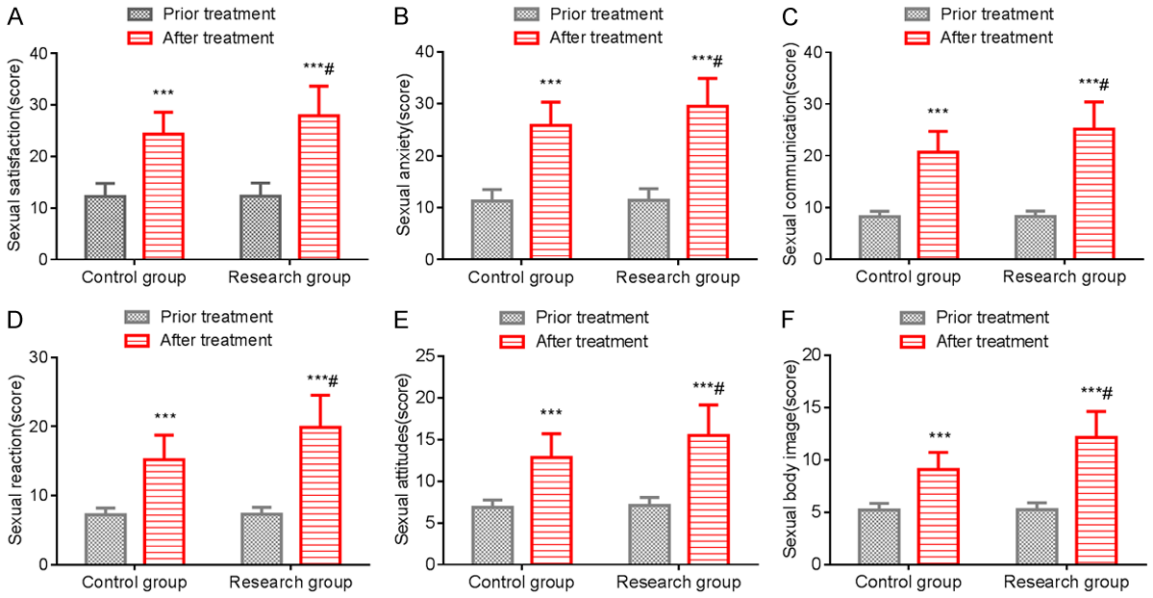

Figure 2. Comparison of quality of sex life between the two groups. A: Sexual satisfaction; B: Sexual anxiety; C: Sexual communication; D: Sexual reaction; E: Sexual attitude; F: Sexual body image. Compared with the same group before the treatment, ***P<0.001; compared with the control group after the treatment, $^{\#}$P<0.05.

the treatment of postpartum pelvic floor dysfunction diseases, the electrophysiological indexes of pelvic the muscles and the quality of the sex life of patients were improved, compared with single pelvic floor functional exercise [20]. Li Yuqi et al. pointed out that compared with single Kegel training, biofeedback combined with electrical stimulation and Kegel training could effectively improve the therapeutic effect of pelvic floor dysfunction diseases and improve pelvic floor prolapse [21]. The reason for the above results may be that electrical stimulation causes neuromuscular excitability and makes nerve terminals release acetylcho-

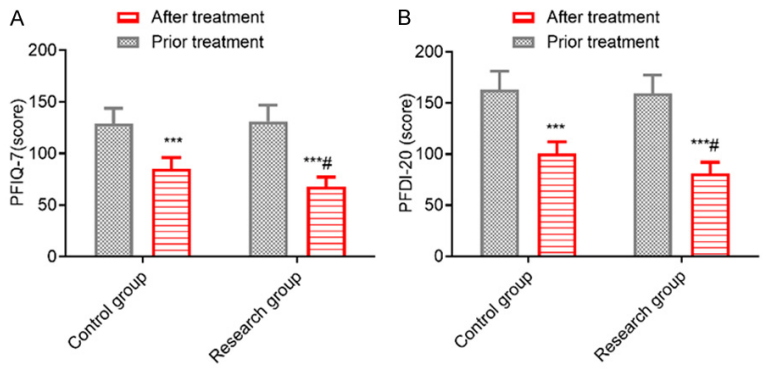

Figure 3. Comparison of quality of life between the two groups. A: PFIQ-7; B: PFDI-20. Compared with the same group before the treatment, ***P<0.001; compared with the control group after the treatment, #P<0.05.

line. Acetylcholine is a transmitter that can cause muscle fiber contraction. Electrical stimulation promotes the contraction of the external urethral sphincter and further strengthens the sphincter contraction through the neural circuit, resulting in the strengthening of the whole pelvic floor muscle group and improvement in prolapse. At the same time, electrical stimulation can stimulate muscle nerves to regulate bladder contractility by inhibiting or exciting the sympathetic pathway, increase bladder capacity, improve detrusor metabolism level, and strengthen urine storage capacity, so as to control urine flow and treat urinary incontinence symptoms [22, 23]. According to the different types of muscle fibers, different current and pulse widths should be set to carry out targeted training, so as to improve the stages of prolapse more effectively.

Biofeedback mainly transmits information such as pelvic floor muscle strength, fatigue and potential value to patients through hearing and vision in the form of pressure curve and electromyography and other forms, and then effective rehabilitation training is carried out to correct wrong contraction activities and improve muscle contraction. A powerful pelvic floor muscle can provide certain structural support for the urethra, bladder and vagina [24]. By improving the sensitivity of pelvic floor muscles and developing the correct muscle contraction, patients can complete their training independently without an instrument, so as to enhance the treatment effect. Besides, patients can also intuitively see their changes and progress in the treatment, so as to fully mobilize the enthusiasm of patients for training and treatment and enhance their confidence.

Hwang UJ et al. pointed out that after the intervention of electrical stimulation, the score of patients' quality of sex life increased by 9.69 points compared with that of the non-electrical stimulation intervention group [25]. In this study, the results showed that the improvement in the quality of sex life and quality of life in the study group were better than those in the control group after treatment, suggesting that pelvic floor functional exercise combined with electrical stimulation biofeedback technology can also improve the quality of patient' sex life and quality of life, which is consistent with the results of the above literature. Electrical stimulation biofeedback technology can effectively improve the pelvic floor muscle group through its nerve reconstruction function and solve problems such as the vaginal relaxation problem, which can promote the recovery of the vagina to a tightening state in order to promote the relationship between husband and wife, build a harmonious family atmosphere, and then improve the quality of their sex life and quality of life. However, the number of patients studied in this research is small, and there is no comparison of the clinical efficacy of electrical stimulation biofeedback therapy combined with pelvic floor functional exercise on patients with different degrees of postpartum pelvic organ prolapse. The clinical research scale can be expanded for an in-depth discussion in the future.

In conclusion, electrical stimulation biofeedback therapy combined with pelvic floor functional exercise is effective for postpartum pelvic organ prolapse patients, which can significantly improve pelvic floor prolapse, improve the quality of their sex life and quality of life. However, it is worth noting that, both pelvic floor functional exercise and electrical stimulation biofeedback treatment have no apparent therapeutic effect on patients with stage II pelvic floor prolapse from the research results. It indicates that although electrical stimulation

biofeedback expands the scope of pelvic organ treatment, it still has limitations for patients with stage II and above. Therefore, it is suggested that surgical treatment should be adopted according to the specific conditions of patients.

Disclosure of conflict of interest

None.

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