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Article

A combined intervention study on the recovery of pelvic floor muscle function after hysterectomy

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Abstract: The incidence of post hysterectomy pelvic floor dysfunction (PFD) is as high as 30%. Pelvic floor muscle training (PFMT) is a common treatment for PFD. However, its effectiveness is limited and the time required is long. In recent years, many studies show that combined interventions may improve the outcomes by addressing both the biomechanical and functional aspects of PFD. This study evaluated the efficacy of single PFMT, PFMT + ES (electrical stimulation), and PFMT + ES + psychological interventions in restoring pelvic floor biomechanics and function after hysterectomy. In this study, 40 patients aged 40–60 years who underwent hysterectomy were selected. The biomechanical outcomes, including pelvic muscle strength, force distribution, and bladder activity, were assessed using standardized biomechanical measurements. Their sexuality and bladder activity were compared after a 6-week period of treatment. The results showed that the patients who were treated with the combination of PFMT + ES + psychological intervention had the most significant improvement in all biomechanical and functional indicators. Specifically, this group exhibited enhanced pelvic muscle mechanics, improved force control, and greater bladder stability, highlighting the synergistic effects of the combined approach. This study concludes that the combined treatment of PFMT + ES + psychological intervention is a very effective conservative treatment, particularly in restoring pelvic biomechanics and function. The findings provide valuable insights into the biomechanical mechanisms underlying PFD recovery and underscore the importance of integrating mechanical, physiological, and psychological approaches for optimal outcomes. However, the small sample size of this single-center study limits the generalizability of the conclusions, which requires cautious promotion in clinical practice.

Keywords: hysterectomy; pelvic floor dysfunction (PFD); biomechanics; pelvic floor muscle training (PFMT); electrical stimulation

1. Instruction

Hysterectomy is a common surgical procedure in gynecology, and about 15%–20% of women in China need to undergo this surgery every year due to disease, and it is showing a trend of rejuvenation [1]. Although surgery can effectively relieve pain and prevent the spread of malignant lesions, the incidence of postoperative pelvic floor dysfunction (PFD) is as high as 30%. It is characterized by pelvic organ prolapse (POP), myofascial pelvic pain, and fecal incontinence (FI), stress urinary incontinence, sexual dysfunction, and chronic pelvic pain, which seriously affects the quality of life of patients [2–4]. As the core organ of the pelvic floor support structure, the removal of the uterus will lead to the loss of support for the bladder, rectum and other peripheral organs, while the surgery may damage the pelvic floor nerves and muscle tissues, which further aggravates the dysfunction [5]. In addition,

patients are often accompanied by psychological problems such as anxiety and depression in the postoperative period, creating a physiological-psychological double burden [1]. It is especially noteworthy that 15%–20% of women need to undergo hysterectomy every year in China, and the trend of youthfulness is significant, which makes the recovery of pelvic floor function after surgery a clinical challenge to be solved urgently [1].

The pelvic floor muscles have the function of maintaining the normal function of the rectal sphincter and urethral sphincter and maintaining the normal position of the pelvic organs and vaginal tightness. Therefore, rehabilitation of the pelvic floor muscles is of great significance to life. Currently, pelvic floor rehabilitation therapy (e.g., biofeedback, electrical stimulation, pelvic floor muscle exercises) is widely used for postoperative interventions. Biofeedback has the advantage of being non-invasive by activating pubic nerve fibers through electrical stimulation and enhancing pelvic floor muscle excitability [2]. Pelvic floor muscle training (PFMT) is also widely recommended as a core tool to improve postoperative PFD. Meta-analysis showed that PFMT can significantly improve sexual function and quality of life by enhancing type I muscle fiber endurance and increasing pelvic floor nerve excitability [2,3,5]. Despite the remarkable progress, the limitations of PFMT should not be ignored: in patients with recalcitrant incontinence due to nerve damage [6] or in the presence of anatomically irreversible damage, a combination of surgical repair is required [2]. For example, a systematic evaluation by de Oliveira et al. (2024) confirmed that PFMT is supported by moderate-quality evidence for the recovery of sexual function, but has limited improvement in urinary incontinence and vaginal prolapse [5]. According to the 2023 PFDN guidelines, integrated rehabilitation combining PFMT and ES has shown superior outcomes in improving PFD compared to monotherapy [7].

However, the effect of monotherapy is affected by individual differences and tolerance of patients, and some studies have shown that its effective rate of improving urinary incontinence is only 40%–60% [3]. The patient's mental health will have a great impact on the treatment effect [6,8,9]. In recent years, the combined intervention mode has gradually become a research hotspot. For example, a randomized controlled trial by Zhu et al. (2022) showed that 6 weeks of postoperative PFMT intervention could increase the activity of pelvic floor electromyographic signals by 30%, which could reduce the incidence of PFD in the long term [3,10], and the satisfaction rate of patients with combined psychological care reached 90% [1]. In current studies, it has been shown that pelvic floor rehabilitation combined with psychological intervention can significantly reduce the incidence of urinary incontinence and improve patients' quality of life and satisfaction [1]. A recent RCT by Alouini et al. demonstrated that PFMT combined with cognitive-behavioral therapy significantly reduced urinary incontinence severity in post-hysterectomy patients [11]. Psychological support can alleviate patient anxiety and indirectly promote rehabilitation compliance. In addition, systematic rehabilitation programs (e.g., holistic therapies combining respiratory training and core muscle stability training) have been shown to be advantageous in postpartum pelvic floor recovery, which may indirectly enhance pelvic floor muscle function by improving the balance of spine-pelvic mechanics [10].

Although existing studies provide a theoretical basis for clinical practice, there are still limitations: first, insufficient standardization of intervention protocols (e.g., significant differences in training frequency and intensity) [3]; and high heterogeneity of assessment tools, such as the use of the Modified Oxford Scale (MOS) or surface electromyography in the assessment of muscle strength, which results in limited comparability of results [3]. This study intends to explore a more precise rehabilitation model by optimizing the multidimensional intervention strategy, which will provide a scientific basis for improving patients' postoperative quality of life.

2. Related work

2.1. Non-surgical treatment

2.1.1. Pelvic floor muscle training

In 1948, Kegel training was initially introduced and established as the gold standard for pelvic floor muscle training (PFMT) [12]. PFMT essentially involves conscious and purposeful exercise, which is achieved through the voluntary contraction of pelvic floor muscles under the control of the suprapubic muscles. The American Gynecologic Urological Association has highly regarded PFMT, deeming it as one of the most intelligent exercise options available for women. Consequently, it has been recommended as the front-line treatment approach for pelvic floor dysfunction (PFD) [13].

The mechanism behind Kegel exercises lies in the repetitive contraction and relaxation of the pelvic floor muscles. By doing so, these muscles are gradually strengthened, leading to an overall improvement in pelvic floor function. What makes this form of exercise particularly accessible is that patients can carry it out independently. They are instructed to contract the pelvic floor muscles and hold the contraction for a duration exceeding 3 s, followed by a relaxation period. Each session typically lasts for 10 to 15 min, and it is recommended to perform such exercises 3 to 4 times daily to achieve optimal results. This simple yet effective exercise routine has the potential to offer significant benefits to patients dealing with pelvic floor issues, empowering them to take an active role in their own rehabilitation process.

2.1.2. Biofeedback therapy

Biofeedback therapy for pelvic floor muscles is a non-invasive and safe method. It simulates bioelectric currents through a specific program to stimulate the damaged pelvic floor nerves. It uses sound and image feedback to assist patients in muscle exercises, aiming to improve the function of pelvic floor muscles. With the help of biofeedback devices, the activities of pelvic floor muscles are transformed into visual signals, enabling patients to intuitively understand the state of their pelvic floor muscles. In this way, patients can learn to correctly contract and relax their pelvic floor muscles.

2.1.3. Electrical stimulation therapy

Electrical stimulation therapy employs electric currents with varying frequencies and intensities to target the pelvic floor muscles. By doing so, it aims to

augment the muscle contraction force and expedite the restoration of nerve function, thereby effectively addressing issues like urinary incontinence and pelvic organ prolapse. Given the diverse nature of patients' conditions, the treatment parameters must be meticulously calibrated for each individual. Typically, this therapy is administered 2–3 times a week, with each session lasting 20–30 min.

In Shao et al.'s research [14], an innovative approach was adopted. Patients underwent biofeedback electrical stimulation in addition to the conventional Kegel training. The findings were remarkable; post-treatment, not only did the patients exhibit enhanced pelvic floor muscle strength, but there was also a significant improvement in stress urinary incontinence. This dual-pronged treatment strategy led to an overall elevation in the patients' quality of life.

Similarly, in Ren et al.'s study [15], a well-structured experiment was devised. A group of 100 participants was selected to receive pelvic floor electrical stimulation therapy, which was superimposed on standard Kegel training. Meanwhile, a control group was set up, where patients only engaged in standard Kegel training. The results clearly demonstrated that those who underwent the combined electrical stimulation treatment boasted better overall electromyogram (EMG) values, as well as improved EMG values for both class I and II muscle fibers. These values were not only superior to their pre-treatment status but also outshone those of the patients who relied solely on Kegel training. Such findings underline the potential benefits of integrating electrical stimulation with Kegel training in pelvic floor rehabilitation programs.

2.1.4. Magnetic stimulation therapy

Magnetic stimulation therapy operates by leveraging induced currents that are generated via a magnetic field. These currents are then directed towards stimulating the pelvic floor nerves and muscles. One of the notable advantages of this approach is that it obviates the need for direct physical contact with the body. As a result, it is capable of reaching and stimulating the pelvic floor tissues at a deeper level. This characteristic makes it a potentially preferable option for certain patients. Specifically, those who experience difficulties in tolerating electrical stimulation or biofeedback therapy due to pain or other related factors may find magnetic stimulation more amenable.

In terms of treatment regimen, the frequency and overall course of magnetic stimulation bear a resemblance to that of electrical stimulation therapy. This similarity in treatment parameters provides clinicians with a degree of familiarity and ease when considering its application. Researchers such as Wu and their team delved into the practical implications of magnetic stimulation in relation to the recovery of pelvic floor muscle function. Their comprehensive study unearthed some significant findings. They discovered that when magnetic stimulation is combined with Kegel pelvic floor muscle function training, it yields a particularly beneficial effect for women dealing with mild uterine prolapse following childbirth. This combined approach not only aids in hastening the involution of the uterus, but also plays a crucial role in bolstering the strength of the pelvic floor muscles, thereby leading to an overall enhancement of the pelvic floor function [16].

Likewise, Mohamed and colleagues [17] have also made important contributions in this field. Their investigations revealed that the integration of electromagnetic stimulation with pelvic floor muscle training (PFMT) can prove to be highly effective in ameliorating the condition of urinary incontinence. These collective findings underscore the growing importance and potential of magnetic stimulation as a viable treatment modality within the realm of pelvic floor rehabilitation. It should be noticed that magnetic stimulation is contraindicated in patients with implanted metallic devices or oncological histories due to potential tissue damage risks.

2.1.5. Drug therapy

For urinary incontinence: For stress urinary incontinence, drugs such as duloxetine can be used. By acting on the adrenergic receptors of the urethral sphincter, they can increase the urethral closure pressure. For urge urinary incontinence, M-receptor antagonists are commonly used, such as solifenacin, tolterodine, etc., which can inhibit the involuntary contraction of the detrusor muscle of the bladder. Mohamed et al. (2024) further validated that electromagnetic stimulation combined with PFMT reduces stress urinary incontinence by enhancing urethral closure pressure, aligning with our findings [17].

For pelvic pain: Non-steroidal anti-inflammatory drugs such as ibuprofen and diclofenac sodium can be used to relieve pain symptoms. Estrogen ointment can also be applied locally to improve the local vaginal environment and enhance the support of pelvic floor tissues. This is suitable for postmenopausal women with pelvic floor dysfunction caused by estrogen deficiency. Anticholinergics (e.g., solifenacin) reduce bladder overactivity by blocking muscarinic receptors, while estrogen therapy improves vaginal epithelium integrity and pelvic floor collagen content, indirectly enhancing tissue support. Postmenopausal or ovarian-resected patients received transdermal estrogen therapy to prevent vaginal atrophy and maintain pelvic floor tissue elasticity [18].

2.2. Surgical treatment

2.2.1. Vaginal obliteration

Vaginal obliteration techniques encompass two main forms: partial vaginal obliteration and total vaginal obliteration. These procedures are particularly tailored for elderly and frail patients. Such individuals often lack the physical resilience to endure complex surgical interventions and, additionally, may have no requirement for an active sexual life. The fundamental objective of vaginal obliteration is to alleviate the distressing symptoms associated with pelvic organ prolapse, providing these patients with much-needed relief.

The history of anti-incontinence surgery dates back to 1914 when the anterior colporrhaphy was first introduced. However, this initial approach had significant limitations, achieving a relatively meager cure rate ranging only from 20% to 30%. What's more, patients who underwent this early form of surgery frequently found themselves in a situation where a second anti-incontinence procedure was necessary to address persisting issues.

In contrast, the vaginal suture technique devised by Kelly was reported to have a comparatively higher success rate. Despite this seeming advantage, the surgery has not gained widespread popularity in contemporary practice. There are several plausible reasons for this. Elderly women, who are often the prime candidates for such procedures, commonly struggle to source sufficient quantities of durable natural fascia required for effective repair. Furthermore, the surgical process itself is intricate and demands a significant investment of time, both of which factors contribute to its limited adoption [18]. This highlights the ongoing need for more refined and accessible surgical solutions in the field of pelvic floor disorders.

2.2.2. Pelvic floor reconstruction surgery

Pelvic floor reconstruction surgery is a crucial approach that employs autologous tissues or biological materials, commonly known as patches, to address the issue of prolapsed pelvic organs. The primary goal of this surgery is to restore the normal anatomical structure and function of the pelvic floor. Representative procedures within this category include transvaginal hysterectomy, anterior colporrhaphy, and posterior colporrhaphy, among others. These operations aim to correct the abnormal position of pelvic organs and enhance the overall support of the pelvic floor.

The U.S. Food and Drug Administration played a significant role in the realm of surgical advancements. In 1996, it approved the first surgical mesh product specifically designed for the treatment of stress urinary incontinence (SUI). This marked an important milestone in the treatment of this condition. Subsequently, in 2002, the FDA further approved a surgical mesh product for the treatment of pelvic organ prolapse (POP). Since these approvals, there has been an increasing trend of utilizing synthetic materials and biological substances to strengthen or reinforce the repair process during pelvic floor reconstruction surgeries. These materials are intended to provide additional support and promote better healing.

However, the use of non-absorbable synthetic polypropylene mesh products has raised concerns. Numerous studies have indicated that these meshes have a relatively high erosion rate, ranging from 10% to 19%. Moreover, they are associated with a variety of complications. These include pain, which can significantly affect a patient’s quality of life; infections, which may require additional medical interventions; bleeding, posing risks to the patient’s health; dyspareunia, causing discomfort during sexual intercourse; and urological problems, which can impact urinary function [19–21].

Hong et al. [4] conducted an in-depth analysis in this area. They comprehensively summarized the development of synthetic and biological materials used in both laparoscopic surgery and pelvic floor reconstruction surgery. By comparing the surgical outcomes and complications of different pelvic floor reconstruction surgeries, they provided valuable insights into the effectiveness and safety of various approaches. Their work contributes to a better understanding of the field and can guide future surgical decisions and material selections.

2.2.3. Laparoscopic Burch colposuspension

The mid-urethral sling is an effective surgical method for treating women with stress urinary incontinence, but not all patients are suitable for or wish to use a

vaginal mesh. For stress urinary incontinence, non-mesh surgeries include pubovaginal fascial sling and retropubic Burch colposuspension. Colposuspension can be performed through open or laparoscopic methods. Laparoscopic colposuspension can reduce the patient's blood loss, pain, and hospital stay [22,23]. Jenkins et al. [24] found through research that laparoscopic Burch colposuspension is an effective method for treating stress urinary incontinence, with an effect comparable to that of open Burch colposuspension. The surgical success rate is affected by the surgeon's experience and surgical skills. Compared with the tension-free sling, there is no difference in the subjective cure rate; however, the objective cure rate is more in favor of the tension-free sling. We believe that for women who undergo pelvic floor repair and simultaneous retropubic surgery, as well as young women, laparoscopic Burch colposuspension is the preferred surgery because it can avoid the potential complications of the mesh. More research is needed to compare these two surgeries.

Taking into account the patient's age, severity of the disease, fertility needs, physical condition and other factors, the doctor will choose the most suitable treatment plan, and sometimes a combination of treatments may be required.

3. Experimental research

3.1. Participants

The subjects of this study were the post-total hysterectomy patients treated in our hospital from January 2023 to March 2024; 40 cases were randomly selected as the subjects of this study and divided into the control group (10 cases) and three study groups (10 cases in each group) by blind selection within the group. Patients were randomized using a computer-generated random sequence with block sizes of 4, stratified by age and BMI. The parameters of the four study groups are shown in **Table 1**. Comparison of the four groups of post-total hysterectomy patients' basic data, such as age, disease characteristics, duration of the disease, and surgical results, showed that the differences in the general data of the four groups were not obvious. This study was conducted according to the International Conference on Harmonization guidelines, respecting the 1964 Declaration of Helsinki. All the post-hysterectomy patients selected for this study volunteered to participate in this study, and the Ethics Committee of our hospital was fully informed and approved the study. Psychological intervention included weekly 45-min cognitive-behavioral therapy (CBT) sessions focusing on body image, sexual function, and stress management, delivered by a certified psychologist.

Table 1. Demographics of the study participants (n = 40).

	CG	**EG 1**	**EG 2**	**EG 3**	***p*-Value**
Age (years)	52 ± 7	51 ± 7	50 ± 8	53 ± 7	0.14
Height (cm)	159.8 ± 4	157.4 ± 5.6	155.4 ± 8.6	156.4 ± 6.6	0.23
Weight (kg)	58.3 ± 9.6	59.2 ± 8.2	57.1 ± 7.5	57.5 ± 6.4	0.78
BMI (kg/m^2)	22.8 ± 4.1	23.8 ± 3.9	23.6 ± 4.3	23.5 ± 4.2	0.45

Inclusion criteria included benign indications (uterine fibroids, endometriosis) and early-stage gynecological malignancies requiring total hysterectomy.

3.2. Methods

Conventional postoperative care was used in all four groups of patients after total hysterectomy (CG: Control Group; EG: Experiment Group). EG 1 was treated with pelvic floor muscle exercise on this basis. EG 2 was treated with pelvic floor muscle exercise + electrical stimulation on this basis. EG 3 was treated with pelvic floor muscle exercise + electrical stimulation and psychological intervention. 6 weeks later, the pelvic floor function and quality of life of the four groups were observed, compared and analyzed. All 40 women are determined by the Female Sexual Function Index (FSFI) and Overactive Bladder Symptom Index (OBS), which are the most common postoperative treatments. and Overactive Bladder Symptom Score (OABSS). The experimental procedure is shown in **Figure 1**.

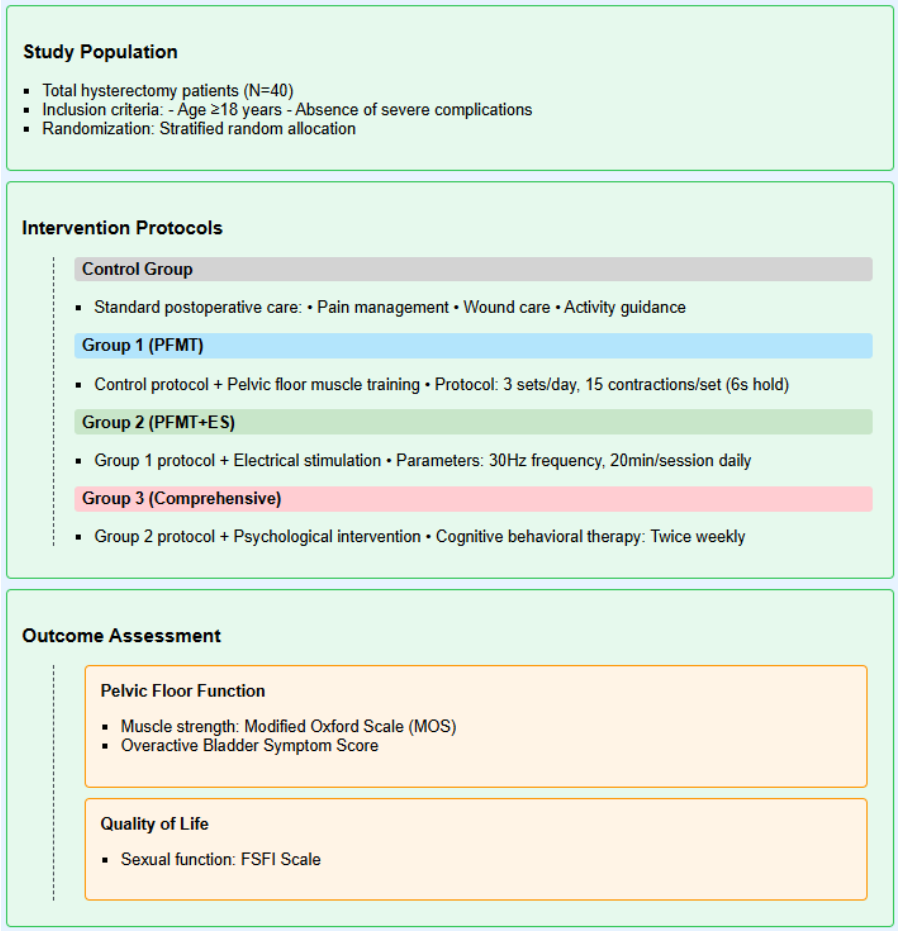


Figure 1. Postoperative rehabilitation study design (PFMT = pelvic floor muscle training; ES = electrical stimulation).

3.2.1. General nursing care

Ensure that the ward is clean and tidy, with appropriate temperature and humidity, and open the windows regularly for ventilation so as to provide a good ward environment for the patients. According to the patient's condition and physical recovery, and then integrating the patient's taste preference, make a scientific and

reasonable personalized, balanced nutritional diet plan for the patient. For the postoperative total hysterectomy patients are given medication for analgesia in a timely manner, and attention is paid to the patients' pain relief and the presence of drug allergies and other adverse reactions.

3.2.2. Pelvic floor intervention

Patients in EG1 performed Kegel exercises to exercise the pelvic floor muscles 3 times a day for 6 weeks. Patients slowly contracted the vagina and anus; the contraction time exceeded 3 s, and then they slowly relaxed, maintained for 10 s, and repeated 15 times in 1 group, with 3 groups/times.

In EG2, patients performed Kegel exercises 3 times a day to exercise the pelvic floor muscles and underwent electrical stimulation therapy on Mondays and Wednesdays for half an hour each time. It lasted for 6 weeks. An electric stimulation therapy instrument (Nanjing Weisi Medical Technology, SA9801) was used. During the electrical stimulation treatment, the patient was placed in a supine position, the body was relaxed, and the vaginal electrodes were placed into the patient's vagina. The parameters of electrical stimulation were frequency 30~60 Hz and wave width 200~300 μs. During the process, the current intensity was gradually increased according to the patient's adaptability for 20 min, and after the end of the electrical stimulation treatment, the neuromuscular electrical stimulation therapy instrument program was set to the biofeedback mode, and the pelvic floor muscle contraction training and relaxation training were adjusted according to the signals from the computer feedback for 10 min/times.

The patients in EG3 performed Kegel exercises to exercise the pelvic floor muscles 3 times a day, and underwent electrical stimulation therapy on Mondays and Wednesdays, as well as psychological intervention once a week for 6 weeks.

3.2.3. Psychological intervention

After hysterectomy, based on the patients' hobbies, cultural levels, and personality characteristics, patients should be encouraged and supported to divert their attention through recreational activities such as reading, listening to music, and painting. Scientifically and rationally spread the new idea to patients that they can still live a good life without a uterus, and provide corresponding examples as evidence to help patients abandon the traditional, restrictive, and psychologically stressful old ideas.

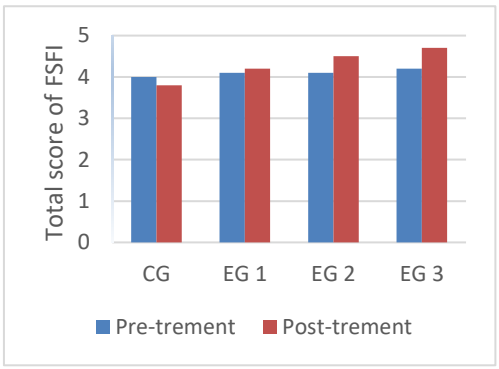
4. Results and discussion

The Female Sexual Function Index (FSFI) is a comprehensive questionnaire designed to evaluate female sexual function. This questionnaire contains 19 items, covering six key areas of sexual function: sexual desire, sexual arousal, sexual lubrication, orgasm, sexual satisfaction, and pain during intercourse. Each item is scored on a scale from 0 to 5, and the higher the score, the better the sexual function. The cumulative FSFI score (the sum of scores in the six areas) ranges from 2 to 36 [25].

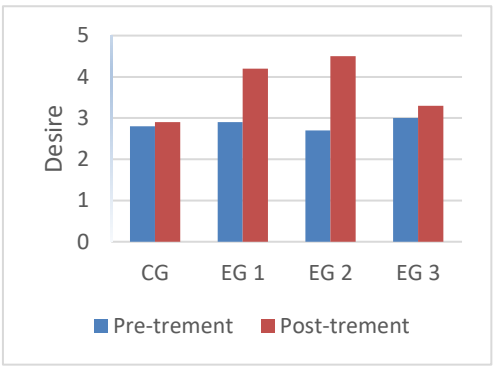
The Overactive Bladder Symptom Score (OABSS) has become a commonly used tool for evaluating overactive bladder (OAB). According to the OABSS results,

we divided the patients into three OAB severity levels: mild (OABSS 1–5), moderate (OABSS 6–11), and severe (OABSS ≥ 12), and compared these levels before and after treatment [26].

In the FSFI evaluation, after 6 weeks of treatment, the total FSFI scores in study groups 2 and 3 increased significantly compared to the baseline (p = 0.038 and p = 0.041), while no significant difference was observed in the control group. In the area of sexual arousal, after 6 weeks of treatment, statistically significant increases were observed in study groups 2 and 3 (p = 0.024 and p = 0.012, respectively). The orgasm area in study groups 2 and 3 also showed improvement, with significant increases in scores after 6 weeks of treatment (p = 0.03). No significant changes were observed in the control group (as shown in **Figure 2**).



(a)



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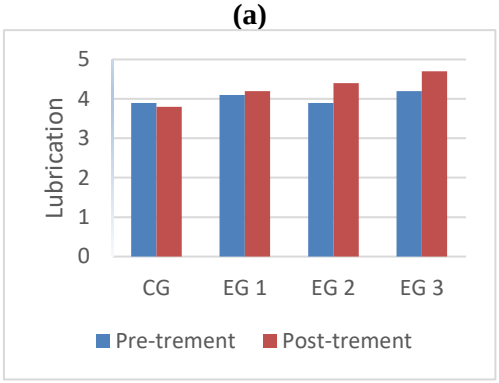

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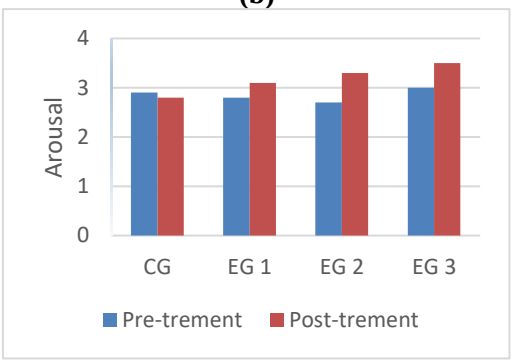

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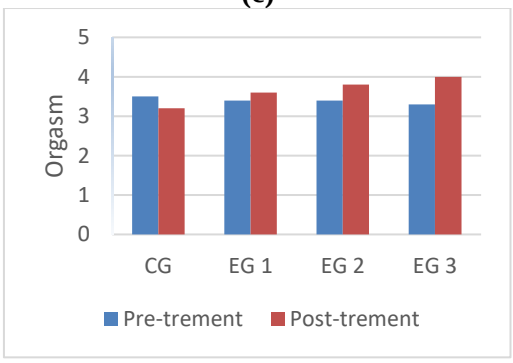

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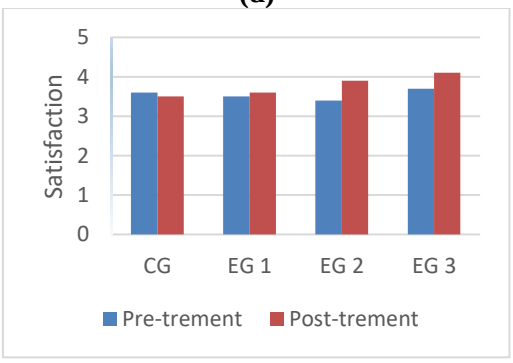

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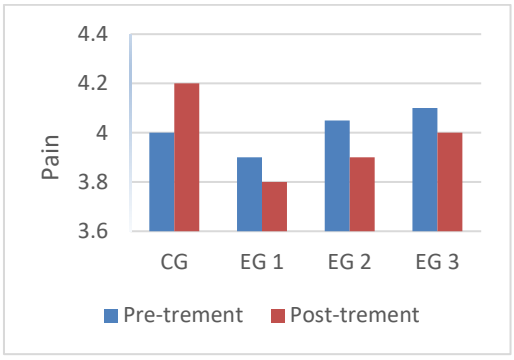

(g)

Figure 2. Total FSFI score of women. **(a)** Sexual function in all domains before and after 6 weeks of treatment: **(b)** desire; **(c)** arousal; **(d)** lubrication; **(e)** orgasm; **(f)** satisfaction; **(g)** pain. CG: Control group, EG: Experiment group.

After 6 weeks of treatment, it was found that the overall OABSS in EG2 and EG3 decreased significantly compared with that before treatment (as shown in **Figure 3** and **Table 2**). Studies have shown that the bladder activity (OAB) of patients treated only with PFMT is lower than that of untreated patients, showing some improvement, but the effect is not very obvious. In the same period, the bladder activity of patients treated with the combination of PFMT and ES improved significantly. Among the patients, the proportion of mild OAB increased by 50%. All patients with severe OAB dropped to the moderate level.

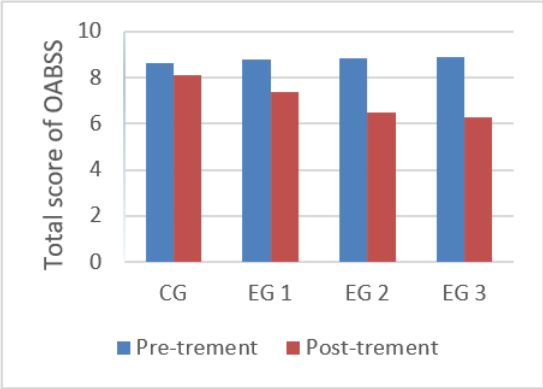

Figure 3. Total OABSS of women.

Table 2. The value of the total score of the overactive bladder symptom score (OABSS).

Comparison	Group	Mean ± SD	*p*-Value
Baseline	CG	8.61 ± 2.72	0.738
	EG 1	8.78 ± 2.61	0.719
	EG 2	8.83 ± 2.59	0.727
	EG 3	8.91 ± 2.66	0.734
Post-treatment	CG	8.13 ± 3.54	0.741
	EG 1	7.40 ± 1.74	0.705
	EG 2	6.50 ± 1.61	0.152
	EG 3	6.30 ± 1.58	0.101

The results of this research indicate that the comprehensive rehabilitation program combining pelvic floor muscle training (PFMT), electrical stimulation, and psychological intervention after hysterectomy has significant advantages in improving patients' pelvic floor muscle strength, urinary incontinence symptoms, and quality of life. Its clinical efficacy is superior to that of single treatment methods. After a 6-week intervention, the maximum pelvic floor muscle contraction pressure of the patients in the combined group increased to (82.5 ± 11.3) cm H_2O, which was 28.7% higher than that of the control group ($P < 0.05$), suggesting that this program can effectively promote the reconstruction of pelvic floor function after surgery. The assessment of the psychological scale showed that the anxiety and depression scores of the combined intervention group decreased by 37.4% compared with the baseline, indicating that psychological support plays a non-negligible role in postoperative rehabilitation. Our findings align with Zhu et al. (2022), who reported a 30% improvement in EMG activity with PFMT+ES; however, our comprehensive approach further demonstrated psychological benefits, suggesting synergistic effects of combined interventions [3].

This study also has certain limitations. For example, a small sample size (n = 40) and it is a single-center study, so the extrapolation of the results needs further verification. Secondly, the influence of patients' underlying diseases (such as diabetes and hypertension) on pelvic floor repair has not been completely excluded, and there may be confounding factors. Moreover, the follow-up time is short (6 weeks), and the long-term efficacy and recurrence rate are still unclear. In addition, this study did not conduct a subgroup analysis of the optimization of electrical stimulation parameters and the frequency of psychological intervention, and more refined dose-effect studies need to be carried out in the future.

Although these limitations may affect the results and interpretation of this study, they also point out important directions for future research. Addressing these limitations in subsequent studies is crucial for verifying our research findings and deepening the understanding of this topic.

The recovery of pelvic floor function after gynecological surgery is affected by various factors, including the surgical method and scope, the patient's age and physical condition, and postoperative rehabilitation training. In order to promote the recovery of pelvic floor function, the surgical method should be optimized, postoperative nursing and monitoring should be strengthened, personalized rehabilitation training plans should be formulated, and a multidisciplinary cooperation team should be established. Future research should further explore the influencing factors and intervention strategies for the recovery of pelvic floor function after gynecological surgery, with a view to providing more scientific and effective guidance for clinical practice. At the same time, with the continuous development of new technologies and methods, the field of pelvic floor function rehabilitation will face more opportunities and challenges.

5. Conclusion

In conclusion, this study focused on the treatment of post-hysterectomy pelvic floor dysfunction (PFD) and demonstrated that the combined approach of pelvic

floor muscle training (PFMT), electrical stimulation (ES), and psychological intervention offers a highly effective conservative treatment option. The significant improvement in multiple indicators, such as pelvic floor muscle strength, bladder activity, sexual function, and psychological well-being, highlights the superiority of this comprehensive rehabilitation program over single treatment modalities.

Given the multifactorial nature of pelvic floor function restoration after gynecological surgery, it is imperative to optimize surgical techniques, bolster postoperative care, develop personalized rehabilitation plans, and foster multidisciplinary collaborations. With the development of emerging technologies and methodologies, it is also believed that there will be more ways to improve pelvic floor function in the future. And this study provides a foundation for future endeavors, with the ultimate goal of offering more precise, effective, and patient-centered care for those affected by PFD.

Conflict of interest: The authors declare no conflict of interest.

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