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Original Research

Basic vs electromyographic biofeedback–assisted pelvic floor muscle training for the improvement of sexual function after total hysterectomy: a prospective study

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Abstract

Background: Pelvic floor muscle training (PFMT) has emerged as a potential intervention to improve post–total hysterectomy (TH) sexual function. Electromyographic (EMG) biofeedback is an adjunct that may improve outcomes.
Aim: In this study we aimed to compare the EMG biofeedback–assisted PFMT and PFMT alone for improving sexual function in women after TH.
Methods: For this prospective study we enrolled women undergoing TH in our hospital between January 2022 and April 2023. Participants were divided according to the treatment they selected: EMG biofeedback–assisted PFMT or PFMT alone.
Outcomes: The primary study outcome was change in patient sexual function evaluated by use of the Female Sexual Function Index. Secondary outcomes were changes in anxiety and depression evaluated with the Hospital Anxiety and Depression Scale score and pelvic floor muscle strength was evaluated with the Glazer assessment performed from before to after treatment.
Results: A total of 73 patients were included, with 38 patients treated with Electromyographic biofeedback–assisted pelvic floor muscle training. After treatment, sexual function was significantly improved compared to baseline in all patients (all $P < .001$). Compared to patients with pelvic floor muscle training, the changes in total Female Sexual Function Index scores from before to after treatment in patients with Electromyographic biofeedback–assisted pelvic floor muscle training were significantly higher (all $P < .05$). There were no significant differences between the 2 groups in the changes in the Glazer score and Hospital Anxiety and Depression Scale scores from before to after treatment (both $P > .05$).
Clinical Translation: The results demonstrate that Electromyographic biofeedback–assisted pelvic floor muscle training may be used to improve the sexual function of patients following TH.
Strengths and Limitations: This study is limited by its single-center design, small sample size, lack of randomization, and absence of estrogen monitoring in enrolled participants.
Conclusions: Electromyographic biofeedback–assisted pelvic floor muscle training appears to be more effective than pelvic floor muscle training alone in improving sexual function among patients after total hysterectomy.

Keywords: total hysterectomy; sexual function; pelvic floor muscle training; prospective study.

Introduction

Total hysterectomy (TH) is a common surgical procedure used to address various gynecological conditions such as uterine fibroids, adenomyosis, endometrial atypical hyperplasia, and certain high-grade squamous intraepithelial lesions not requiring fertility preservation. However, TH can inadvertently lead to damage to the pelvic floor structure, nerves, and organs, resulting in complications like urinary incontinence, organ prolapse, and sexual dysfunction.[1] The pelvic floor, comprising muscles, ligaments, and nerves, supports the bladder, uterus, and rectum within the pelvic cavity. Key ligaments like the cardinal ligament provide crucial mechanical support to the cervix and upper vagina. During TH, these structures are at risk of mechanical weakening and ischemic injury, potentially altering pelvic floor function.[2,3] The autonomic nerve fibers of the uterine vaginal plexus wrap tightly around the cervix and surrounding tissues and are at risk of being damaged during TH. Lakeman et al. described nerve damage that can result during the TH procedure.[4] Autonomic nerve fibers originating from the uterine vaginal plexus traverse major ligaments that have impacts on pelvic organ and smooth muscle function. Damage to these nerves during TH can disrupt pelvic floor integrity and vaginal tone, which can adversely affect sexual function.[5] Pelvic floor muscle (PFM) weakness, as observed in some individuals after TH, can hinder orgasm attainment due to diminished PFM contraction. This decline in muscle strength may also compromise the blood supply to the pelvic floor, leading to insufficient vaginal lubrication, discomfort during intercourse, and unsatisfactory orgasms.[6,7] Contraction of PFMs is important in the female orgasmic response. Decreases in PFM strength lead to decreases in the blood supply to the pelvic floor, resulting in insufficient vaginal lubrication, difficulty with intercourse, and unsatisfactory orgasm.[8]

After TH, patients also face heightened susceptibility to psychological issues like depression and anxiety. Concerns regarding sexual function postsurgery are significant contributors to these psychological challenges among women.

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[9,10] A study indicates that approximately 21% of women, with an average age of 59, perceive the uterus as crucial to their sexual experiences. Moreover, between 10% and 20% of women may experience deterioration in sexual function following TH.[11] Consequently, addressing and enhancing sexual function post-TH has emerged as a pressing concern demanding immediate attention.

Pelvic floor muscle training (PFMT) has demonstrated positive effects on women's sexual function.[12] Enhanced PFM strength contributes to improved muscle contraction, leading to heightened sexual arousal and satisfaction with orgasms.[13] PFMT facilitates increased blood flow to PFMs and enhances clitoral sensitivity, thereby improving sexual arousal, lubrication, and orgasm.[14] Consequently, PFMT exerts a favorable influence on women's sexual function. However, whether PFMT yields similar benefits for women undergoing TH remains underexplored, despite the importance of addressing sexual function and associated psychological issues post-TH. Research indicates that 10%-20% of women may experience sexual dysfunction following TH surgery.[11] The 2020 Guidelines for the Diagnosis and Treatment of Pelvic Organ Prolapse in China recommend PFMT as an effective intervention for enhancing sexual function.[15] Nonetheless, the specific impact of PFMT on sexual function in post-TH individuals remains uncertain.

In clinical practice, adjuncts like electromyographic (EMG) biofeedback are commonly employed to augment the effects of PFMT. The EMG biofeedback method involves using a vaginal probe to capture PFM electrical activity, which is displayed on a screen.[16] This technique aims to enhance awareness of PFM function and improve voluntary control of these muscles and the external urethral sphincter during voiding.[17]

We hypothesized that PFMT may be an effective treatment modality for women who underwent TH and also that combining PFMT with EMG biofeedback may provide more effective PFM awareness and more successful outcomes than PFMT alone. Therefore, in this study we aimed to compare the EMG biofeedback–assisted PFMT and PFMT alone for improvement of sexual function in women following TH.

Methods

Study design and patients

This prospective study enrolled women who underwent TH for benign disease in our hospital between January 2022 and April 2023. Inclusion criteria for the study participants were the following: (1) women between 40 and 55 years of age who were premenopausal, with prior sexual experience; (2) patients undergoing TH for benign disease; (3) patients and their families required to comprehend and consent to participation in the study; (4) patients underwent TH procedures that were standardized and performed laparoscopically with ovary preservation by the same surgeon; (5) patients demonstrating well-healed vaginal tips 3 months postsurgery and readiness for sexual intercourse upon examination. Exclusion criteria were as follows: patients with (1) low compliance, (2) history of malignant tumor; (3) urinary diseases or serious heart, liver, kidney, or other vital organ diseases, or body mass index (BMI) > 28 kg/m^2. This study was approved by the Ethics Committee of Zhenjiang Maternal and Child Health Hospital (no. 2021-007). Signed informed consent forms were provided by the patients and their families. The reporting of this study adheres to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) reporting guidelines for observational studies.[18]

Treatment

All surgical procedures were conducted laparoscopically, and as none of the enrolled participants were menopausal, ovarian preservation was ensured in all cases. Patients were divided into an EMG biofeedback–assisted PFMT group and a PFMT group according to their chosen procedure, which was selected mainly due to economic conditions and time issues. The 2 modes of treatment both lasted 3 months.

For patients with EMG biofeedback–assisted PFMT, participants received a total of 10-15 treatment sessions, each lasting approximately 30 minutes. Utilizing a PHENIX USB4 biofeedback device from Electronic Concept Lignon Innovation (France), a vaginal probe captured PFM electrical activity and displayed it on a screen. This biofeedback system was integrated with PFMT exercises during sessions, aiming to teach correct contraction techniques and home exercise programs. Visualizing PFM activity during exercises potentially enhanced motivation and adherence to prescribed routines.

For patients with PFMT, a personalized PFMT program was developed for home use. Patients were instructed to perform 3 sets of exercises daily, which they documented in an exercise diary. Additionally, biweekly phone contacts were made to monitor exercise adherence, provide bladder management guidance, and offer lifestyle advice when necessary.

Baseline assessments were completed by all participants who underwent laparoscopic TH, including the Female Sexual Function Index (FSFI) and Hospital Anxiety and Depression (HAD) scales, as well as PFM strength evaluations using the Glazer method. A follow-up visit was conducted 3 months postsurgery to assess vaginal apex healing. After 3 months of treatment, participants completed the FSFI and HAD assessments again, and PFM strength values were reassessed to evaluate improvements in sexual function.

Patient baseline characteristic data were collected, including diagnosis, age, BMI, education, symptoms, residence, duration of marriage, nature of work, menstrual cycle, and duration of menstruation.

Outcomes

The primary outcomes were the changes in sexual function evaluated with the FSFI). Secondary outcomes were changes in anxiety and depression evaluated with the HADS, and PFM strength evaluated with the Glazer assessment before and after treatment.

The FSFI is a validated 19-item self-report measure of female sexual function, which provides scores on 6 domains using factor analysis and measures sexual desire, arousal, lubrication, orgasm, satisfaction, and pain. Each domain is scored on a scale of 0-6, with higher scores indicating better function. The maximum score of the 19-question survey is 36 points and the minimum score is 2 points, with higher scores indicating better sexual function. A total score > 26.55 indicates the absence of female sexual dysfunction.[19]

Anxiety and depression were assessed using the HADS,[20] which consists of 14 items that are rated on a 4-point Likert-type scale. The HADS-Depression score was used to assess depression and the HADS-Anxiety score was used to assess anxiety, with a score of at least 9 in each subscale indicating the presence of anxiety or depression.

Pelvic floor muscle strength was evaluated using the Glazer assessment [21] before treatment and again after treatment. The Glazer score objectively reflected the status of the PFMs of the participants.

Statistical analysis

The statistical analysis was performed using SPSS Statistics version 22.0 (IBM, Armonk, NY, United States). Continuous data with a normal distribution were reported as mean (SD) and analyzed using the Student *t*-test; otherwise, they were presented as median (IQR) and analyzed using the Mann–Whitney U-test. Categorical data were described as n (%) and analyzed using the chi-square test or Fisher's exact test. The paired-sample *t*-test was used to compare and confirm the relevant indicators among the same group of indicators before and after treatment. Covariance analysis was used to compare the changes in related indicators before and after treatment in the 2 groups. The influence of confounding factors such as HADS on FSFI values was controlled by regression analysis. Two-sided *P* values <.05 were considered statistically significant.

Results

A total of 73 women were included, with 38 women treated with EMG biofeedback–assisted PFMT. There were no significant difference in diagnosis, age, education, symptoms, residence, duration of marriage, nature of work, menstrual cycle, or duration of menstruation between the EMG biofeedback–assisted PFMT group and the PFMT only group. However, compared to patients in the PFMT only group, patients in the EMG biofeedback–assisted PFMT group had significantly lower BMI (mean [SD] 23.62 [2.72] vs 25.30 [3.05], $P = .015$) (Table 1).

Before treatment, there were no statistically significant differences between the EMG biofeedback–assisted PFMT and the PFMT group in 5 aspects of the FSFI scale, while there were statistically significant differences between the 2 groups in orgasm and lubrication (both $P < .05$) (Table 2). Compared with pretreatment sexual function, posttreatment sexual function was significantly improved in both patients treated with EMG biofeedback–assisted PFMT and those treated with PFMT alone (all $P < .001$) (Table 3). Compared to patients with PFMT, the changes of sexual desire (1.42 [0.53] vs 0.77 [0.50], $P < .001$), sexual arousal (1.08 [0.66] vs 0.53 [0.45], $P < .001$), lubrication (1.04 [0.70] vs 0.53 [0.59], $P = .001$), orgasm (1.20 [0.53] vs 0.62 [0.41], $P < .001$)and satisfaction (1.06 [0.67] vs 0.66 [0.65], $P < 0.001$) and total FSFI scores (6.52 [2.73] vs 3.61 [1.93], $P = 0.011$) from before to after treatment in patients with EMG biofeedback–assisted PFMT were significantly higher. There was no significant difference in pain between the 2 groups ($P = .357$) (Table 4).

After treatment, anxiety, depression, and total HADS scores were significantly lower in patients with EMG biofeedback–assisted PFMT and patients with PFMT compared with those before treatment (all $P < .001$) (Table 5). The changes in anxiety, depression, and the total HADS scores from before to after treatment were comparable in both groups (all $P > .05$) (Table 6).

There was no significant difference in the changes in the total Glazer scores from before to after treatment between the 2 groups ($P = .581$) (Table 7).

Logistic regression analysis was performed to observe the impact of psychological factors, namely HADS score, on FSFI, showing that HADS score had an impact on FSFI (odds ratio [OR], 1.237; 95% CI, 1.122-1.364; $P = .000$), and psychological factors affected the sexual function of participants. The influence of anxiety factors (OR, 1.422; 95% CI, 1.126-1.795; $P = .003$) on FSFI was greater than that of depression factors (OR, 1.120; 95% CI, 0.942-1.332; $P = .200$) (Table S1).

Discussion

This study showed that the sexual function of women in both groups improved after treatment. Compared to PFMT only, EMG biofeedback–assisted PFMT can significantly improve the sexual function of patients following TH, and the EMG biofeedback–assisted PFMT group was showed superior outcomes compared to the family training group in 5 aspects: libido, sexual arousal, lubrication, orgasm, and satisfaction. These results indicate that EMG biofeedback–assisted PFMT may be used to improve the sexual function of patients following TH.

Participants in the EMG biofeedback–assisted PFMT group had a total of 10-15 treatments in the hospital, each lasting about 30 minutes. The advantage of opting for EMG biofeedback–assisted PFMT lies in the real-time correction of incorrect Kegel training techniques by healthcare professionals, thereby enhancing therapeutic efficacy. Additionally, physicians could conveniently supervise participants' adherence to training regimens through training diaries, which were regularly provided by participants in this group during each treatment session. In contrast, participants in the PFMT-only group used telephone contact to submit training diaries twice a week and receive guidance on optimizing their training routines. However, due to the demands of household tasks and other responsibilities, many participants struggled to consistently perform Kegel exercises. Those who opted for home training often faced time constraints that limited their ability to dedicate sufficient time to Kegel exercises. Consequently, participants in the PFMT group had fewer opportunities for in-person doctor visits, potentially leading to delays in addressing faulty training techniques, compared to those in the EMG biofeedback–assisted PFMT group. This discrepancy in the frequency of doctor visits and the timely correction of Kegel training errors may account for the superior treatment outcomes observed in the EMG biofeedback–assisted PFMT group compared to the PFMT-only group.

Pelvic floor muscle contractions are integral to the female orgasm response.[22] Graber and Koline-Graber placed a pressure-sensitive device inside the vagina to measure PFM contractions and reported differences in the physiological state of PFMs in women who did and those who did not orgasm, which strongly supports the importance of PFMs in female orgasm responses.[20] In this study, PFM strength assessment was performed in both groups before and after treatment and revealed significant increases in PFM strength following treatment in both groups, with no statistical difference between them. After treatment, sexual function was also significantly improved compared with that before treatment in both patients with EMG biofeedback–assisted PFMT and patients with PFMT only. This finding reinforces

Table 1. Comparison of baseline characteristics.[a]

Variable	EMG biofeedback–assisted PFMT group (n = 38)	PFMT group (n = 35),	*t* value	*P* value
BMI, mean (SD)	23.62 (2.72)	25.30 (3.05)	–2.481	.015
Age, y, mean (SD)	48.34 (3.63)	49.29 (3.76)	–1.091	.279
Duration of marriage, y, mean (SD)	25.39 (5.04)	26.43 (4.43)	–0.928	.357
Menstrual cycle, d, mean (SD)	28.74 (2.30)	29.77 (5.97)	–0.993	.324
Duration of menstruation, d, mean (SD)	6.11 (1.48)	6.43 (1.58)	–0.902	.37
Residence, No. (%)				
Town	32 (84.21%)	30 (85.71%)	3.733	.155
Rural	6 (15.79%)	3 (8.57%)		
Migrant	0 (0.00%)	2 (5.71%)		
Diagnosis, No. (%)				
Uterine myoma	18 (47.37%)	19 (54.29%)	1.089	.780
Adenomyosis of uterus	11 (28.95%)	11 (31.43%)		
High-grade squamous intraepithelial lesion	5 (13.16%)	3 (8.57%)		
Atypical endometrial hyperplasia	4 (10.53%)	2 (5.71%)		
Symptoms, No. (%)				
Heavy menorrhea	5 (13.16%)	4 (11.43%)	5.538	.354
Dysmenorrhea	12 (31.58%)	7 (20.00%)		
Heavy menstruation with anemia	0 (0.00%)	2 (5.71%)		
Anemia	2 (5.26%)	5 (14.29%)		
Dysmenorrhea with prolonged periods	1 (2.63%)	1 (2.86%)		
Asymptomatic	18 (47.37%)	16 (45.71%)		
Education, No. (%)				
Junior high school and below	21 (55.26%)	22 (62.86%)	3.955	.138
Senior high school	9 (23.68%)	11 (31.43%)		
College or above	8 (21.05%)	2 (5.71%)		
Delivery, No. (%)				
Vaginal delivery	26 (68.42%)	25 (71.43%)	0.078	.780
Cesarean section	12 (31.58%)	10 (28.57%)		
Nature of work, No. (%)				
Housework	12 (31.58%)	3 (8.57%)	7.801	.05
Mental labor and manual labor	2 (5.26%)	4 (11.43%)		
Mental work	13 (34.21%)	11 (31.43%)		
Manual labor	11 (28.95%)	17 (48.57%)		

Abbreviations: BMI, body mass index; EMG, electromyographic; PFMT, pelvic floor muscle training. [a]General patient information was obtained at the beginning of treatment.

Table 2. Comparison of FSFI scale scores between EMG biofeedback–assisted PFMT group and PFMT group before treatment.

FSFI scores	EMG biofeedback–assisted PFMT group (n = 38) before treatment	PFMT group (n = 35) before treatment	*t* value	*P* value
Desire	2.67 (0.62)	2.61 (0.56)	0.452	.653
Arousal	3.49 (0.72)	3.51 (0.66)	–0.1	.921
Lubrication	4.74 (0.75)	5.11 (0.74)	–2.078	.041
Orgasm	3.71 (0.54)	4.11 (0.62)	–2.98	.004
Satisfaction	4.22 (0.63)	4.31 (0.66)	–0.581	.563
Pain	4.99 (0.65)	5.09 (0.73)	–0.596	.553
Total score	23.82 (2.93)	24.72 (2.89)	–1.325	.190

Abbreviations: EMG, electromyographic; FSFI, Female Sexual Function Index; PFMT, pelvic floor muscle training.

existing evidence that PFMT effectively enhances sexual function by improving PFM strength.

Sobhgol et al. proposed that sexual function is influenced by physiological and psychological factors, with PFMT identified as the most effective means of strengthening pelvic floor function.[21] Improved sexual function not only enhances sexual quality of life but also ameliorates psychological issues in women.[23] Some participants showed symptoms of depression and anxiety before surgery. Communication with these patients revealed that the main sources of these symptoms were worry about their disease, fear of the imminent operation, and the possible impact of the operation on future life. After treatment, the symptoms of anxiety and depression in the 2 groups were significantly improved, and the HADS scores were within the normal range, indicating that their anxiety and depression were not long-term conditions existing before surgery. The improvement of the psychological state of the participants was related to the disappearance of worries about surgery and disease. At the same time, the participants found that the surgery did not affect their sexual function, and even after PFMT only, the sexual function was improved. Thus, a positive psychological state contributed to enhanced sexual function.

Numerous studies have elucidated the structural and neural changes in the pelvic floor following TH, including pelvic floor structure changes and pelvic floor nerve damage, as well as the concerns and even fears of women undergoing surgery for postoperative sexual function, and most women's

Table 3. Comparison of FSFI scale between EMG biofeedback–assisted PFMT group and PFMT group before and after treatment.

FSFI scores	Before treatment	After treatment	*t* value	*P* value
EMG biofeedback–assisted PFMT group (n = 38)				
Desire	2.67 (0.62)	4.09 (0.37)	−16.536	<.001
Arousal	3.49 (0.72)	4.57 (0.26)	−10.159	<.001
Lubrication	4.74 (0.75)	5.79 (0.29)	−9.222	<.001
Orgasm	3.70 (0.54)	4.91 (0.22)	−14.061	<.001
Satisfaction	4.22 (0.63)	5.26 (0.22)	−9.187	<.001
Pain	4.99 (0.65)	5.73 (0.35)	−7.32	<.001
Total score	23.82 (2.93)	30.34 (0.81)	−14.714	<.001
PFMT group (n = 35)				
Desire	2.61 (0.56)	3.38 (0.39)	−9.22	<.001
Arousal	3.51 (0.66)	4.04 (0.36)	−6.912	<.001
Lubrication	5.11 (0.74)	5.64 (0.49)	−5.352	<.001
Orgasm	4.11 (0.62)	4.73 (0.43)	−8.905	<.001
Satisfaction	4.31 (0.66)	4.97 (0.55)	−6.03	<.001
Pain	5.09 (0.73)	5.58 (0.42)	−4.234	<.001
Total score	24.72 (2.89)	28.34 (1.66)	−11.06	<.001

Abbreviations: EMG, electromyographic; FSFI, Female Sexual Function Index; PFMT, pelvic floor muscle training.

Table 4. Comparison of efficacy evaluation of FSFI scale between EMG biofeedback–assisted PFMT group and PFMT group: scores after – before treatment.

FSFI scores	Score after – before treatment, mean (SD) EMG biofeedback–assisted PFMT group (n = 38)	PFMT group (n = 35)	*t* value	*P* value
Desire	1.42 (0.53)	0.77 (0.50)	5.401	<.001
Arousal	1.08 (0.66)	0.53 (0.45)	4.128	<.001
Lubrication	1.04 (0.70)	0.53 (0.59)	3.345	.001
Orgasm	1.20 (0.53)	0.62 (0.41)	5.179	<.001
Satisfaction	1.06 (0.67)	0.66 (0.65)	2.595	.011
Pain	0.74 (0.62)	0.61 (0.59)	0.927	.357
Total	6.52 (2.73)	3.61 (1.93)	5.209	0

Abbreviations: EMG, electromyographic; FSFI, Female Sexual Function Index; PFMT, pelvic floor muscle training.

Table 5. Comparison of HADS scores before and after treatment between EMG biofeedback–assisted PFMT group and PFMT group.

HADS score	Before treatment	After treatment	*t* Value	*P* value
EMG biofeedback–assisted PFMT group (n = 38)				
Anxiety scores	3.63 (3.17)	1.00 (0.90)	5.056	<.001
Depression scores	4.76 (3.28)	2.08 (1.44)	5.006	<.001
Total	8.39 (6.21)	3.00 (1.76)	5.385	<.001
PFMT group (n = 35)				
Anxiety scores	3.03 (2.28)	1.37 (1.42)	3.838	<.001
Depression scores	4.34 (3.15)	2.26 (1.65)	3.875	<.001
Total	7.37 (4.70)	3.63 (2.24)	4.598	<.001

Abbreviations: EMG, electromyographic; HADS, Hospital Anxiety and Depression Scale; PFMT, pelvic floor muscle training.

Table 6. Comparison of HADS efficacy evaluation between the EMG biofeedback–assisted PFMT group and the PFMT group: scores after – before treatment.

HADS score	Score after – before treatment, mean (SD) EMG biofeedback–assisted PFMT group (n = 38)	PFMT group (n = 35)	*t* value	*P* value
Anxiety scores	−2.63 (3.21)	−1.66 (2.55)	−1.428	.158
Depression scores	−2.68 (3.31)	−2.09 (3.18)	−0.787	.434
Total	−5.39 (6.18)	−3.74 (4.81)	−1.267	.209

Abbreviations: EMG, electromyographic; HADS, Hospital Anxiety and Depression Scale; PFMT, pelvic floor muscle training.

postoperative sexual function is unsatisfactory [24]. The change of pelvic floor structure and damage to the pelvic floor nerve may affect pelvic floor function and thus affect sexual function as well[25]. Numerous studies have shown that PFMT can significantly improve sexual function in women who undergo postpartum, perimenopausal, or pelvic floor dysfunction surgery[26–28]. In a randomized controlled study, Citak et al[29] evaluated the effect of PFMT on postpartum

Table 7. Comparison of Glazer score between EMG biofeedback–assisted PFMT group and PFMT group.

Glazer score	Score after – before treatment, mean (SD) EMG biofeedback–assisted PFMT group score (n = 38)	PFMT group (n = 35)	*t* value	*P* value
Total	14.04 (8.47)	12.91 (8.81)	0.555	.581

Abbreviations: EMG, electromyographic; PFMT, pelvic floor muscle training.

female sexual function and found improved FSFI orgasmic scores in patients who received PFMT. Randomized controlled trials conducted by Braekken et al[30] revealed that PFMT improved sexual function in women with pelvic organ prolapse and led to improvements in libido, orgasm, pain during intercourse, etc. In addition, adjuncts like EMG biofeedback are commonly employed to augment the effects of PFMT, and this technique may enhance awareness of pelvic floor muscle function and improve voluntary control of these muscles and the external urethral sphincter during voiding. However, to our knowledge no previous study has investigated how to improve the sexual function of women undergoing TH for benign diseases. In this study, the results suggest that after TH both groups of women showed improvement in sexual function after treatment, and compared to PFMT only, EMG biofeedback–assisted PFMT can significantly improve the sexual function of patients who have undergone TH. However, given that women undergo TH for treatment of adenomyosis, uterine bleeding, and other reasons, the improvement of postoperative sexual function may also be attributable to successful treatment, a situation that was not addressed in this study.

Many women experience sexual dysfunction after TH. Some gynecologists believe that trauma to the nerves and arterioles that supply the vagina, uterus, and clitoris during surgery can lead to sexual dysfunction. Lakeman et al. described the potential for nerve damage during a TH procedure. Similarly, Butler-Manuel et al. demonstrated that separation of the uterine and principal ligaments during TH can lead to nerve damage.[31] Therefore, by preserving the pelvic nerve fibers, sexual arousal and orgasm after TH can be sustained. Surgeons who are familiar with the exact anatomical location of the pelvic nerves can protect these vital nerve bundles and blood vessels during surgery so that women can maintain as much sexual function as possible.

Limitations

This study has several limitations. First, it is a retrospective single-center study, and the sample size was limited. As a result, potential biases cannot be entirely excluded. Second, a more fundamental limitation is the absence of randomization and blinding. The latter may not be possible, but lack of randomization as a fundamental process may lead to potential biases. That women who got biofeedback-assisted were likely of better means may be the fundamental driving factor more so than BT itself. Third, the mean age of the patients enrolled in this study was 48 years, and they were in perimenopause, which was directly related to the decrease of estrogen levels. However, the estrogen level of the patients was not monitored in this study, which was one of the limitations of this study. Estrogen receptors are found in the vagina, vulva, pelvic floor muscle tissue, pelvic fascia, urethra, and bladder triangle during the reproductive period. Anatomical and histological changes in female genital tissue due to estrogen deficiency, including reduced collagen and hyaluronic acid content, and decreased elastin levels [32] can lead to a general decline in pelvic floor muscle tone and sometimes prolapse of reproductive or urinary organs [33], negatively affecting sexual function in perimenopausal women.[34] In future studies, estrogen monitoring should be carried out. Whether estrogen use in perimenopausal women can improve their sexual function remains to be studied.

Conclusions

In this study, compared to PFMT alone, EMG biofeedback–assisted PFMT can significantly improve the sexual function of patients after TH. EMG biofeedback–assisted PFMT appears to be more effective than PFMT alone in improving sexual function among patients after TH. However, multicenter randomized controlled trials are needed to verify this result in the future. TH can cause changes in pelvic floor structure and pelvic nerve damage, resulting in pelvic floor dysfunction disease, and sexual dysfunction is only one of the possible effects. PFMT not only can improve sexual function, but may also prevent pelvic floor dysfunction diseases such as urinary incontinence and organ prolapse. Therefore, PFMT should be carried out as early as possible after TH surgery, and it can bring benefits to participants whether they receive biofeedback in the hospital or conduct home training under the guidance of physicians.

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Author contributions

Y.W. and W.L. contributed to the study conception and design. All authors collected the data and performed the data analysis. All authors contributed to the interpretation of the data and the completion of figures and tables. All authors contributed to the drafting of the article and final approval of the submitted version.

Supplementary material

Supplementary material is available at *Sexual Medicine* online.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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