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Effects of Electrical Stimulation, Pelvic Floor Muscle Exercise, and Biofeedback Program on Improving Pelvic Floor Function and Quality of Life in Postoperative Patients with Early-Stage Cervical Cancer

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Pelvic floor muscle exercise (PME), biofeedback, and electrical stimulation improve pelvic floor function, but the effect of their combination in patients with early-stage cervical cancer is unclear. This study intended to design a combined intervention encompassing these three interventions and explore its effect on pelvic floor function in postoperative patients with early-stage cervical cancer. Totally, 177 postoperative patients with early-stage cervical cancer were assigned to combination (N = 81) and PME (N = 96) groups according to actual interventions. Pelvic Floor Distress Inventory-Short Form 20 (PFDI-20), International Consultation on Incontinence Questionnaire Urinary Incontinence Short Form (ICIQ-UI-SF), and EORTC Core Quality of Life questionnaire (EORTC QLQ-C30) scores were assessed at the seventh day after surgery (W0), and at 4 (W4), 8 (W8), and 12 (W12) weeks after W0. PFDI-20 scores at W8 (P = 0.042) and W12 (P = 0.006), and ICIQ-UI-SF scores at W4 (P = 0.012), W8 (P = 0.024), and W12 (P = 0.003) were lower in the combination group versus PME group. PFDI-20 decline and ICIQ-UI-SF decline (W0-W12) were greater in the combination group versus PME group (both P = 0.007). Combined intervention (versus PME) was independently related to greater PFDI-20 decline (B = 5.548, P < 0.001) and ICIQ-UI-SF decline (W0-W12) (B = 1.544, P = 0.006). EORTC QLQ-C30 global health status scores at W12 were higher in the combination group versus PME group (P = 0.045), while EORTC QLQ-C30 function and symptom scores at any time points were not different between the two groups (all P > 0.05). Combined intervention achieves greater pelvic floor function improvement and better quality of life compared to PME in postoperative patients with early-stage cervical cancer.

Keywords: biofeedback; electrical stimulation; pelvic floor function; pelvic floor muscle exercise; postoperative cervical cancer
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Introduction

Cervical cancer is the fourth most frequently diagnosed cancer in women, with an estimated 604,000 new cases and 342,000 deaths in 2020, worldwide (Sung et al. 2021). Surgery is the recommended treatment for patients with early-stage cervical cancer (Abu-Rustum et al. 2020; Poddar and Maheshwari 2021; Brandt et al. 2022). However, approximately 20% to 45% of patients with early-stage cervical cancer experience pelvic floor dysfunction after surgery (Jackson and Naik 2006; Shan et al. 2023). Pelvic floor dysfunction further contributes to vari-

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ous symptoms, such as urine retention, urinary incontinence, urination difficulties, constipation, and sexual dysfunction, which severely degrades the quality of life in postoperative patients with early-stage cervical cancer (Jackson and Naik 2006; Wang et al. 2021; Stanca et al. 2022). Currently, many nursing interventions, such as pelvic floor muscle exercise (PME), have been widely applied to improve pelvic floor function (Radziminska et al. 2018; Brennen et al. 2020; Todhunter-Brown et al. 2022; Zong et al. 2022). However, it is still needed to explore novel interventions that assist in the promotion of pelvic floor function and quality of life in postoperative patients with early-stage cervical cancer.

In addition to traditional PME, electrical stimulation and biofeedback also show the potential to ameliorate the impaired pelvic floor function (Ignacio Antonio et al. 2022; Liang et al. 2022; Lv et al. 2023). Electrical stimulation applies electric currents to trigger passive contractions of the pelvic floor muscles and increase neuromuscular excitability (Enoka et al. 2020; Liu et al. 2022). Biofeedback converts physiological signals into audible or visual signals that can be perceived, enabling patients and physicians to clearly know the status of the pelvic floor muscles, and guiding them to take effective actions (Giggins et al. 2013). It should be clarified that each of PME, electrical stimulation, and biofeedback solely has been widely applied to improve pelvic floor function (Jerez-Roig et al. 2013; Qaseem et al. 2014; Narayanan and Bharucha 2019). Additionally, their combination is recommended for ameliorating urinary incontinence according to the Cochrane review (Todhunter-Brown et al. 2022). Meanwhile, a previous study focuses on postoperative cervical cancer patients, but it uses an intervention combining Pilates exercise with communication compliance and PME; this study reports that this intervention improves pelvic floor function and family intimacy and adaptability in these patients (Yu et al. 2022). Taken together, the effect of the combination of biofeedback, electrical stimulation, and PME on enhancing pelvic floor function in postoperative patients with early-stage cervical cancer is scarce.

Accordingly, this real-world prospective study designed a combined intervention program consisting of electrical stimulation, PME, and biofeedback and aimed to explore its effect on pelvic floor function and quality of life in postoperative patients with early-stage cervical cancer.

Methods

Patients

In this prospective cohort study, a total of 177 postoperative patients with early-stage cervical cancer who received the combined intervention (electrical stimulation combined with PME and biofeedback) or PME rehabilitation between May 2020 and January 2023 were enrolled. The inclusion criteria were: i) diagnosed with cervical cancer by pathological examination; ii) aged more than 18 years old; iii) with I-IIA of the International Federation of Gynecology and Obstetrics (FIGO) stage; iv) received radical hysterectomy; v) about to receive combined intervention or PME rehabilitation after surgery; vi) had the willingness to be followed up regularly based on the protocol. The exclusion criteria were: i) with urinary system diseases, such as ureteritis, kidney stones, and nephritis; ii) with symptoms, such as urinary incontinence, bladder storage, and pelvic organ prolapse symptoms; iii) with a history of urinary surgery; iv) with a history of pelvic surgery; v) received neoadjuvant therapy; vi) had a cognitional functional disorder that could not complete assessment questionnaire normally. This study obtained approval from the Ethics Committee. Each patient provided written informed consent.

Characteristics acquisition

After enrollment, the characteristics of the patients were acquired, which included age, menopausal status, marriage status, education level, registered location, human papillomavirus (HPV) positivity, histologic classification, pathological grade, FIGO stage, surgery type, adjuvant radiotherapy, and adjuvant chemotherapy.

Rehabilitations

This study did not disrupt the patient's treatment in any way. The rehabilitation was selected according to the actual condition (patients' willingness, disease status, distance between the residence and the hospital, and so on) of patients after the operation. As a result, there were a total of 96 patients in the PME group and 81 patients in the combination group. The routine protocol of the PME group was as follows: patients were recommended to begin conventional PME (also known as the Kegel exercise) from the seventh day after surgery (W0). This exercise was recommended to be performed 1-3 times a day for a period of 6-12 weeks, depending on the patient's physical condition (Zong et al. 2022). The routine protocol of the combination group was as follows: from W0, electrical stimulation was conducted once a week in the hospital and lasted for 6-12 weeks based on the patient's physical condition. The parameters were determined according to the patient's pain tolerance. The parameters were generally set as follows: frequency 20 to 50 Hz, pulse width 300 us, and current 0 to 80 mA, which were adjusted until the patient could no longer feel pain. Besides, the Kegel exercise was required to be conducted 1-3 times per day from W0 and lasted for 6-12 weeks based on the patient's physical condition. Additionally, biofeedback was recommended to be completed once a week in the hospital (Rivalta et al. 2010). The type of biofeedback was pelvic floor muscle biofeedback electrical stimulation therapy (PHENIX USB 4, Sugiyama France, Paris, France), which was performed according to the treatment plan for stress urinary incontinence. To ensure the quality of the intervention, the electromyographic voltage needed to be lower or higher than the target voltage during the relaxation or contraction training. The

instructors of the Kegel exercise were responsible nurses. Meanwhile, the Kegel exercise was orally explained and demonstrated by the responsible nurses before surgery in all patients.

Follow-up and evaluation

Patients were followed up at W0, 4 weeks after W0 (W4), 8 weeks after W0 (W8), and 12 weeks after W0 (W12) regularly. A total of 15 patients were lost to follow-up, eight in the PME group and seven in the combination group. Besides, the Pelvic Floor Distress Inventory-Short Form 20 (PFDI-20) and International Consultation on Incontinence Questionnaire Urinary Incontinence Short Form (ICIQ-UI-SF) scores were evaluated at W0 (seventh day after radical hysterectomy), W4, W8, and W12 to assess pelvic floor function (Lim et al. 2019; Mashayekh-Amiri et al. 2023). The EORTC Core Quality of Life questionnaire (EORTC QLQ-C30) was also assessed at W0, W4, W8, and W12 to evaluate life quality (Kaasa et al. 1995). This PFDI-20 score had 20 items scored from 0-4, covering three scopes: Pelvic Organ Prolapse Distress Inventory 6 (POPDI-6), Colorectal-Anal Distress Inventory-8 (CRADI-8), and Urinary Distress Inventory 6 (UDI-6). Scores were calculated by multiplying the mean score of each scope by 25. The score of each scope was 0-100 and the total PFDI-20 score was 0-300, with higher scores indicating more severe pelvic function status. The ICIQ-UI-SF score ranged from 0 to 21 (the higher the score, the more severe the disease) and was calculated by 3 items: frequency, volume of leakage, and overall impact of incontinence. The EORTC QLQ-C30 score contained 3 items: global health status, function, and symptom. The score of each item ranged from 0 to 100, with higher global health status or function scores representing a better quality of life, and a higher symptom score representing a worse quality of life.

The postoperative symptoms were evaluated by patients' self-reports according to PFDI-20 scores.

Statistics

SPSS version.26.0 (IBM, USA) was conducted for data analyses. Student t-test, chi-square test, Fisher's exact test, or Mann-Whitney U test were used for comparison analyses. Enter-method multiple linear regression models were constructed to find factors related to the improvement of pelvic floor function. A $P < 0.05$ was represented statistical significance.

Results

Information of the combination group and PME group

The mean age was 47.6 ± 10.9 years in the combination group, and it was 49.8 ± 10.2 years in the PME group ($P = 0.175$). The proportion of patients who were registered in the rural location or urban location differed between the combination group and the PME group ($P = 0.022$). Other clinical features did not differ between the two groups, including menopausal status, marital status, educational level, HPV positivity, histologic classification, pathological grade, FIGO stage, surgery type, adjuvant radiotherapy, and adjuvant chemotherapy (all $P > 0.05$). The specific properties of the two groups are exhibited in Table 1.

In all enrolled patients, the common postoperative symptoms included urinary incontinence, difficulty in defecation, and fecal incontinence according to PDFI-20 scores. The rates of urinary incontinence, difficulty in defecation, and fecal incontinence were 40.1%, 37.9%, and 11.9%, respectively.

Comparison of PFDI-20 scores between the combination group and PME group

PFDI-20 scores at W0 ($P = 0.304$) and W4 ($P = 0.151$) did not differ between the two groups. However, PFDI-20 scores at W8 (7.4 ± 4.5 vs. 9.3 ± 6.8) ($P = 0.042$) and W12 (6.4 ± 3.0 vs. 8.0 ± 4.3) ($P = 0.006$) were lower in the combination group than in the PME group (Fig. 1A). PFDI-20 decline (W0-W12) was greater in the combination group compared with the PME group (22.4 ± 9.7 vs. 18.4 ± 9.1) ($P = 0.007$) (Fig. 1B).

This study further compared the subscales of the PFDI-20 score between the two groups. It was found that the POPDI-6 score at W8 (2.4 ± 2.0 vs. 3.2 ± 3.0) ($P = 0.032$) and W12 (2.3 ± 1.3 vs. 2.8 ± 1.6) ($P = 0.016$) was decreased in the combination group compared to the PME group. The CRADI-8 score at W12 was reduced in the combination group compared to the PME group (2.4 ± 1.4 vs. 3.0 ± 2.0) ($P = 0.043$). The UDI-6 score at W4 (4.2 ± 2.5 vs. 5.0 ± 3.0) ($P = 0.045$) and W12 (1.7 ± 1.4 vs. 2.2 ± 1.5) ($P = 0.032$) was decreased in the combination group compared to the PME group (Supplementary Table S1).

Independent factors related to PFDI-20 decline (W0-W12)

Combined intervention (vs. PME) ($B = 5.548$, $P < 0.001$) was independently related to greater PFDI-20 decline (W0-W12). Laparotomy (vs. laparoscope) ($B = -4.497$, $P = 0.047$) and adjuvant radiotherapy (yes vs. no) ($B = -4.445$, $P = 0.022$) were independently correlated with smaller PFDI-20 decline (W0-W12). However, other factors, including age, menopausal status, marital status, education level, registered location, HPV positivity, histologic classification, pathological grade, FIGO stage, and adjuvant chemotherapy, were not related to PFDI-20 decline (W0-W12) in postoperative patients with early-stage cervical cancer (all $P > 0.05$) (Table 2).

Comparison of ICIQ-UI-SF scores between the combination group and PME group

ICIQ-UI-SF scores at W0 were not different between the two groups ($P = 0.457$). Of note, ICIQ-UI-SF scores at W4 (5.1 ± 2.7 vs. 6.1 ± 2.6) ($P = 0.012$), W8 (3.5 ± 2.4 vs. 4.3 ± 2.3) ($P = 0.024$), and W12 (2.5 ± 1.9 vs. 3.4 ± 2.0) ($P = 0.003$) were lower in the combination group vs. the PME group (Fig. 2A). ICIQ-UI-SF decline (W0-W12) was

Table 1. Characteristics of postoperative patients with early-stage cervical cancer.

Characteristics	PME group (N = 96)	Combination group (N = 81)	*P* value
Age, years	49.8 ± 10.2	47.6 ± 10.9	0.175
Menopausal status			0.070
Premenopause	45 (46.9)	49 (60.5)	
Postmenopause	51 (53.1)	32 (39.5)	
Married			0.370
No	12 (12.5)	14 (17.3)	
Yes	84 (87.5)	67 (82.7)	
Education level			0.333
Primary school	25 (26.0)	16 (19.8)	
Middle to high school	58 (60.4)	52 (64.2)	
University or above	13 (13.5)	13 (16.0)	
Registered location			0.022
Rural	15 (15.6)	4 (4.9)	
Urban	81 (84.4)	77 (95.1)	
HPV positivity	73 (76.0)	68 (84.0)	0.193
Histologic classification			0.583
Adenosquamous carcinoma	3 (3.1)	5 (6.2)	
Adenocarcinoma	14 (14.6)	10 (12.3)	
Squamous carcinoma	79 (82.3)	66 (81.5)	
Pathological grade			0.202
Grade I	32 (33.3)	20 (24.7)	
Grade II	38 (39.6)	34 (42.0)	
Grade III	26 (27.1)	27 (33.3)	
FIGO stage			0.130
I	64 (66.7)	45 (55.6)	
IIa	32 (33.3)	36 (44.4)	
Surgery type			0.180
Laparoscope	77 (80.2)	58 (71.6)	
Laparotomy	19 (19.8)	23 (28.4)	
Adjuvant radiotherapy	57 (59.4)	51 (63.0)	0.626
Adjuvant chemotherapy	25 (26.0)	26 (32.1)	0.375

Data were presented by number (percentage) except for age which was presented by mean±standard deviation. PME, Pelvic floor Muscle Exercise; HPV, human papillomavirus; FIGO, the International Federation of Gynecology and Obstetrics.

greater in the combination group vs. the PME group (6.5 ± 3.5 vs. 5.0 ± 3.2) ($P = 0.007$) (Fig. 2B).

Independent factors related to ICIQ-UI-SF decline (W0-W12)

Combined intervention (vs. PME) was independently associated with greater ICIQ-UI-SF decline (W0-W12) ($B = 1.544$, $P = 0.006$). Adjuvant radiotherapy (yes vs. no) was independently correlated with smaller ICIQ-UI-SF decline (W0-W12) ($B = -1.499$, $P = 0.046$). Other factors, including age, menopausal status, marital status, education level, registered location, HPV positivity, histologic classification, pathological grade, FIGO stage, surgery type, and adjuvant chemotherapy, were not related to ICIQ-UI-SF decline (W0-W12) in postoperative patients with early-stage cervical cancer (all $P > 0.05$) (Table 3).

Comparison of EORTC QLQ-C30 scores between the combination group and PME group

EORTC QLQ-C30 global-health status scores at W0 ($P = 0.747$), W4 ($P = 0.360$), and W8 ($P = 0.248$) did not differ between the two groups. Notably, EORTC QLQ-C30 global-health status scores at W12 were higher in the combination group vs. the PME group (76.2 ± 14.9 vs. 71.6 ± 13.8) ($P = 0.045$) (Fig. 3A). EORTC QLQ-C30 function (Fig. 3B) and symptom (Fig. 3C) scores at W0, W4, W8, and W12 did not differ between the two groups (all $P > 0.05$).

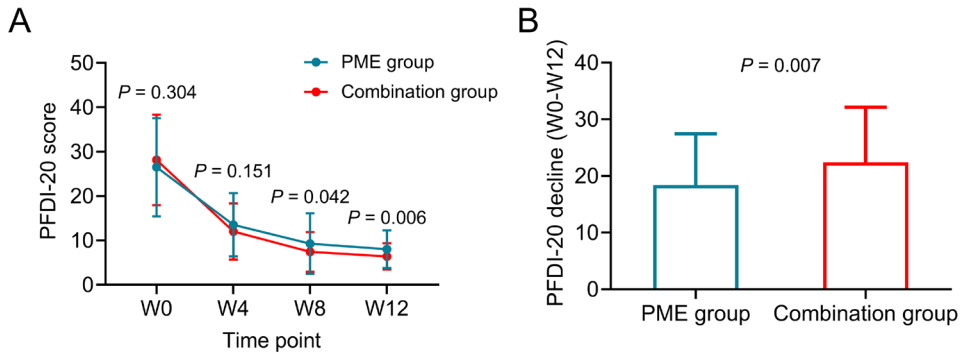

Fig. 1. PFDI-20 scores in the two groups.
Comparison of PFDI-20 scores at W0, W4, W8, and W12 (A), as well as PFDI-20 decline (W0-W12) (B), between the combination group and PME group.

Table 2. Multiple linear regression model for PFDI-20 decline (W0-W12).

Factors	*B* value	*SE*	*β* value	*t* value	*P* value	VIF
Rehabilitation,combined intervention vs. PME	5.548	1.428	0.290	3.884	< 0.001	1.117
Age, per year	−0.151	0.112	−0.159	−1.342	0.182	2.830
Menopausal status, postmenopause vs. premenopause	2.469	2.223	0.129	1.111	0.268	2.718
Married, yes vs. no	0.918	1.925	0.035	0.477	0.634	1.067
Education level, per level	−0.007	1.145	0.000	−0.006	0.995	1.085
Registered location, urban vs. rural	−3.150	2.323	−0.101	−1.356	0.177	1.118
HPV positivity, yes vs.no	−2.394	1.817	−0.100	−1.318	0.190	1.155
Histologic classification, squamous carcinoma vs. adenosquamous carcinoma or adenocarcinoma	−1.744	1.767	−0.071	−0.987	0.325	1.039
Pathological grade, per grade	0.658	1.017	0.053	0.647	0.519	1.322
FIGO stage, IIa vs. I	−2.239	2.464	−0.114	−0.909	0.365	3.145
Surgery type, laparotomy vs. laparoscope	−4.497	2.248	−0.196	−2.000	0.047	1.927
Adjuvant radiotherapy, yes vs. no	−4.445	1.916	−0.229	−2.320	0.022	1.945
Adjuvant chemotherapy, yes vs. no	−0.430	1.956	−0.020	−0.220	0.826	1.739

PFDI-20, Pelvic Floor Distress Inventory-Short Form 20; W0, baseline (the 7th day after surgery); W12, the 12th week after baseline; SE, standard error; VIF, variance inflation factor; PME, Pelvic floor Muscle Exercise; HPV, human papillomavirus; FIGO, the International Federation of Gynecology and Obstetrics.

Discussion

Pelvic floor dysfunction is a common complication after radical hysterectomy in patients with early-stage cervical cancer, and interventions against this complication include PME, electrical stimulation, biofeedback, etc. (Jackson and Naik 2006; Wu et al. 2021; Sparaco and Bonavita 2022). However, no study focuses on the effect of PME combined with electrical stimulation and biofeedback on enhancing pelvic floor function in postoperative patients with early-stage cervical cancer. In the current study, it was observed that the combined intervention could enhance pelvic floor function compared to PME; in addition, after 12 weeks, the combined intervention achieved a greater pelvic floor function improvement compared to PME in postoperative patients with early-stage cervical cancer. The potential reasons would be that: (1) Electrical stimulation could apply electrical currents and pulse widths to stimulate the pelvic floor muscles to perform passive contractions, which was beneficial in improving the pelvic floor function (Sung et al. 2000; Rivalta et al. 2010; Enoka et al. 2020). (2) Biofeedback allowed physicians and patients to know the condition of pelvic floor muscles; thereby, they could take effective countermeasures (Sung et al. 2000; Rivalta et al. 2010; Wu et al. 2021). Therefore, the combined intervention improved pelvic floor function and achieved a greater improvement of pelvic floor function after 12 weeks compared to PME in postoperative patients with early-stage cervical cancer.

To eliminate the interference of confounding factors, multiple linear regression models were performed in this study. It was found that the combined intervention (vs. PME) was independently correlated with greater pelvic floor function improvement after 12 weeks in postoperative patients with early-stage cervical cancer, which further confirmed our above findings. In addition, we discovered that

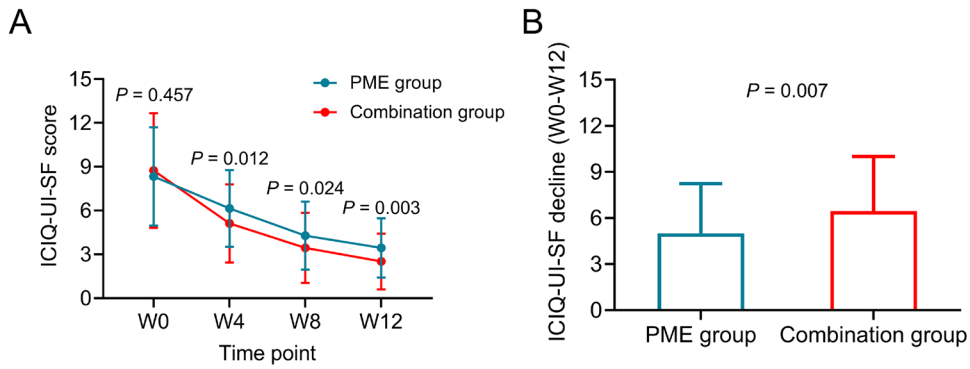

Fig. 2. ICIQ-UI-SF scores in the two groups.
Comparison of ICIQ-UI-SF scores at W0, W4, W8, and W12 (A), as well as ICIQ-UI-SF decline (W0-W12) (B), between the combination group and PME group.

Table 3. Multiple linear regression model for ICIQ-UI-SF decline (W0-W12).

Factors	*B* value	*SE*	*β* value	*t* value	*P* value	VIF
Rehabilitation,combined intervention vs. PME	1.544	0.556	0.224	2.774	0.006	1.117
Age, per year	0.050	0.044	0.147	1.147	0.253	2.830
Menopausal status, postmenopause vs. premenopause	−0.906	0.866	−0.132	−1.046	0.297	2.718
Married, yes vs. no	0.096	0.750	0.010	0.128	0.899	1.067
Education level, per level	0.394	0.446	0.070	0.884	0.378	1.085
Registered location, urban vs. rural	−0.090	0.905	−0.008	−0.099	0.921	1.118
HPV positivity, yes vs.no	−0.253	0.708	−0.029	−0.358	0.721	1.155
Histologic classification, squamous carcinoma vs. adenosquamous carcinoma or adenocarcinoma	0.068	0.688	0.008	0.099	0.921	1.039
Pathological grade, per grade	0.229	0.396	0.051	0.577	0.565	1.322
FIGO stage, IIa vs. I	−0.126	0.960	−0.018	−0.131	0.896	3.145
Surgery type, laparotomy vs. laparoscope	−0.278	0.876	−0.034	−0.317	0.752	1.927
Adjuvant radiotherapy, yes vs. no	−1.499	0.746	−0.214	−2.008	0.046	1.945
Adjuvant chemotherapy, yes vs. no	−0.522	0.762	−0.069	−0.685	0.495	1.739

ICIQ-UI-SF, International Consultation on Incontinence Questionnaire Urinary Incontinence Short Form; W0, baseline (the 7th day after surgery); W12, the 12th week after baseline; SE, standard error; VIF, variance inflation factor; PME, Pelvic floor Muscle Exercise; HPV, human papillomavirus; FIGO, the International Federation of Gynecology and Obstetrics.

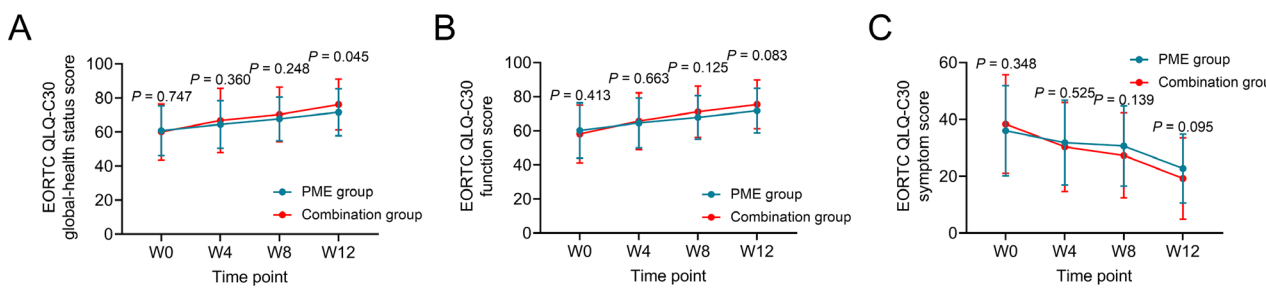

Fig. 3. EORTC QLQ-C30 scores in the two groups.
Comparison of EORTC QLQ-C30 global-health status (A), function (B), and symptom (C) scores between the combination group and PME group.

laparotomy (vs. laparoscope) was independently associated with smaller pelvic floor function improvement after 12 weeks in postoperative patients with early-stage cervical cancer. The potential reasons would be that: (1) laparotomy would be more traumatic compared to laparoscopic surgery, resulting in more severe damage to the posterior part of the uterosacral ligament, where the inferior hypogastric plexus was located; subsequently, the impaired inferior hypogastric plexus would obstruct the recovery of pelvic floor function (Jackson and Naik 2006; Laterza et al. 2015; Cao et al.

2020). (2) The extent of surgical incision of the abdominal muscles might affect the pelvic floor muscle function through the loss of control of intro-abdominal pressure (Iglesia and Smithling 2017; Lagosz et al. 2022). Therefore, laparotomy would lead to a smaller pelvic floor function improvement after 12 weeks in postoperative patients with early-stage cervical cancer. Moreover, we found that adjuvant radiotherapy was independently correlated with smaller pelvic floor function improvement after 12 weeks in postoperative patients with early-stage cervical cancer. A reason behind this could be that adjuvant radiotherapy would damage the structure and function of the pelvic floor muscles, which obstructed the recovery of pelvic floor function (Bernard et al. 2016). Hence, adjuvant radiotherapy resulted in a smaller pelvic floor function improvement after 12 weeks in postoperative patients with early-stage cervical cancer.

Pelvic floor dysfunction affects bowel, bladder, and sexual functions, which severely affects the quality of life in postoperative patients with early-stage cervical cancer (Jackson and Naik 2006). In the current study, it was found that the quality of life was enhanced by the combined intervention compared to PME in postoperative patients with early-stage cervical cancer. The potential explanations would be that: (1) As discussed above, the combined intervention had a better effect on improving pelvic floor function compared to PME, which would further assist in improving the quality of life (Sung et al. 2000; Rivalta et al. 2010; Wu et al. 2021; Alouini et al. 2022). (2) Biofeedback and electrical stimulation required patients to go to the hospital regularly, which enabled patients to have a chance to communicate with the physicians; then, physicians could teach them how to deal with the discomforts in their daily lives (Vonthein et al. 2013; Sung et al. 2000; Luddecke and Felnhofer 2022). Thus, it would indirectly assist in improving the quality of life in postoperative patients with early-stage cervical cancer. Moreover, it should be clarified that the proportion of rural patients receiving the combined intervention was lower than those receiving PME. A potential reason might be that the combined intervention required patients to frequently go to the hospital, which was inconvenient for rural patients (Li et al. 2018). Therefore, rural patients tended to choose PME rather than the combined intervention. Although the proportion of rural patients and urban patients in the two groups was different, this factor might not affect our findings. Because the baseline PFDI-20, ICIQ-UI-SF, and EORTC QLQ-C30 scores were not different between the two groups. In addition, our multiple linear regression models suggested that registered location (urban vs. rural) was not associated with pelvic floor function improvement.

Previous studies often address urinary incontinence, fecal incontinence, and sexual dysfunction as pelvic floor dysfunction in cervical cancer patients (Baessler et al. 2021; Wang et al. 2021). In this study, the common symptoms of pelvic floor dysfunction included urinary incontinence, difficulty in defecation, and fecal incontinence in postoperative patients with early-stage cervical cancer according to PFDI-20 scores, with rates of 40.1%, 37.9%, and 11.9%, respectively.

Several limitations should be noticed in this study. (1) This was a non-intervention study, and the baseline feature, registered location, was unmatched between the two groups, which might influence the results of this study; thus, our findings should be validated by further randomized-controlled trials. (2) The long-term (such as after 6 months) effect of the combined intervention on pelvic floor function and quality of life in postoperative patients with early-stage cervical cancer could be further explored. (3) Restricted by the study regions, the generalizability of our findings still needed to be validated. (4) PFDI-20, ICIQ-UI-SF, and EORTC QLQ-C30 scores were self-assessed; thus, assessment bias might exist. (5) Whether the frequency of pelvic floor exercises could be influenced by surgery type (laparotomy and laparoscopy), and the correlations between the frequency of pelvic floor exercises and the improvement in pelvic floor dysfunction or quality of life should be further explored. (6) The development of nerve-sparing techniques reduced postoperative complications, such as neurogenic bladder dysfunction in patients with early-stage cervical cancer. However, this study did not restrict the application of nerve-sparing techniques, which might affect our findings. Further studies should consider exploring the effect of the combined intervention on pelvic floor function and quality of life in patients with early-stage cervical cancer who received nerve-sparing radical hysterectomy, as well as in patients who received radical hysterectomy without nerve-sparing. (7) Many young patients also suffered from cervical cancer. Therefore, the effect of the combined intervention on sexual function in postoperative patients with early-stage cervical cancer deserved to be explored. (8) The postoperative recovery should be considered. Therefore, further studies should set up a non-intervention group.

In conclusion, the combined intervention achieves a greater pelvic floor function improvement and exhibits the potential to improve the quality of life compared to PME in postoperative patients with early-stage cervical cancer. Further studies should consider investigating the cost-effectiveness of this combined intervention.

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Conflict of Interest

The authors declare no conflict of interest.

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Supplementary Files

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