

The effect of pelvic floor muscle training combined with electrical stimulation at different times on urinary control ability in patients after radical prostatectomy

Ting Yang^{1,a}, Zelin Guo^{2,b}, JingNaXie^{3,c}, Xing Li^{4,d}, Fan Cheng^{5,e}

¹ Department of Urology, Renmin Hospital of Wuhan University, Wuhan, 430060, Hubei, China

² Department of Urology, Renmin Hospital of Wuhan University, Wuhan, 430060, Hubei, China

³ Department of Urology, Renmin Hospital of Wuhan University, Wuhan, 430060, Hubei, China

⁴ Department of Urology, Renmin Hospital of Wuhan University, Wuhan, 430060, Hubei, China

⁵ Department of Urology, Renmin Hospital of Wuhan University, Wuhan, 430060, Hubei, China

aEmail:whu123478lin@126.com

bEmail:13695198702@163.com

cEmail:176498059@qq.com

dEmail:18841653662@163.com

eEmail:urology1969@aliyun.com

CITATION

Ting Y, Zelin G. et al. The effect of pelvic floor muscle training combined with electrical stimulation at different times on urinary control ability in patients after radical prostatectomy. *Psycho-Oncology*.

ARTICLE INFO

Received: July 9th, 25

Accepted: July 9th, 25

Available online: December 15th, 25

COPYRIGHT



Copyright © 2025 by author(s).

Journal of Infrastructure, Policy and Development is published by EnPress Publisher, LLC. This work is licensed under the Creative Commons Attribution (CC BY) license.

<https://creativecommons.org/licenses/by/4.0/>

Abstract: Objective: Urinary incontinence (UI) is a common complication after radical prostatectomy (RP), significantly affecting patients' quality of life. Although pelvic floor muscle training (PFMT) is recommended to improve postoperative urinary control, the optimal timing for electrical stimulation (ES) and its synergistic effects remain unclear. This study aims to explore the intervention effects of PFMT combined with ES at different timings on UI in patients after RP. This study aims to investigate the effect of PFMT combined with ES in patients with urinary incontinence after RP, so as to provide a reference for clinical nursing practice.

Methods: 90 patients who underwent RP were recruited from a tertiary public hospital in China and randomly allocated (1:1) into an experimental group (n = 45) or a control group (n = 45). The control group received routine nursing care involving PFMT, whereas the experimental group received combined intervention with PFMT and pelvic floor ES therapy in addition to routine care. The intervention effects were evaluated and compared between the two groups at three time points: on the day of catheter removal, 1 month after intervention, and 3 months after intervention. Assessment tools included the 1-hour pad test, the International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF), the Incontinence Quality of Life Questionnaire (I-QOL), and the Broome Pelvic Muscle Self-Efficacy Scale (BPMSES). The primary outcome was the severity of urinary incontinence. Secondary outcomes encompassed quality of life and self-efficacy related to PFMT.

Results: Participants in both the experimental and control groups were comparable at baseline. A statistically significant difference was observed in the amount of urine leakage measured by the 1-hour pad test before and after the intervention between the two groups ($P < 0.05$). At the 1-month follow-up, the experimental group demonstrated significantly lower ICIQ-SF scores (8.24 ± 4.22) compared to the control group (11.60 ± 4.22). At the 1-month post-intervention assessment, the experimental group exhibited a statistically significant improvement compared to the control group ($P < 0.05$). By the 3-month follow-up, the experimental group (4.84 ± 4.79) showed lower scores than the control group (7.07 ± 5.72), although this difference was not statistically significant ($P > 0.05$). A significant group $\times$ time interaction was identified for both I-QOL and BPMSES scores ($P < 0.05$), indicating differential trajectories of improvement between the groups over the intervention period.

Conclusion: The combination of PFMT with ES effectively improved the objective severity of urinary incontinence, enhanced self-efficacy, and promoted quality of life in patients following radical prostatectomy. Larger multicenter studies with extended postoperative follow-up durations are warranted to further validate and generalize these findings.

Keywords: Urinary Incontinence, Radical Prostatectomy, Quality of Life, Electrical Stimulation, Postoperative Rehabilitation, Pelvic Floor Muscle Training.

1 Introduction

Prostate cancer is the most common malignant tumor of the male genitourinary system. In 2020, approximately 1.4 million new cases were diagnosed worldwide, accounting for 7.3% of all malignant tumors. It is the second most frequently diagnosed cancer in men, following lung cancer [1]. Prostate cancer exhibits a strong age-dependent association, affecting approximately one in six men during their lifetime and remaining a leading cause of cancer-related mortality among males worldwide [2]. RP serves as a first-line treatment for prostate cancer [3]. Combined with adjuvant therapies such as androgen deprivation therapy, chemotherapy, and radiation, it has significantly improved survival rates among prostate cancer patients. According to data from the American Cancer Society, the 5-year relative survival rate for prostate cancer has markedly increased to 98%, while mortality has decreased by 52% from its peak [4]. Although survival time has been extended after RP, surgery-related complications such as urinary symptoms and sexual dysfunction can exert long-term negative effects on patients. Among these, UI is one of the most severe and common complications following RP.

Post-prostatectomy urinary incontinence refers to the involuntary leakage of urine through the urethra resulting from intraoperative pelvic floor nerve injury, damage to the urethral sphincter complex, loss of the suspensory mechanism, and resection of the bladder neck. Symptoms are often exacerbated during activities that increase abdominal pressure, such as coughing or physical exertion. The International Continence Society recommends PFMT as the first-line conservative treatment for post-prostatectomy incontinence, with its mechanism of action being the enhancement of urinary control through activation of PFMT. Recent studies, both domestically and internationally, have demonstrated favorable therapeutic effects of ES in treating urinary incontinence among female patients. ES activates the pudendal nerve and its branches, eliciting contractions of the striated muscles surrounding the urethra, thereby enhancing pelvic floor muscle strength. Additionally, it suppresses detrusor overactivity, contributing to a reduction in the incidence of urinary incontinence [5]. Evidence indicates that the combined application of PFMT and ES yields significantly greater improvement in urinary incontinence recovery among men after prostatectomy compared to PFMT alone or conventional postoperative care [6]. Several studies have confirmed the effectiveness of PFMT and ES in improving post-prostatectomy urinary incontinence. However, these studies primarily focus on the effects of different interventions without systematically comparing the impact of intervention timing. This study aims to identify the optimal timing for interventions to maximize recovery, thus providing evidence for developing more effective rehabilitation strategies in clinical practice.

2 Materials and methods

2.1 Subjects of study

Patients who underwent RP in the urology department of a tertiary Grade A hospital in Wuhan were selected as study participants using a convenience sampling method. The subsequent section outlines the precise inclusion and exclusion criteria used to determine participant eligibility for this study.

Inclusion Criteria

- (1) pathologically confirmed prostate cancer treated with radical prostatectomy.
- (2) self-reported urine leakage and a daily pad usage of ≥ 1 pad after catheter removal.
- (3) clear cognitive function with fluent verbal or written communication abilities.
- (4) provision of informed consent to participate in the study.

Exclusion criteria

- (1) presence of cognitive impairment limiting ability to cooperate with medical staff for treatments and assessments.
- (2) history of urinary incontinence prior to surgery.
- (3) receipt of radiation therapy within six months after surgery.
- (4) inability to comply with scheduled postoperative outpatient follow-ups and interventions during the study period.

All participants provided informed consent and voluntarily participated in the study. The research protocol was approved by the institutional ethics committee of the affiliated hospital. The sample size was calculated based on standard formulas for clinical studies. With a two-sided α of 0.05, a power ($1-\beta$) of 0.90, and an effect size of 0.75, a minimum of 39 participants per group was required. Accounting for a potential dropout rate of 10%, a total of 90 patients were enrolled, with 45 allocated to each group. A total of 45 patients admitted between August 2024 and November 2024 were assigned to the control group and received conventional postoperative PMFT. Another 45 patients admitted between February 2025 and May 2025 were assigned to the experimental group and received additional ES therapy in combination with the conventional training.

2.2 Intervention Methods

Interventions were initiated within 3 days following catheter removal, depending on the patient's clinical stability and readiness. All participants received standardized instructions regarding their assigned rehabilitation protocols, including demonstrations by trained physiotherapists.

exercises three times daily, according to the protocol described. Each session consisted of one set of 10 contractions. Each contraction was held for 10 seconds, followed by a 10-second rest period. This resulted in a daily total of 30 contraControl group (n=45) : Control group followed a structured PFMT program. Patients performed pelvic floor muscle ctions. These exercises were integrated into daily routines such as walking and lifting objects.

Experimental group (n=45) : Experimental group adhered to the identical PFMT protocol as described previously, involving three daily sessions each comprising one set of 10 sustained contractions held for 10 seconds followed by a 10-second rest, totaling 30 contractions daily). Additionally, experimental group received Transcutaneous Electrical Stimulation (TES).The TES intervention was administered as follows.

- **Electrode Placement:** Surface electrodes were positioned over the perineal area to target the pelvic floor musculature. **Stimulation Parameters:** Stimulation consisted of biphasic symmetrical rectangular pulses.
- **Frequency:** Set within the typical range for neuromuscular facilitation (commonly 20-50 Hz).
- **Pulse Width (Duration):** Set within the typical range for comfort and efficacy (commonly 200-300 microseconds).
- **Intensity:** The current amplitude was adjusted to a strong but comfortable sensory level, sufficient to elicit a palpable contraction of the pelvic floor muscles without causing pain or discomfort. This was determined individually for each participant at each session.
- **Duration per Session:** Each TES session lasted 20 minutes.
- **Frequency:** TES was applied three times per week.
- **Individual Adaptation:** All interventions (both PFMT and TES) were adapted according to individual tolerance and readiness.
- **Total Duration:** The combined intervention program (PFMT + TES) continued for a total of 3 months.

2.3 Data Collection and Quality Control

General patient data were collected by the researchers through the electronic medical record system. During hospitalization, designated ward nurses provided instructions to patients or their family members on the proper procedure for conducting the 1-hour pad test. To ensure accuracy and consistency in data collection, all personnel involved received standardized training prior to the study. The intervention team consisted of five members. A head nurse from the urology department and one expert in prostate cancer diagnosis and treatment were responsible for quality control and guidance of the intervention protocol. Two pelvic floor physical therapists (one of whom held a national certification in pelvic floor rehabilitation) were responsible for specialized training in PMFT and the execution of the intervention. One graduate nursing student (Master's candidate) contributed to the design and implementation of the intervention protocol, as well as data collection, management, and analysis.

2.4 Outcomes and Measures

Primary data collection tools included participant demographic and disease-related characteristics, such as age, body mass index (BMI), educational level, presence of chronic comorbidities, Gleason score, and surgical approach.

Follow-up assessments were conducted via telephone or WeChat on the day of catheter removal, as well as at 1 month and 3 months post-intervention. Data pertaining to the 1-hour pad test, International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF), Incontinence Quality of Life Questionnaire (I-QOL), and Broome Pelvic Muscle Self-Efficacy Scale (BPMSES) were collected using a self-designed online questionnaire administered through a self-designed electronic questionnaire (by scanning a QR code on the smartphone) .

Objective Severity of Urinary Incontinence

The pad test, recommended by clinical guidelines, was used to objectively evaluate the severity of urinary incontinence [7]. The 1-hour pad test was employed for this assessment. Results were categorized as follows: no leakage (negative test), mild (leakage <2g), moderate (leakage 2–10g), or severe (leakage >10g).

The testing procedure was performed as follows: a disposable absorbent pad was placed at the external urethral meatus. Participants were instructed to drink 500 mL of water and rest for approximately 15 minutes. They then performed a standardized protocol including activities of daily living (15 minutes) followed by walking for 30 minutes. At the end of the 1-hour test period, the pad was removed and weighed to determine the amount of urine loss.

Subjective Severity of Urinary Incontinence

The subjective severity of urinary incontinence was assessed using the International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF), developed by the International Continence Society[8]. This instrument comprises four items: frequency of urine leakage (scored 0–5), volume of urine leakage (scored 0–6), impact on quality of life (scored 0–10), and a self-description of symptoms (not scored). The total score ranges from 0 to 21, with higher scores indicating greater severity of urinary incontinence and its associated impact.

Quality of Life

Quality of life was evaluated using the Incontinence Quality of Life Questionnaire (I-QOL) [9]. This instrument assesses the impact of urinary incontinence on quality of life across three domains: behavioral, psychological, and social. The questionnaire consists of 22 items, each rated on a 5-point scale. The total score ranges from 22 to 110, with higher scores indicating better quality of life.

Self-Efficacy in Pelvic Floor Muscle Training

Self-efficacy in PFMT was evaluated using the Chinese version of the 23-item BPMSES[10] . Total scores range from 0 to 100, with higher scores indicating greater self-efficacy in performing PFMT.

2.5 Statistical Analysis

Statistical analyses were performed using SPSS version 26.0 . Baseline characteristics were compared between the two groups. Continuous variables were assessed for normality within each group using the Shapiro-Wilk test. Data exhibiting normal distribution in both groups are presented as mean $\pm$ standard deviation ($\bar{x} \pm SD$) and compared using the independent samples t-test. For variables violating the normality assumption, data are expressed as median and interquartile range [M (Q1, Q3)] and analyzed using the Mann-Whitney U test, with corresponding Z-values reported. Categorical variables are summarized as frequencies and percentages [n (%)], with group comparisons performed using Pearson's chi-square test. Fisher's exact test was employed when the assumptions for chi-square test were not met. A two-sided p-value < 0.05 was considered statistically significant for all analyses.

3 Results

3.1 Comparison of Baseline Characteristics Between the Experimental and Control Groups

Baseline characteristics, including age, body mass index, educational level, Gleason score, surgical approach, and presence of chronic comorbidities, were comparable between the experimental and control groups, with no statistically significant differences ($P > 0.05$). Detailed data are presented in Table 1.

Table 1. Comparison of general data between the experimental and control groups

Variable	experimental group (n=45)	control group (n=45)	χ^2 Value	P Value
Age (years), ($\bar{x} \pm SD$)	66.60 $\pm$ 7.86	66.46 $\pm$ 5.56	-0.092a	0.926
BMI . ($\bar{x} \pm SD$)	26.07 $\pm$ 12.92	26.24 $\pm$ 12.93	0.061a	0.952
Gleason scores, n (%)			2.734b	0.435
6	5 (11.1)	5 (11.1)		
7	11 (24.4)	18 (40)		
8	17 (37.8)	12 (26.7)		
≥ 9	12 (26.7)	10 (22.2)		
Education level, n (%)				0.355c
Primary school or below	5 (11.11)	7 (15.56)		
Junior high school	12 (26.67)	12 (26.67)		
Senior high school or secondariespecialized school	15 (33.33)	8 (17.78)		
Junior college or above	13 (28.89)	18 (40.0)		
Surgical Approach, n (%)			0.001b	0.999
LRP	29 (64.4)	30 (66.7)		
RALP	16 (35.6)	15 (33.3)		
Presence of chronic comorbidities, n (%)				0.509c
NO	14 (31.11)	18 (40.0)		
YES	31 (68.89)	27 (60.0)		

Note: a, t-value; b, Z-value; c, Fisher's exact test.

3.2 Comparison of the 1-Hour Pad Test Between the Experimental and Control Groups

The severity of urine leakage assessed by the 1-hour pad test (categorized as none/mild/moderate/severe) was treated as an ordinal outcome. A cumulative link mixed model (CLMM) was applied, with group, time, and their interaction specified as fixed effects, and a random intercept was included for each subject to account for repeated measurements. The main effects of time and group, as well as their interaction effect, were evaluated using likelihood-ratio (LR) tests (LR χ^2 and corresponding P-values are reported). As a supplementary analysis, ordinal logistic regression models were fitted at each time point to assess between-group differences.

A statistically significant difference was observed in the amount of urine leakage (grams) between the two groups before and after the intervention ($P < 0.05$). Detailed results are presented in Table 2.

Table 2. Comparison of the 1-Hour Pad Test between the experimental and control groups

Group	1-Hour Pad Test, n (%)			F_{time}	F_{group}	$F_{time \times group}$
	Before treatment	After 1 month of treatment	After 3 month of treatment			
experimental group						
no leakage	0 (0.0)	12 (26.7)	26 (57.8)			
mild	11 (24.4)	13 (28.9)	5 (11.1)			
moderate	13 (28.9)	8 (17.8)	8 (17.8)			
severe	21 (46.7)	12 (26.7)	6 (13.3)			
control group				87.765 ^a	3.999 ^b	22.125 ^a
no leakage	0 (0.0)	1 (2.2)	10 (22.2)			
mild	12 (26.7)	14 (31.1)	13 (28.9)			
moderate	14 (31.1)	12 (26.7)	9 (20.0)			
severe	19 (42.2)	18 (40.0)	13 (28.9)			
χ^2 value	0.160	6.694	9.019			
P value	0.689	0.010	0.003			

Note: a, $P < 0.001$; b, $P < 0.05$; c, $P > 0.05$.

3.3 Comparison of ICIQ-SF Scores Between the Experimental and Control Groups at different time points

Analysis of the ICIQ-SF scores at different time points revealed a significant main effect of time ($F = 175.216$, $P < 0.001$), a significant main effect of group ($F = 5.169$, $P < 0.05$), and a significant group $\times$ time interaction ($F = 9.462$, $P < 0.001$). Mean scores were comparable at baseline between the experimental group (13.42 ± 3.40) and the control group (13.38 ± 3.82 ; $t = -0.004$, $P = 0.997$). Both groups showed a notable reduction in scores over time. At the 1-month follow-up, the experimental group (8.24 ± 4.22) demonstrated

significantly lower scores than the control group (11.60 ± 4.22 ; $t = -3.836$, $P < 0.001$). By the 3-month follow-up, the experimental group (4.84 ± 4.79) exhibited lower scores than the control group (7.07 ± 5.72), although this difference did not reach statistical significance ($t = -1.796$, $P = 0.073$). These findings suggest distinct patterns and magnitudes of improvement over time between the two groups, with the primary difference observed at the 1-month assessment. Detailed results are presented in Table 3.

Table 3. Comparison of the 1-Hour Pad Test between the experimental and control groups

Group	ICIQ-SF Scores , ($\bar{x} \pm SD$)			F_{time}	F_{group}	$F_{time \times group}$
	Before treatment	After 1 month of treatment	After 3 months of treatment			
experimental group	13.42 $\pm$ 3.40	8.24 $\pm$ 4.22	4.84 $\pm$ 4.79	175.216 ^a	5.169 ^b	9.462 ^a
control group	13.38 $\pm$ 3.82	11.60 $\pm$ 4.22	7.07 $\pm$ 5.72			
<i>t value</i>	-0.004	-3.836	-1.796			
<i>P value</i>	0.997	<0.001	0.073			

Note: a, $P < 0.001$; b, $P < 0.05$; c, $P > 0.05$.

3.4 Comparison of I-QOL and BPMSES scores Between the Experimental and Control Groups at different time points

Analysis of the I-QOL scores across different time points revealed a significant main effect of time ($F = 104.950$, $P < 0.001$), a significant main effect of group ($F = 4.837$, $P < 0.05$), and a significant time $\times$ group interaction ($F = 16.894$, $P < 0.001$). No significant difference was observed between the two groups at baseline. However, the experimental group showed significantly greater improvement in I-QOL scores compared to the control group at both the 1-month and 3-month follow-up assessments ($P < 0.001$). Analysis of the BPMSES scores across time points revealed a significant main effect of time ($F = 62.784$, $P < 0.001$), a significant main effect of group ($F = 5.248$, $P < 0.05$), and a significant time $\times$ group interaction ($F = 15.810$, $P < 0.001$). While no significant between-group difference was observed at baseline, both groups showed increased scores over the intervention period. At both the 1-month and 3-month follow-ups, the experimental group demonstrated significantly greater improvement in scores compared to the control group ($P < 0.001$). Detailed results are presented in Table 4.

Table 4. Comparison of the I-QOL and BPMSES scores between the experimental and control groups

Group	I-QOL scores, ($\bar{x} \pm SD$)			F_{time}	F_{group}	$F_{time \times group}$
	Before treatment	After 1 month of treatment	After 3 month of treatment			
experimental group	56.27 $\pm$ 24.64	81.98 $\pm$ 16.59	89.76 $\pm$ 12.55	104.950 ^a	4.837 ^b	16.894 ^a
control group	59.76 $\pm$ 22.42	65.91 $\pm$ 21.16	77.47 $\pm$ 22.37			
<i>t</i> value	-1.045	3.594	2.708			
<i>P</i> value	0.296	<0.001	0.007			

Group	BPMSES scores, ($\bar{x} \pm SD$)			F_{time}	F_{group}	$F_{time \times group}$
	Before treatment	After 1 month of treatment	After 3 month of treatment			
experimental group	51.98 $\pm$ 20.88	70.53 $\pm$ 15.71	82.96 $\pm$ 8.86	62.784 ^a	5.248 ^b	15.810 ^a
control group	57.76 $\pm$ 19.58	57.69 $\pm$ 17.38	69.82 $\pm$ 19.69			
<i>t</i> value	-1.354	3.573	3.711			
<i>P</i> value	0.179	<0.001	<0.001			

Note: a, $P < 0.001$; b, $P < 0.05$; c, $P > 0.05$.

4 Discussion

RP is the primary treatment modality for localized and select cases of locally advanced prostate cancer. However, the procedure carries a risk of injury to the external urethral sphincter and neurovascular bundles, which frequently leads to urinary incontinence. This condition represents one of the most common complications following radical prostatectomy, with reported incidence rates ranging from 1% to 40% [11-12]. ES therapy for urinary incontinence primarily involves the application of electrical currents via surface skin electrodes or an intra-anal probe to stimulate the pelvic floor muscles. This intervention aims to elicit muscle contractions, enhance pelvic floor muscle strength, and thereby improve urinary continence by reducing urine leakage. In this study, anal surface electromyography electrodes were utilized to assist patients in promptly identifying the correct contraction of pelvic floor muscles. ES was applied to activate both fast-twitch and slow-twitch muscle fibers of the pelvic floor, enabling patients to consciously contract the periurethral and perianal musculature, thereby enhancing both the strength and elasticity of pelvic muscle contractions. Furthermore, electromyographic biofeedback recorded subtle electrical potentials generated by pelvic floor muscle activity and converted them into visual, auditory, and tactile signals, which were provided as real-time feedback to the participants [13].

In this study, following the 3-months intervention period, both groups exhibited a significant reduction in the 1-hour pad test results and a marked improvement in I-QOL and BPMSES scores compared to baseline measurements ($P < 0.05$). These results demonstrate that both PFMT alone and its combination with transcutaneous neuromuscular electrical stimulation led to substantial improvements in urinary incontinence symptoms. The therapeutic benefits were specifically reflected in a reduced volume of urine leakage per episode, decreased severity of incontinence, and significantly enhanced quality of life and self-efficacy among the patients.

At the 1-month assessment, the mean ICIQ-SF score was significantly reduced in the experimental group (8.24 ± 4.22) relative to the control group (11.60 ± 4.22 ; $P < 0.001$). By 3 months, the experimental group maintained a lower mean score (4.84 ± 4.79) compared to the control group (7.07 ± 5.72), though the difference was no longer statistically significant ($P > 0.05$). Comparison of ICIQ-SF scores indicated a statistically significant difference in subjective urinary incontinence between the groups at the 1-month follow-up, whereas no significant difference was observed at the 3-month assessment. Several factors may account for these findings. Significant heterogeneity exists in training protocols for male pelvic floor muscle training and in the assessment tools used to verify correct muscle activation, which has impeded the establishment of uniform measurement standards and contributed to variability in outcomes. A systematic review indicated that while these interventions demonstrate short-term efficacy, their long-term sustainability remains uncertain. Further research is warranted to establish optimal practice models for lifestyle interventions and to evaluate the long-term effectiveness through longitudinal studies[14].

5 Conclusion

As the intervention progressed, a statistically significant reduction in urine leakage measured by the 1-hour pad test was observed in the experimental group compared to the control group ($P < 0.05$). A significant group $\times$ time interaction was observed for both I-QOL and BPMSES scores ($P < 0.05$). At the 1-month and 3-month follow-ups, the experimental group demonstrated significantly lower ICIQ-SF scores compared to the control group ($P < 0.001$). Conversely, the experimental group showed significantly higher BPMSES scores than the control group at these time points ($P < 0.05$). These results indicate that combining electrical stimulation with PFMT can lead to greater improvement in objective incontinence severity, enhance self-efficacy in performing PFMT, and improve

overall quality of life within the first three months after surgery, compared to PFMT alone. These findings are consistent with those reported by Sciarra A[15]. This study has several limitations. First, the relatively small sample size recruited from a single center may limit the generalizability of the findings. Additionally, the assessment of outcomes relied heavily on subjective measures, with a paucity of objective indicators. The short follow-up period further restricts the ability to evaluate the long-term efficacy of transcutaneous neuromuscular electrical stimulation combined with pelvic floor muscle training in managing post-prostatectomy incontinence. Moreover, due to sample size constraints, a treatment group receiving electrical stimulation alone was not included, precluding a comparative analysis of its isolated effects. Future multicenter studies with larger samples and extended follow-up durations are warranted to optimize the intervention protocol and strengthen the evidence base for this combined approach.

Reference

1. Sung, H., Ferlay, J., Siegel, R. L., Laversanne, M., Soerjomataram, I., Jemal, A., & Bray, F. (2021). Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. *CA: a cancer journal for clinicians*, 71(3), 209–249. <https://doi.org/10.3322/caac.21660>
2. Park, J. J., Hong, Y., Kwon, A., Shim, S. R., & Kim, J. H. (2023). Efficacy of surgical treatment for post-prostatectomy urinary incontinence: a systematic review and network meta-analysis. *International journal of surgery (London, England)*, 109(3), 401–411. <https://doi.org/10.1097/JS9.0000000000000170>
3. Davuluri, M., DeMeo, G., Penukonda, S., Zahid, B., & Hu, J. C. (2023). Guiding Clinical Decision Making for Surgical Incontinence Treatment After Prostatectomy: A Review of the Literature. *Current urology reports*, 24(11), 527–532. <https://doi.org/10.1007/s11934-023-01181-6>
4. Siegel, R. L., Miller, K. D., Fuchs, H. E., & Jemal, A. (2021). Cancer Statistics, 2021. *CA: a cancer journal for clinicians*, 71(1), 7–33. <https://doi.org/10.3322/caac.21654>
5. Yıldız, N., Çelen, S., Özlülerden, Y., & Alkan, H. (2023). Efficacy of perineal electrical stimulation in men with urinary incontinence after radical prostatectomy. A prospective randomized controlled trial. *Neurourology and urodynamics*, 42(1), 340–348. <https://doi.org/10.1002/nau.25096>
6. Szczygielska, D., Knapik, A., Pop, T., Rottermund, J., & Saulicz, E. (2022). The Effectiveness of Pelvic Floor Muscle Training in Men after Radical Prostatectomy Measured with the Insert Test. *International journal of environmental research and public health*, 19(5), 2890. <https://doi.org/10.3390/ijerph19052890>
7. Gacci, M., Sakalis, V. I., Karavitakis, M., Cornu, J. N., Gratzke, C., Herrmann, T. R. W., Kyriazis, I., Malde, S., Mamoulakis, C., Rieken, M., Schouten, N., Smith, E. J., Speakman, M. J., Tikkinen, K. A. O., & Gravas, S. (2022). European Association of Urology Guidelines on Male Urinary Incontinence. *European urology*, 82(4), 387–398.
8. Avery, K., Donovan, J., Peters, T. J., Shaw, C., Gotoh, M., & Abrams, P. (2004). ICIQ: a brief and robust measure for evaluating the symptoms and impact of urinary incontinence. *Neurourology and urodynamics*, 23(4), 322–330. <https://doi.org/10.1002/nau.20041>

9. Wang XQ. Development of Chinese versions of Modified Female Self-image Rating Scale(MBIS),Urinary Incontinence Quality of Life Questionnaire(I-QOL) and Uterine Leiomyoma Symptoms and Health-related Quality of Life Questionnaire (UFS-QOL) and its verification in China population [D]. Beijing :Peking Union Medical College,2013.
10. Bai X, Su F, Li H. Reliability and validity evaluation of the Chinese version of the pelvic floor muscle exercise self-efficacy scale. *Chinese Gen Pract.* 2015;18(15):1857–60. doi: 10.3969/j.issn.1007-9572.2015.15.027
11. Santos, J. E. M. D., Brasil, V. V., Azevedo, C., Izidoro, L. C. R., Batista, A. J. G., Ferreira, A. C. S., & Mata, L. R. F. D. (2024). Pelvic floor muscle training in men with post-prostatectomy urinary incontinence: a scoping review. *Revista latino-americana de enfermagem*, 32, e4386. <https://doi.org/10.1590/1518-8345.7335.4386>
12. Bekelman, J. E., Rumble, R. B., Chen, R. C., Pisansky, T. M., Finelli, A., Feifer, A., Nguyen, P. L., Loblaw, D. A., Tagawa, S. T., Gillesen, S., Morgan, T. M., Liu, G., Vapiwala, N., Haluschak, J. J., Stephenson, A., Touijer, K., Kungel, T., & Freedland, S. J. (2018). Clinically Localized Prostate Cancer: ASCO Clinical Practice Guideline Endorsement of an American Urological Association/American Society for Radiation Oncology/Society of Urologic Oncology Guideline. *Journal of clinical oncology : official journal of the American Society of Clinical Oncology*, 36(32), 3251–3258. <https://doi.org/10.1200/JCO.18.00606>
13. Kharaji, G., ShahAli, S., Ebrahimi-Takamjani, I., Sarrafzadeh, J., Sanaei, F., & Shanbehzadeh, S. (2023). Supervised versus unsupervised pelvic floor muscle training in the treatment of women with urinary incontinence - a systematic review and meta-analysis. *International urogynecology journal*, 34(7), 1339–1349. <https://doi.org/10.1007/s00192-023-05489-2>
14. Buckingham, S. A., Williams, A. J., Morrissey, K., Price, L., & Harrison, J. (2019). Mobile health interventions to promote physical activity and reduce sedentary behaviour in the workplace: A systematic review. *Digital health*, 5, 2055207619839883. <https://doi.org/10.1177/2055207619839883>
15. Sciarra, A., Viscuso, P., Arditi, A., Mariotti, G., De Berardinis, E., Di Pierro, G. B., Canale, V., Gentilucci, A., Maria Busetto, G., Maggi, M., Eisenberg, M. L., Vilson, F., Chung, B. I., Ferro, M., Salciccia, S., & Del Giudice, F. (2021). A biofeedback-guided programme or pelvic floor muscle electric stimulation can improve early recovery of urinary continence after radical prostatectomy: A meta-analysis and systematic review. *International journal of clinical practice*, 75(10), e14208. <https://doi.org/10.1111/ijcp.14208>

Acronyms	Description
UI	Urinary incontinence
ES	Electrical Stimulation
PEMT	Pelvic Floor Muscle Training
RP	Radical Prostatectomy
PFMS	Pelvic Floor Muscle Strength
BMI	body mass index
OAB-V8	OAB-Version 8
MOS	Modified Oxford Scale
SUI	Stress Urinary Incontinence
I-QoL	Incontinence Quality of Life
BPMSES	Broome Pelvic Muscle Self-Efficacy Scale
LRP	Laparoscopic Radical Prostatectomy
RALP	Robotic-assisted laparoscopic radical prostatectomy
RP	Radical Prostatectomy
ICIQ-SF	International Consultation on Incontinence Questionnaire Short Form
BNS	Bilateral Nerve-Sparing
C-RARP	conventional Robot-Assisted Radical Prostatectomy
MRI	Magnetic Resonance Imaging
SUI	Stress Urinary Incontinence
NSCLBP	Nonspecific Chronic Low Back Pain
PFME	Pelvic Floor Muscle Exercises
CLMM	cumulative link mixed model
KT	Kinesio Taping
OAB	Overactive Bladder
PFD	Pelvic Floor Dysfunctions
PFMT+ES	PFMT combined with Electrical Stimulation
ANOVA	Analysis of variance