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Review article

Functional Electrical Stimulation for Male Urinary Incontinence: A Literature Review

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Abstract

Male urinary incontinence (UI), particularly post-prostatectomy incontinence (PPI), poses a significant burden on quality of life and remains a persistent challenge in urological rehabilitation. Functional Electrical Stimulation (FES) has emerged as a promising adjunctive therapy to enhance pelvic floor muscle function and accelerate continence recovery. This literature review synthesizes current evidence on the efficacy and clinical application of FES in managing male UI. A structured search was conducted across PubMed, Scopus, ScienceDirect, and Cochrane Library databases to identify relevant studies published between 2018 and 2024. Inclusion criteria encompassed randomized controlled trials, systematic reviews, meta-analyses, and quasi-experimental studies involving FES interventions for men with UI. From 2,108 initial records, 8 high-quality studies were included in the final analysis. The majority of findings indicate that FES, particularly when combined with Pelvic Floor Muscle Training (PFMT), significantly reduces incontinence episodes, improves quality of life, and promotes earlier continence recovery. Most reported outcomes were observed in the short to medium term (ranging from 4 weeks to 6 months), with limited evidence supporting long-term efficacy beyond one year. However, variability in stimulation protocols and limited long-term data underscore the need for standardized treatment guidelines and further research. In conclusion, FES represents a safe, effective, and evidence-supported intervention in the conservative management of male urinary incontinence.

INTRODUCTION

Urinary incontinence (UI) in men, particularly after radical prostatectomy, can have profound physical, psychological, and social effects.[1] It impairs daily functioning, restricts social participation, and often leads to emotional distress such as embarrassment, anxiety, and depression.[2,3]

In the context of aging populations and increasing rates of prostate cancer diagnosis and treatment, particularly via radical prostatectomy, the burden of male UI is expected to rise substantially.[4,5]

Post-prostatectomy incontinence (PPI) remains one of the most common complications post-surgery.[6,7] It is

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estimated that 30–60% of patients experience some degree of urinary incontinence within the first six months after surgery, with a substantial subset suffering from persistent leakage beyond one year.[6–8] Despite advances in surgical techniques, such as nerve-sparing and robotic-assisted prostatectomy, UI continues to significantly affect patient quality of life and satisfaction with cancer treatment outcomes.[4,9,10] The lack of uniform rehabilitation protocols further complicates the management of this condition.[11]

Pelvic Floor Muscle Training (PFMT) is widely accepted as a first-line conservative therapy. PFMT aims to strengthen the pelvic floor musculature responsible for continence through repeated voluntary contractions. However, many patients experience difficulty identifying or activating the correct muscle groups, and adherence to exercise regimens remains a significant barrier. Additionally, recovery is often slow and incomplete, particularly in older patients or those with pre-existing neuromuscular deficits.

Functional Electrical Stimulation (FES) has emerged as a promising adjunctive or alternative intervention. FES delivers targeted low-frequency electrical impulses to the pelvic floor and perineal nerves, particularly the pudendal nerve, with the goal of improving muscle activation and enhancing neuromuscular re-education.[12,13] In addition to muscle strengthening, FES may influence neuroplasticity, potentially restoring voluntary control of the urinary sphincter.[14,15] Because FES is a passive modality, it may benefit patients who are unable to perform or coordinate voluntary PFMT.

Recent trials have confirmed that when FES is combined with PFMT, patients experience faster continence recovery and higher quality of life compared to PFMT alone.[8,16,17] Despite growing interest, clinical application remains limited due to variability in stimulation protocols, device types, and duration of therapy. This review synthesizes the latest evidence from 2018 to 2024 to evaluate the efficacy, mechanisms, and clinical implications of FES in managing male urinary incontinence, with a focus on post-prostatectomy.

Despite emerging evidence supporting the benefits of Functional Electrical Stimulation (FES), there remains a lack of standardized clinical protocols, limited consensus on optimal stimulation parameters, and inconsistent integration into post-prostatectomy rehabilitation programs. Furthermore, existing literature reviews often group male and female populations together or focus broadly on pelvic floor therapies without isolating the specific role of FES in male urinary incontinence. This review addresses these gaps by synthesizing recent evidence (2018–2024) that specifically evaluates the efficacy, mechanisms, and clinical relevance of FES in the management of post-prostatectomy male urinary incontinence.

METHODS

This literature review was conducted using a narrative approach, incorporating systematic search strategies to ensure comprehensive coverage of the relevant literature. The databases PubMed, Cochrane Library, ScienceDirect, and Scopus were searched for studies published between January 2018 and May 2024.

A structured search strategy was applied using Boolean operators (AND, OR) across each database. The search string used in PubMed was: ("functional electrical stimulation" OR "neuromuscular electrical stimulation" OR FES) AND ("male urinary incontinence" OR "post-prostatectomy incontinence") AND ("pelvic floor muscle training" OR PFMT). Similar strategies were adapted for Cochrane Library, ScienceDirect, and Scopus using relevant syntax. Filters were applied to include only English-language studies involving human

male participants, published between January 2018 and May 2024. The inclusion criteria were: (1) original peer-reviewed studies; (2) randomized controlled trials (RCTs), quasi-experimental studies, systematic reviews, or meta-analyses; (3) male participants diagnosed with urinary incontinence following radical prostatectomy; and (4) studies examining FES either alone or in combination with PFMT or other rehabilitative strategies. Studies focusing exclusively on female participants, case reports, editorials, conference abstracts, and non-intervention studies were excluded.

The screening process followed PRISMA guidelines (figure 1). After duplicate removal, titles and abstracts were screened independently by two reviewers. Disagreements were resolved through consensus or consultation with a third reviewer. Full-text articles that met the inclusion criteria were retrieved for detailed analysis. A total of 2,108 articles were initially identified; after screening and eligibility checks, 42 studies were shortlisted for full-text review. Ultimately, 8 studies were included in the synthesis based on relevance, quality, and availability of outcome data.

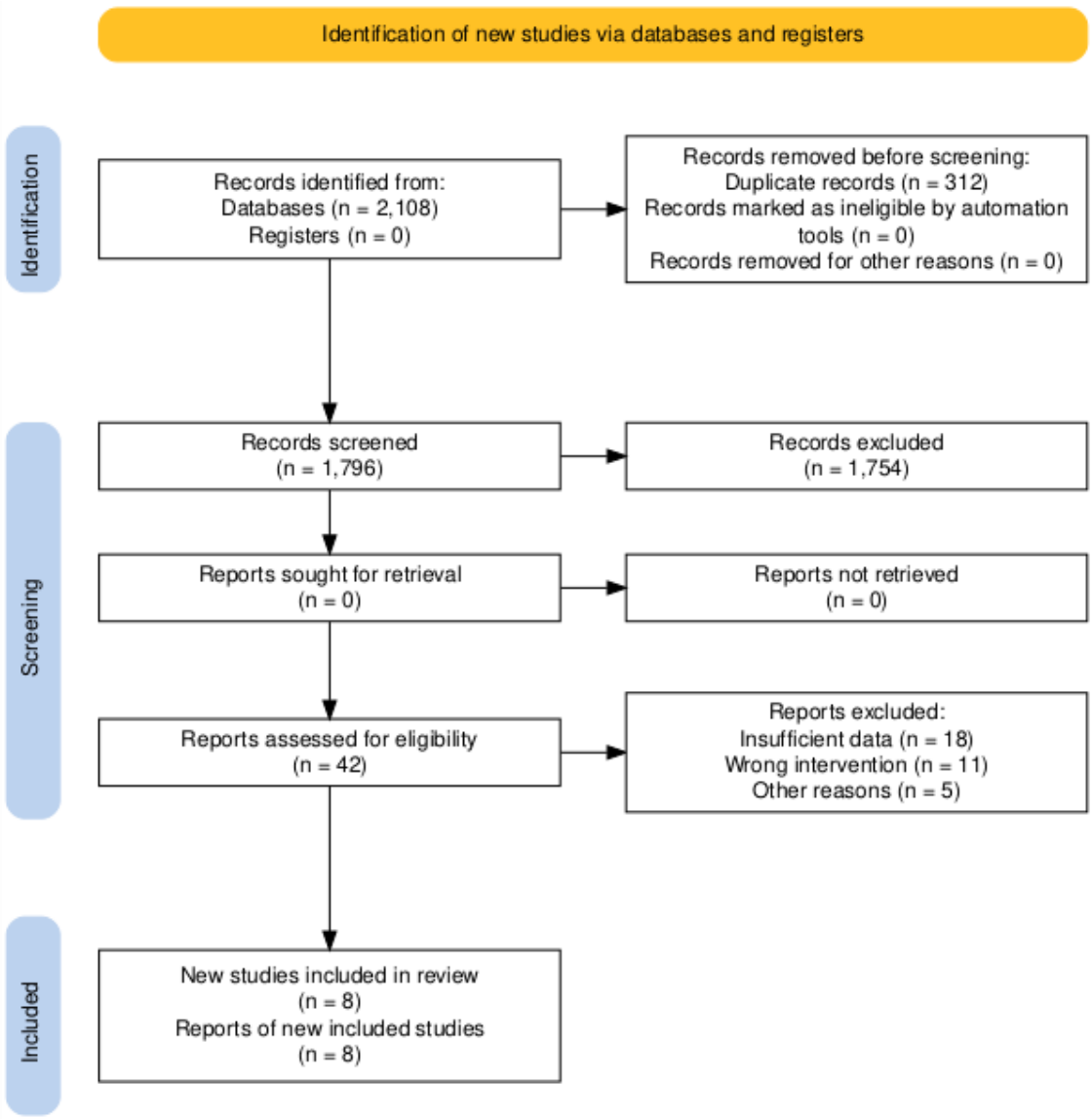

Figure 1
Summary screening process followed PRISMA guidelines

Data extracted from the studies included author and year, study design, sample size, participant characteristics, type and protocol of FES intervention, outcome measures, and key findings. The methodological quality of included randomized controlled trials was assessed using the Cochrane Risk of Bias 2.0 (RoB 2) tool, while systematic reviews and meta-analyses were evaluated with the AMSTAR-2 (A MeaSurement Tool to Assess Systematic Reviews) checklist. Each study was independently assessed by two reviewers, and discrepancies were resolved through discussion. By focusing on high-quality recent studies, this methodology aimed to provide an updated, evidence-based synthesis of the role of FES in post-prostatectomy urinary incontinence in men.

RESULTS

A total of eight studies met the inclusion criteria and were included in this review. These studies comprised randomized controlled trials, meta-analyses, retrospective cohorts, and reviews, all focusing on the application of FES for male urinary incontinence. The interventions varied across studies, with some utilizing FES alone, while others combined it with PFMT or biofeedback. The outcomes assessed included time to continence, quality of life measures, psychological well-being, and neuromuscular function.

Table 1
Summary of Included Studies on FES for Male Urinary Incontinence

No.	Study (Author, Year)	Design	Sample Size	Intervention	Follow-Up	Key Findings
1	Sciarra et al., 2021 [16]	Meta-analysis	12 studies	PFMT + FES vs PFMT alone	Varies (4–24 wks)	FES improved early continence recovery significantly
2	Yu et al., 2024 [8]	Network meta-analysis	60+ studies	Combined rehabilitation strategies	3–6 mo	FES + PFMT was most effective at 3–6 months
3	Chen et al., 2023 [12]	RCT Protocol	90	Pudendal nerve stimulation vs PFMT	Planned: 6 mo	Study in progress; aims to evaluate comparative efficacy
4	Feng et al., 2021 [15]	RCT	96	EPNS vs PFMT + TES	3 mo	EPNS group had significantly better short-term outcomes
5	Huang et al., 2024 [13]	Retrospective cohort	121	FES + PFMT vs PFMT alone	12 wks	FES group showed faster recovery and better QOL
6	Zhang et al., 2024 [18]	RCT	90	Biofeedback + FES + PFMT	6 mo	Improved continence and anxiety outcomes
7	[17]	Umbrella review	29,925 pts	PFMT ± FES/Biofeedback	Short-to-mid term	Supports short-term benefits; long-term unclear
8	Balog et al., 2019[14]	Narrative review	–	Mechanistic review	N/A	FES may enhance BDNF-mediated neuroplasticity

The findings consistently demonstrate that FES, especially when combined with PFMT, provides superior results in terms of early continence recovery, patient satisfaction, and reduction in urinary leakage episodes. Variability in the protocols used—such as frequency, duration, and stimulation mode—was noted, but the overall trend supports the clinical utility of FES in urological rehabilitation. Table 1 presents a

detailed summary of the characteristics and key findings of the included studies. The duration of follow-up across included studies ranged from 4 weeks to 12 months. Most randomized controlled trials evaluated outcomes at 6 to 12 weeks, with only a limited number reporting long-term follow-up beyond 6 months. This variability makes it challenging to assess sustained benefits of FES beyond the early recovery period. Regarding methodological quality, the majority of RCTs demonstrated low to moderate risk of bias, primarily due to unclear allocation concealment and lack of blinding in some studies. Meta-analyses included high-quality trials and were evaluated as moderate-to-high quality using AMSTAR-2. Retrospective and narrative reviews, while informative, inherently carry a higher risk of bias due to design limitations

DISCUSSION

Multiple high-quality trials and meta-analyses confirm that combining FES with PFMT results in faster continence recovery than PFMT alone.[8,16,17] These studies consistently demonstrate that the addition of FES to traditional pelvic floor training enhances early continence recovery and increases the likelihood of achieving full continence within 3 to 6 months post-surgery. Moreover, early application of FES postoperatively may yield better outcomes by facilitating neuromuscular reactivation during the critical early healing period.[13]

Mechanistically, FES works by activating motor units in pelvic floor muscles and modulating pudendal nerve pathways, which may lead to improvements in sphincter strength and urinary control. These effects are supported by neurophysiological studies showing increased pelvic muscle tone, improved reflex latency, and enhanced neuromuscular coordination.[14,15] Some researchers propose that electrical stimulation may promote long-term neural regeneration through BDNF expression and synaptic plasticity, though evidence in humans remains limited. Still, FES offers a non-invasive pathway to augment the biological rehabilitation of urinary function.[19–21]

Psychosocially, the application of FES has been linked to improvements in patient-reported outcomes including anxiety, self-efficacy, and quality of life. This is particularly relevant in male patients who may experience shame or social withdrawal due to incontinence symptoms. Studies by Zhang et al. and Huang et al. found significant reductions in anxiety levels and psychological distress after FES-integrated rehabilitation programs.[13,18] These benefits may enhance adherence to therapy and reduce dropout rates, thereby reinforcing the long-term success of continence rehabilitation.

Patient characteristics appear to significantly influence the outcomes of FES-based rehabilitation. Younger patients or those with better baseline pelvic muscle strength tend to show faster continence recovery. In contrast, older adults, individuals with diabetes, prior pelvic surgeries, or pre-existing neurological conditions may exhibit slower or suboptimal responses due to impaired neuromuscular integrity. Additionally, cognitive capacity and patient motivation have been linked to adherence with FES and PFMT regimens, especially when home-based systems are used. These factors underscore the importance of individualized treatment planning and stratified research to identify responders and non-responders to FES.

Despite the benefits, protocol variability remains a critical issue. Studies differ in terms of stimulation frequency, pulse width, electrode type, application site, and treatment duration, leading to heterogeneous results.[22,23] Some trials employ transcutaneous stimulation while others use trans anal or intravaginal approaches, each potentially influencing

outcome measures. As such, there is a need for standardized FES protocols and consensus on optimal parameters to facilitate robust comparisons and meta-analytic integration.[24–26]

The majority of clinical trials also tend to focus on short-term outcomes (3–6 months), with limited longitudinal data on sustained continence or relapse rates beyond the first postoperative year. Studies by Yu et al. and Sciarra et al. noted this gap and emphasized the need for long-term follow-up studies and standardized patient-reported outcome measures.[8,16] Additionally, very few studies address maintenance strategies such as booster stimulation sessions or long-term behavioural reinforcement.

Finally, cost-effectiveness and accessibility of FES remain underexplored. While devices have become more compact and affordable, their availability in low-resource settings is still limited. Training and supervision by physiotherapists or urology nurses are often required, potentially increasing healthcare costs. Some health systems have begun integrating home-based FES units with telemonitoring features, which may offer promising alternatives for sustainable delivery. Future research should include health economics analyses and patient preference data to guide policy decisions and clinical recommendations.

The evidence synthesized in this review has several strengths, including the inclusion of recent high-quality meta-analyses, randomized controlled trials, and mechanistic investigations. The studies span diverse settings and employ validated outcome measures, enhancing the generalizability of findings. However, limitations persist. Sample sizes in some RCTs were modest, and many studies reported only short-term follow-up. Heterogeneity in FES protocols, lack of blinding, and variability in control interventions pose challenges to result comparability. Additionally, few studies report subgroup analyses by age, comorbidity, or adherence levels. These limitations highlight the need for standardized, large-scale, long-term studies with stratified designs to enhance external validity and clinical applicability.

CONCLUSION

Functional Electrical Stimulation (FES) has emerged as a valuable adjunct to traditional pelvic floor rehabilitation for men suffering from urinary incontinence following radical prostatectomy. The combination of FES with Pelvic Floor Muscle Training (PFMT) has demonstrated superior outcomes in terms of faster continence recovery, improved neuromuscular control, and enhanced quality of life. In addition to physical rehabilitation, FES also supports psychological well-being, which is essential for comprehensive recovery in this patient population.

Despite these benefits, the absence of standardized FES protocols remains a significant barrier to widespread clinical implementation. Current variations in stimulation frequency, duration, electrode placement, and device types hinder reproducibility and limit cross-study comparability. For FES to be reliably adopted into clinical guidelines and routine urological practice, there is an urgent need for consensus-driven, evidence-based protocol standardization.

Future high-quality research should prioritize the identification of optimal stimulation parameters, evaluate sustained long-term benefits beyond one year, and incorporate cost-effectiveness analyses across diverse healthcare settings. By addressing these critical gaps, FES can be more effectively integrated as a reliable, evidence-supported intervention in the conservative management of male urinary incontinence.

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