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REVIEW ARTICLE

Penile traction therapy after radical pelvic surgery: Does it work?

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Abstract

Sexual dysfunction, including erectile dysfunction and penile shortening, is a frequent consequence of radical pelvic surgeries such as prostatectomy, cystoprostatectomy, and rectal cancer surgery. These complications primarily result from nerve injury and hypoxia-induced corporal fibrosis. As survivorship care gains prominence in oncology, preserving sexual function and penile anatomy has become a critical objective. Penile traction therapy (PTT) is a non-invasive intervention that applies controlled mechanical stretch to the penis. Through mechanotransduction, PTT may stimulate tissue remodeling, preserve length, and reduce fibrosis. Initially developed for Peyronie's disease, PTT is now being explored for penile rehabilitation following pelvic surgery. Preliminary clinical studies, including randomized controlled trials, suggest that early initiation of PTT may help maintain or even improve penile length and erectile function (EF). Treatment is generally well tolerated, with high adherence and minimal side effects. The advent of second-generation devices, offering enhanced ergonomics and reduced daily usage times, has further improved feasibility and patient compliance. This review outlines the pathophysiological basis of post-surgical penile changes, the mechanism of action of PTT, and the emerging evidence base for its use in the post-oncological setting. Although PTT use remains off-label in this context, it represents a promising component of multimodal penile rehabilitation strategies. Its broader adoption is currently limited by barriers such as device cost, lack of insurance coverage, and the absence of standardized protocols. Structured follow-up, patient education, and multicenter long-term studies are essential to validate efficacy, establish best practices, and optimize accessibility for patients recovering from radical pelvic surgery.

KEYWORDS

erectile dysfunction, penile fibrosis, penile rehabilitation, penile shortening, penile traction therapy, postoperative sexual function, radical pelvic surgery

1 | INTRODUCTION

Cancer remains one of the leading global causes of morbidity and mortality[1]. Projections estimate that by 2030, the annual incidence of new cancer cases will exceed 26 million worldwide[2]. While improvements in diagnostic and therapeutic modalities have significantly increased survival rates, cancer diagnosis and treatment often exert profound physical and psychological burdens that compromise patients' overall quality of life[3].

In alignment with the World Health Organization's (WHO) holistic definition of health, there has been a

paradigm shift in oncology care to address not only the disease itself but also the broader spectrum of survivorship challenges, including psychological, social, and sexual well-being[4]. Among the long-term sequelae experienced by cancer survivors, sexual dysfunction stands out due to its high prevalence and its substantial impact on quality of life[5].

Radical pelvic surgeries, such as radical prostatectomy (RP)[6], radical cystoprostatectomy (RC)[7], and rectal cancer surgery (RCS)[8], are cornerstone treatments for malignancies of the prostate, bladder, and rectum. However, these procedures carry a substantial risk of postoperative sexual dysfunction due to the complex and densely packed neurovascular anatomy of the male pelvis[9]. In male patients, the resultant sexual side effects encompass erectile dysfunction (ED), penile shortening, penile curvature, dysorgasmia, and various ejaculatory disorders, including retrograde ejaculation, anejaculation, and climacturia[10]. Broader issues such as decreased sexual activity, reduced satisfaction, and altered body image are also commonly reported following treatment for pelvic malignancies[11,12]. Among the various domains of sexual dysfunction, ED is the most frequently encountered complication after radical pelvic surgery, accounting for up to 10% of all ED cases in men[11,13]. Defined by the National Institutes of Health (NIH) as the "inability to attain and/or maintain a penile erection sufficient for satisfactory sexual performance," ED is recognized by both the WHO and the International Consultation on Urologic Disease[14,15].

Following RP, the reported prevalence of ED ranges from 14% to over 90%, depending on factors such as patient age, baseline function, and the extent of nerve-sparing during surgery[16]. In a prospective study, 71% of men reported perceived penile shortening after RP, with an average loss of 1cm–1.5 cm, particularly pronounced in the early postoperative period[17]. These changes can have a profound impact on sexual self-esteem and overall quality of life[18]. In response to these findings, Montorsi et al.[15] introduced the concept of early penile oxygenation, subsequently termed "penile rehabilitation," in 1997. Although the concept has since garnered considerable attention, its implementation remains inconsistent across institutions[19].

Over the past two decades, there has been a growing interest in understanding and mitigating ED following radical pelvic surgery[20]. Various treatment strategies have been explored, but their success has been inconsistent[21]. Penile rehabilitation programs, aimed at promoting recovery of spontaneous erectile function (EF) and minimizing the duration and severity of postoperative ED, have emerged as one of the most promising interventions[22].

Commonly employed strategies include phosphodiesterase type 5 inhibitors (PDE5is)[23] and vacuum erection devices (VEDs)[24], both of which have demonstrated benefits in preserving EF and penile dimensions, particularly in the short to mid-term postoperative period. More recently, penile traction therapy (PTT) has gained attention as a non-invasive adjunct[25]. By applying controlled longitudinal stretch to the penis, PTT may counteract fibrotic remodeling, maintain tunical elasticity, and promote length restoration[25]. Although high-quality evidence remains limited, emerging data suggest that early and consistent use of PTT may support both structural preservation and functional recovery in men undergoing radical pelvic surgery[26,27].

This paper provides a comprehensive review of the evidence on penile rehabilitation, with particular focus on EF recovery and penile length preservation after radical pelvic surgeries. Special emphasis is placed on PTT, a non-pharmacologic, mechanical intervention, in the context of RP, RC, and RCS. The review is based on a narrative synthesis of the literature. Relevant publications were identified through PubMed/MEDLINE, Embase, and the Cochrane Library, covering the years 1980–2025. Search terms included "penile traction therapy," "penile rehabilitation," "radical prostatectomy" "radical cystoprostatectomy" and "rectal cancer surgery." Priority was given to English-language clinical trials, preclinical studies, and guideline documents directly related to post-radical pelvic surgery rehabilitation.

2 | PATHOPHYSIOLOGY OF PENILE CHANGES AFTER PELVIC SURGERY

The etiology of ED following radical pelvic surgery is complex and multifactorial[28]. In the early 1980s, Walsh et al.[29] introduced the nerve-sparing RP to preserve the cavernous nerve branches of the pelvic plexus. In their initial retrospective series of 12 patients, all maintained EF postoperatively, and six achieved vaginal penetration and orgasm[29]. Among those followed for more than 6 months, five regained full potency. These observations underscored the neurogenic basis of ED post-RP, primarily due to cavernous nerve injury[29].

Despite refinements in surgical technique, spontaneous EF often remains compromised in the early postoperative period[30,31]. This is largely attributed to neurapraxia, a transient, reversible form of cavernous nerve dysfunction caused by intraoperative traction, thermal injury, or dissection[32]. This neural deficit can result in the temporary loss of erectile capacity, sometimes persisting for up to 2 years[32].

While the mechanisms of post-surgical ED and penile shortening are multifactorial, including cavernous nerve injury[33], vascular compromise[34], hypoxia-induced apoptosis of corporal smooth muscle[35], and progressive fibrosis[36], the unifying pathophysiological rationale for penile rehabilitation centers on the concept of penile corporal hypoxia. Following nerve injury, the loss of spontaneous and nocturnal erections leads to reduced oxygenation[37–39], triggering a cascade of events: smooth

muscle apoptosis, increased collagen deposition, cavernosal fibrosis, and ultimately veno-occlusive dysfunction[40].

Preclinical models have shown that apoptosis begins in the subtunical region shortly after cavernous neurectomy, whereas nerve crush injuries lead to delayed changes[41]. Once smooth muscle content drops below 40%, venous leak becomes inevitable[42]. Clinical studies by Mulhall et al.[43] corroborate this, showing over 50% of men undergoing nerve-sparing RP develop venous leak within one year, starting as early as month four.

Prolonged hypoxia also disrupts the smooth muscle-to-collagen ratio by increasing transforming growth factor-beta 1 (TGF-β1) and the expression of collagen types I and III[44,45]. However, the impact of physiologic flaccid-state hypoxia on long-term integrity remains debated[46,47]. Regardless, patients with confirmed neurovascular injury may enter a vicious cycle of smooth muscle loss culminating in irreversible corporo-veno-occlusive dysfunction[48]. Notably, even those with intact nerve bundles can develop progressive fibrosis due to prolonged neurapraxia, resulting in the same endpoint, veno-occlusive insufficiency[35]. These patients are ideal candidates for penile rehabilitation, which seeks to halt or reverse fibrotic progression during the window of reversible nerve dysfunction[38].

In light of the multifactorial pathophysiology described above, ranging from transient neural injury and hypoxia-induced corporal apoptosis to progressive fibrosis and eventual veno-occlusive dysfunction, it becomes evident that preserving penile structure and function in the early postoperative period is a therapeutic priority. Conventional penile rehabilitation strategies, including PDE5is[49] and VEDs[50], primarily target erectile capacity but may fall short in mitigating structural deterioration, especially in cases with significant neurovascular injury[24]. Mechanical interventions have therefore garnered growing interest for their potential to address not only function but also morphology. Among these, PTT has emerged as a promising modality capable of counteracting post-surgical penile shortening, reducing tissue contracture, and possibly stimulating favorable cellular remodeling[51]. The following section delves into the fundamental principles and biological mechanisms underlying PTT, along with preclinical and clinical insights into its role in post-radical pelvic surgery rehabilitation.

3 | PRINCIPLES AND MECHANISMS OF PTT

The concept of applying mechanical force to lengthen the penis dates back centuries, with rudimentary methods such as suspending weights from the organ historically employed in various cultures[52]. These primitive approaches, though rooted in esthetic or cultural traditions, were often unsafe and frequently resulted in adverse outcomes such as penile edema, neuropraxia, and ED[52]. Modern PTT, by contrast, represents a medically supervised, evidence-based evolution of these historical principles.

The modern medical application of PTT emerged in the early 2000s[53]. First-generation devices featured a base ring placed at the root of the penis, a distal ring secured below the glans, and two parallel rods incorporating spring mechanisms to generate longitudinal traction[54]. These devices required prolonged daily use, often between 2 h and 9 h, to achieve meaningful therapeutic gains. However, the physical discomfort and cumbersome nature of early devices frequently led to poor adherence and inconsistent outcomes[55]. The introduction of second-generation devices addressed these limitations by incorporating features such as dynamic traction adjustment, improved glans fixation, and angular force application[56]. These innovations significantly enhanced user comfort and allowed for effective therapy with shorter wear times, sometimes as little as 30 minute per day, without compromising clinical efficacy[56].

The biological effects of PTT are attributed to mechanotransduction, a process by which mechanical forces are translated into cellular and molecular responses that promote tissue remodeling[57]. Continuous tensile stress has been shown to stimulate neocollagenesis, reduce the rigidity of fibrotic plaques, and induce penile tissue expansion[58]. At the molecular level, PTT upregulates enzymes such as matrix metalloproteinases (MMPs) and collagenase, which contribute to the breakdown of fibrotic tissue, while downregulating profibrotic mediators, such as TGF-β1[57] (Figure 1).

Recent animal studies using the bilateral cavernous nerve injury (BCNI) model, which replicates the post-RP environment, have demonstrated that PTT may preserve cavernosal smooth muscle content, reduce fibrosis, and enhance the expression of endothelial nitric oxide synthase (eNOS)[51]. Notably, the application of PTT extends beyond Peyronie's disease. Preclinical studies employing the BCNI model, a validated simulation of post-RP conditions, have demonstrated that PTT may also preserve cavernosal smooth muscle content, enhance eNOS expression, and reduce penile fibrosis[51]. These findings highlight its potential as a restorative tool in the post-surgical ED setting (Figure 1).

Commercially available PTT systems have evolved to meet diverse clinical needs, ranging from cosmetic lengthening to surgical rehabilitation. Devices such as the Penimaster PRO (MSP Concept, Berlin, Germany), Andropenis and Andropeyronie (Andromedical, Madrid, Spain), and RestoreX (PathRight Medical, Plymouth, USA) differ in their glans fixation techniques and directional force capabilities (Table 1) (Figure 2). While systems like the Penimaster PRO utilize glans suction for enhanced comfort, others, like RestoreX, incorporate angular countertraction, which is particularly beneficial

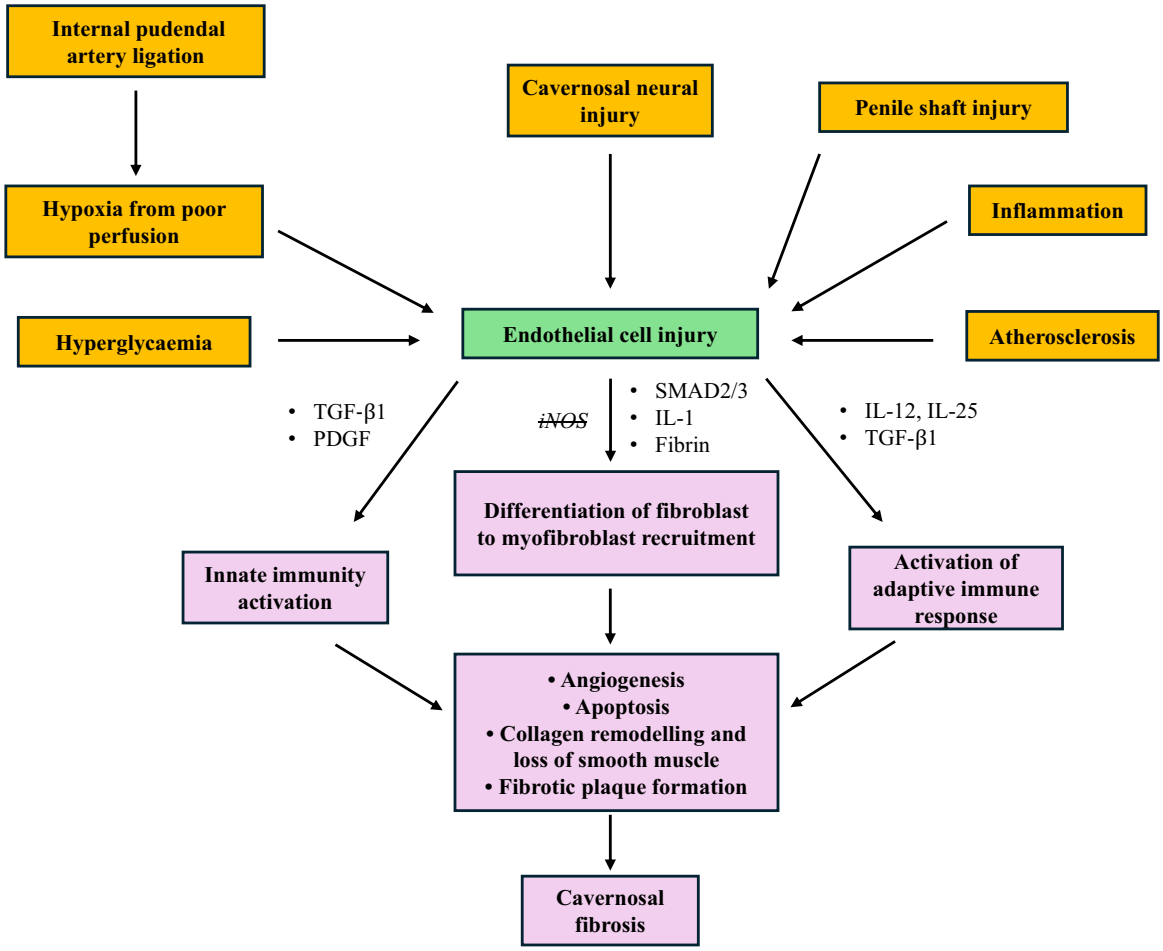

FIGURE 1 Proposed cellular pathways leading to cavernosal fibrosis and erectile dysfunction (ED). Endothelial cell injury serves as the initial trigger and may arise from cavernous nerve trauma (e.g., during radical pelvic surgery), repetitive penile microtrauma, chronic inflammation, or atherosclerotic disease. These insults induce the local release of profibrotic cytokines, including transforming growth factor-β1 (TGF-β1), interleukin-1 (IL-1), and platelet-derived growth factor (PDGF). These mediators drive the transdifferentiation of resident fibroblasts into myofibroblasts, which actively deposit extracellular matrix components and promote tissue contraction. In parallel, antifibrotic and cytoprotective mechanisms, such as the nitric oxide (NO) pathway, particularly inducible nitric oxide synthase (iNOS), are suppressed. The resulting imbalance leads to cavernosal smooth muscle apoptosis, collagen overaccumulation, and architectural disarray of the corpus cavernosum. These alterations compromise veno-occlusive function and contribute to the development of ED. In some patients, this same fibrotic cascade may localize and organize into plaques, giving rise to Peyronie's disease.

for curvature correction in Peyronie's disease. Across platforms, these devices share a common objective: to promote structural remodeling and functional recovery of the penis, whether after surgery, in fibrotic disease, or for esthetic purposes. As such, PTT has emerged as a versatile and increasingly integral component of penile rehabilitation protocols.

4 | CURRENT EVIDENCE ON PTT AFTER RADICAL PELVIC SURGERY

As previously noted, PTT was originally developed for the treatment of Peyronie's disease, a condition that lies beyond the scope of this chapter[59]. However, recent studies have consistently demonstrated the beneficial role of PTT in the context of radical pelvic surgeries, particularly in terms of penile length preservation and EF recovery[25,26]. These emerging findings support the incorporation of PTT into multimodal penile rehabilitation protocols for post-radical pelvic surgery patients.

Prospective trials have increasingly supported the clinical utility of PTT following RP. In a pivotal randomized controlled trial (RCT) conducted by Toussi et al.[25], 82 post-RP patients were enrolled and assigned to either a second-generation PTT protocol ($n = 55$) or a control group ($n = 27$). After 6 months of therapy, patients in the PTT group exhibited significantly better preservation of stretched penile length (+1.6 cm vs. +0.3 cm; $p < 0.01$) and EF (no change vs. a 6.5-point decline in the International Index of Erectile Function-Erectile Function Domain (IIEF-EF); $p = 0.03$) compared to controls. In addition, participants reported superior sexual satisfaction (IIEF-IS: +1 vs. −3.5; $p < 0.01$), and a

TABLE 1 Penile traction devices.

Device	Manufacturer	Approximate cost	Mechanism	Indications studied
Andropenis	Andromedical, Madrid, Spain	£119–196	Mechanical traction with extending rods	Peyronie's disease, dysmorphophobia
Andropeyronie	Andromedical, Madrid, Spain	£89–129	Mechanical traction with extending rods	Peyronie's disease
Fast Size	Fast Size Medical, CA, USA	£240	Mechanical traction with extending rods	Prior to penile implant
FS Extender	US Physio Med, CA, USA	£145–222	Mechanical traction with extending rods	Peyronie's disease
Golden Erect XL	Ronas Tajhiz Teb, Tehran, Iran	Unknown	Mechanical traction	Dysmorphophobia
Penimaster PRO	MSP Concept, Berlin, Germany	£155–259	Vacuum cusp on glans, and extending rods	Peyronie's disease
RestoreX	PathRight Medical, Plymouth, USA	£406	Mechanical traction with counter bending	Peyronie's disease

lower proportion required intracavernosal injection therapy to achieve erection (19% vs. 50%; $p < 0.05$), while PDE5i use remained similar between groups (86% vs. 94%). Notably, 56% of patients using PTT reported penile length improvement (vs. 0% in controls; $p < 0.0001$), and the majority expressed strong treatment acceptance, with 87% willing to repeat the therapy and 93% willing to recommend it. The intervention protocol consisted of daily traction sessions lasting 30–60 minutes, initiated 1 month postoperatively. Treatment adherence exceeded 85%, and adverse effects were mild and self-limiting, predominantly penile erythema (20%) and discomfort (36.7%).

Further evidence was provided by Zganjar et al.[26], who extended the initial 6-month RCT into a 3-month open-label phase to evaluate long-term benefits and the impact of treatment timing. Participants were allowed to either continue or initiate PTT during this phase, yielding critical insights into the importance of early intervention. Patients who began PTT one month postoperatively demonstrated superior outcomes, including a mean penile length gain of +1.7 cm ($p < 0.01$) and minimal decline in EF (−0.5 IIEF-EF points). In contrast, those who initiated PTT at 6 months postoperatively experienced less favorable outcomes, with only a +0.5 cm gain in penile length and a significant reduction in EF (−6 IIEF-EF points). Importantly, improvements in EF persisted beyond therapy discontinuation, suggesting a durable therapeutic effect. Compliance remained high (86%–100%), and adverse events were again limited to mild, transient findings, such as glanular erythema or discoloration in 36% of participants.

Collectively, these studies represent the most robust clinical evidence to date supporting the efficacy and safety of PTT in the postoperative setting. They highlight the importance of early initiation and consistent adherence to optimize both functional and anatomical outcomes in penile rehabilitation following RP.

5 | PRACTICAL CONSIDERATIONS FOR CLINICAL USE OF PTT

The successful implementation of PTT following radical pelvic surgery requires thoughtful consideration of patient selection, device choice, treatment timing, and adherence strategies. While PTT was originally developed for Peyronie's disease, recent RCTs have demonstrated its utility in preserving penile length and mitigating ED in patients undergoing RP[25,26]. The ideal candidates for post-RP PTT are motivated individuals with early postoperative penile shortening, declining EF, or those planning for delayed penile prosthesis implantation[26]. Importantly, therapy should be initiated early, typically within the first month after catheter removal, as outcomes are significantly more favorable when PTT is started during the early postoperative period compared to delayed initiation at 6 months[26].

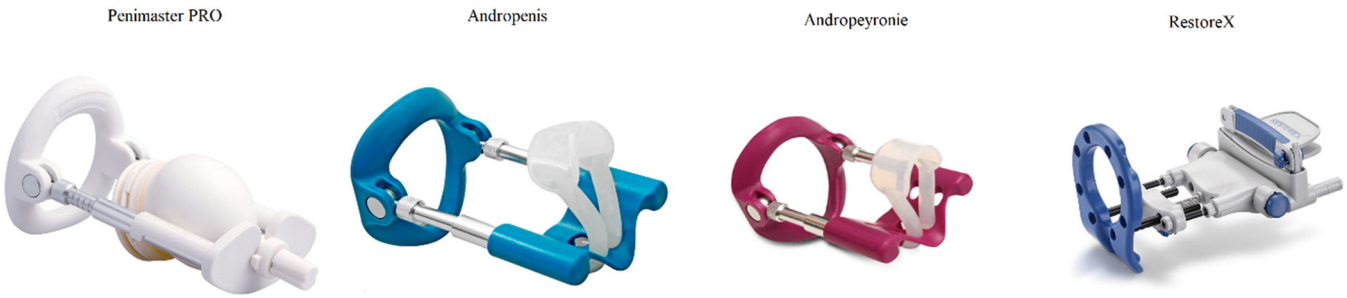

FIGURE 2 Comparative visual overview of four PTT devices. From left to right: Penimaster PRO, utilizes a vacuum-based glans chamber for atraumatic fixation, allowing multidirectional traction; Andropenis, a first-generation device with static traction rods and a silicone noose; Andropeyronie, a variant of Andropenis, tailored for Peyronie's disease, featuring a curved base plate and customized support; RestoreX, a second-generation PTT device with controlled directional traction and counter-bending capability, developed specifically for Peyronie's disease and post-surgical penile rehabilitation.

TABLE 2 Summary of PTT in post-radical pelvic surgery penile rehabilitation.

Feature	PTT
Mechanism of action	Applies mechanical stretch to stimulate tissue remodeling and reduce fibrosis via mechanotransduction; increases MMPs, reduces TGF-β1 [51,57]
Primary benefits	Preserves penile length; may improve EF and reduce post-RP fibrosis [25,26]
Efficacy evidence	Early RCTs show promising improvements in length and EF recovery; evidence still emerging [25,26]
Typical protocol	Daily use for 30–60 min; newer devices reduce wear time; best outcomes with early initiation [25,26]
Indications	Penile shortening, ED post-RP; originally designed for Peyronie's disease
Regulatory status	Some devices FDA-approved for Peyronie's disease; off-label use for post-RP penile rehabilitation
Patient satisfaction and adherence	High adherence reported in early studies; early initiation improves outcomes and engagement [25,26]
Challenges	Limited studies; discomfort during long wear; inconsistent protocols; device variability; less widespread access; requires further validation [25,26]

Abbreviations: EF, erectile function; FDA, Food and Drug Administration; MMPs, matrix metalloproteinases; PTT, penile traction therapy; RCT, randomized controlled trial; RP, radical prostatectomy; TGF-β1, transforming growth factor-beta 1.

Second-generation traction devices, particularly the RestoreX system, have improved clinical applicability by reducing required wear time to 30 min–60 min per day, while maintaining high efficacy and tolerability[25]. This represents a substantial advancement over first-generation systems, which required several hours of daily use and were often limited by discomfort and poor adherence[54,55]. In the study by Toussi et al.[25], adherence exceeded 85%, and most patients found the therapy acceptable; 87% reported willingness to repeat treatment, and 93% would recommend it to others. Reported benefits included significant improvements in stretched penile length and stabilization of EF, along with improved sexual satisfaction and reduced need for intracavernosal injection therapy[25]. Adverse effects were mild and self-limiting, predominantly penile erythema and transient discomfort, occurring in 20%–36.7% of users[25,26].

Device selection should take into account user comfort, ease of application, and directional force capabilities. For example, RestoreX offers angular counter-traction, which may enhance efficacy, while Penimaster PRO utilizes glans suction to improve comfort[56]. Although several devices are Food and Drug Administration-cleared (FDA) for the treatment of Peyronie's disease, their use in post-RP rehabilitation is considered off-label. It should be disclosed during informed consent discussions[56].

To optimize outcomes, clinicians should provide comprehensive instruction on device use, ensure patients have realistic expectations, and implement structured follow-up to monitor progress. Outcome measures should include baseline and serial assessments of stretched penile length, penile curvature (if present), and validated EF indices such as the IIEF-EF domain[25,26]. Combining PTT with pharmacologic agents, particularly PDE5is, may confer synergistic benefits and should be considered in patients without contraindications[23,49]. PTT can also be integrated into multimodal penile rehabilitation strategies that include VEDs and intracavernosal therapies, depending on the patient's response profile and goals[24,40]. Key features, benefits, and challenges of PTT in the post-radical pelvic surgery setting are summarized in Table 2.

6 | CONCLUSION

Although high-level evidence remains limited, current data support PTT as a safe, well-tolerated, and patient-driven modality for preserving penile length and function after radical pelvic surgery. However, several real-world barriers hinder widespread clinical adoption. These include the relatively high cost of devices, lack of insurance reimbursement, and restricted availability in many regions. Moreover, the absence of standardized treatment protocols contributes to heterogeneity in clinical practice and uncertainty regarding optimal timing, duration, and patient selection. To overcome these limitations, future research should prioritize multicenter, long-term trials that establish evidence-based protocols and evaluate cost-effectiveness. Addressing these challenges will be essential to integrate PTT into routine postoperative rehabilitation and to maximize its potential benefits for patients recovering from radical pelvic surgery.

AUTHOR CONTRIBUTIONS

Ahmet Tevfik Albayrak was responsible for the study design, data curation, and formal analysis. He prepared the original draft of the manuscript, managed the overall project, and fulfilled all corresponding author responsibilities. Mustafa Faruk Usta critically revised the manuscript for important intellectual content and approved the final version for submission.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

ETHICS STATEMENT

This work is a narrative review and did not involve any studies with human participants or animals conducted by the authors. All data discussed herein are derived from previously published, peer-reviewed literature. Ethical approval and informed consent were therefore not required. The authors affirm that this manuscript adheres to the ethical standards of scientific integrity and publication ethics as outlined by the International Committee of Medical Journal Editors (ICMJE) and the Committee on Publication Ethics (COPE).

DATA AVAILABILITY STATEMENT

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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