Review Article

A narrative review of pelvic floor muscle training in the management of incontinence following prostate treatment

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Background and Objective: Urinary incontinence following prostate treatment (IPT) is a common complication with corresponding negative impacts on quality of life. Pelvic floor muscle training (PFMT) is a non-invasive treatment strategy to treat combat this clinical issue, and has been recognized by medical associations globally and increasingly supported by large bodies of literature. Accordingly, many studies demonstrate a significant benefit of pelvic floor muscle training to continence status and quality of life in men with incontinence following prostate treatment. However, related research is limited by variety in treatment regimens, outcome measures, and study designs, with unclear impact on treatment success. We aim to provide a brief overview of pathology and incidence of incontinence following prostate surgery and an understanding how PFMT is currently used to treat and prevent this clinical consequence.

Methods: A comprehensive literature search was conducted utilizing PubMed, Medline, and Google Scholar. Search criteria included systematic reviews and randomized control trials published in the year 2000 to present. References of resulting studies were further analyzed to identify further articles of relevance. Keywords searched included: "post-prostatectomy incontinence", "pelvic muscle strengthening", "Benign Prostatic Hyperplasia", and "pelvic floor muscle training". Peer-reviewed publications that demonstrated a novel addition to the existing body of literature on this subject were included.

Key Content and Findings: Upon review of the current research landscape, PFMT is largely supported in treatment of IPT. Analysis of current literature on this subject demonstrates heterogeneity in protocols, measures of treatment success, and patient numbers. Nevertheless, benefits to continence and quality of life are noted across an expansive body of literature and as such, PFMT is therefore recommended as an important part of the treatment algorithm following radical prostatectomy.

Conclusions: PFMT is an important and effective part of the treatment algorithm in the prevention and treatment of IPT. Additional research is needed to more extensively assess PFMT's role in treating this clinical consequence, especially following other prostate surgeries.

Keywords: Post-prostatectomy incontinence (PPI); pelvic floor muscle training (PFMT); benign prostatic hyperplasia; pelvic muscle strengthening

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Introduction

Incontinence after prostate treatment (IPT) is a significant adverse consequence that is common in men undergoing prostate surgery. Although urinary incontinence (UI) may develop following different types of prostate surgeries, the vast majority of cases result from radical prostatectomy (RP) [post-prostatectomy incontinence (PPI)]. Post-surgical incontinence has been shown to impact psychological well-being, rates of depression, and overall quality of life (QOL) (1,2). Despite long-term incontinence rates after prostatectomy commonly reported to be less than 10%, other robust literature suggests incontinence affects a much larger proportion of men undergoing prostatectomy (3,4). In their Prostate Cancer Outcomes Study, Stanford and colleagues detailed that 66.4% of patients reported incontinence at 6 months following prostatectomy, with 25.2% rating it as a moderate-to-big problem (5). At 15-year follow-up, 18.3% of this cohort reported no urinary control or frequent leakage (6). Notably, the AUA/SUFU Guideline on IPT (AUA Guideline) details that surgical approach does not impact rates of IPT, with similar rates seen across open and robotic-assisted approaches (7).

This high variability in reported rates of IPT stems, in part, due to differing definitions of continence as well as variation in how this data is assessed. Indeed, outcomes defining treatment success vary and may include subjective number of incontinence episodes, results collected from validated questionnaires, or absence/number of pads used. Further, assessment methods can influence outcomes greatly and include the use of validated questionnaires, bladder diaries, or basic physician interview. Combined, these varying definitions and assessment methods likely influence reported continence rates greatly. Importantly, given evidence demonstrating significant decreases in health-related QOL if any pads are used, it may be preferred to use more strict definitions of success in a standardized fashion (8).

It is important to highlight that urinary incontinence may occur in prostate surgeries other than RP. Notably, surgeries for benign prostatic hyperplasia (BPH) have shown to account for 10% of cases of male stress urinary incontinence (SUI) (9). Buckley *et al.* examined rates of incontinence following RP in comparison to transurethral resection of the prostate (TURP) and found that 63% of patients who had undergone TURP endorsed some degree of urinary incontinence 12 months post-operatively (10). Upon further stratification, 24% of patients complained of a moderate amount of leakage at least once daily. Similarly, in a study examining urinary incontinence following photoselective vaporization of the prostate (PVP), the prevalence of urinary incontinence was found to be 40%, with both urge urinary incontinence and SUI being reported by patients (11). Studies have similarly explored incidence of urinary incontinence following Holmium laser Enucleation of the Prostate (HoLEP), which range between 16–44% and show that the highest symptom severity is seen in the first 3 months post-operatively (12).

Both the anatomy and physiology of continence, and their potential contribution to IPT, are not completely understood. While a complete review of anatomic and physiologic etiologies of continence is beyond the scope of this review, a basic overview of these concepts is important to guide an understanding of the mechanism by which pelvic floor muscle training (PFMT) may benefit continence restoration in men undergoing prostate surgery. Continence in men is hypothesized to be a function of numerous muscular structures, including the detrusor, internal smooth muscle sphincter, rhabdosphincter, and levator muscle (3,13,14). Broadly PPI is thought to primarily relate to surgical loss of the prostate and proximal sphincter, combined with concurrent external sphincter incompetence (3,15,16). While external sphincter incompetence can result from direct surgical injury, other mechanisms are thought to contribute to this muscular weakness. For example, the nervous supply supporting continence is complex and shown to involve both somatic and autonomic contributions (17). Both the identification of denervation in men following RP, and the commonly observed delayed recovery of continence after RP, support denervation of the sphincter (as opposed to direct sphincteric injury) as a possible factor underlying PPI (17). Additional continence mechanisms are also thought to relate to additional anatomic structures and characteristics such as the puboprostatic ligaments and urethral length (18).

Indeed, the possible contributions to continence of these combined anatomic structures underlie numerous surgical modifications implemented to minimize PPI. These modifications include nerve-sparing techniques, preservation of urethral length, placement of a Rocco stitch prior to vesicourethral anastomosis, as well as puboprostatic ligament preservation (19-22). Although favorable rates of incontinence have been reported with these techniques, the AUA Guidelines state that "there is no current evidence that any surgical maneuvers, beyond bilateral neurovascular bundle preservation, results in improved continence recovery" (7).

Table 1 The search strategy summary

Items	Specification
Date of search (specified to date, month and year)	2/14/2022
Databases and other sources searched	Google Scholar, PubMed, Medline
Search terms used (including MeSH and free text search terms and filters)	Post-prostatectomy incontinence, pelvic muscle strengthening, Benign Prostatic Hyperplasia, Pelvic floor muscle training
Timeframe	1/1/2000–present
Inclusion and exclusion criteria (study type, language restrictions etc.)	• Inclusion criteria: ○ Study type: ▪ Randomized control trials ▪ Systematic reviews ○ Studies comparing PFMT to placebo ○ Studies comparing differences in PFMT protocols ○ Studies published within last 25 years • Exclusion criteria None
Selection process (who conducted the selection, whether it was conducted independently, how consensus was obtained, etc.)	References were independently selected by primary author and cross-selected by corresponding authors for consensus
Any additional considerations, if applicable	None

In contrast, there is data to support the benefit of PFMT in continence restoration (7,23). Further, it is recommended that clinicians offer PFMT to patients undergoing radical prostatectomy in the immediate post-operative period (7). This article reviews contemporary data available to understand how PFMT is used in the prevention and treatment of IFPS, with primary focus on PPI. We present the following article in accordance with the Narrative Review reporting checklist (available at https://tau.amegroups.com/article/view/10.21037/tau-22-143/rc).

Methods

A comprehensive literature search was conducted utilizing PubMed, Medline, and Google Scholar. Search strategy for articles utilized can be referenced in *Table 1*. Search criteria included systematic reviews and randomized control trials published in the year 2000 to present. References of resulting studies were further analyzed to identify further articles of relevance. Keywords searched included: "post-prostatectomy incontinence", "pelvic muscle strengthening", "Benign Prostatic Hyperplasia", and "pelvic floor muscle training". Peer-reviewed publications that demonstrated a novel addition to the existing body of literature on this subject were included.

Discussion

Management of IPT requires an understanding of the mechanisms for development of symptoms as well as the physiology of PFMT and variability amongst protocols. a non-invasive treatment strategy to treat combat this clinical issue, and has been recognized by medical associations globally and increasingly supported by large bodies of literature. Accordingly, many studies demonstrate a significant benefit of pelvic floor muscle training to continence status and quality of life in men with incontinence following prostate treatment. However, related research is limited by variety in treatment regimens, outcome measures, and study designs, with unclear impact on treatment success. This variability also complicates our understanding of appropriate treatment initiation, duration, and use across different pathologies (prostate cancer versus benign prostatic hyperplasia). This review accordingly highlights existing research to understand how PFMT is utilized in the treatment and prevention of incontinence following prostate surgery. We additionally provide a brief overview of current treatment regimens.

Physiology of PFMT in IPT

Broadly, the primary action of PFMT is through activation and strengthening of the pelvic floor musculature. PFMT is shown to increase muscle function parameters, including both strength and endurance (24). PFMT also increases muscle mass or bulk, which may serve to provide compressive actions to the urethra or bladder neck given the fixed space of the pelvis (25). Supporting evidence is seen in investigation utilizing pre- and post-operative MRI demonstrating that degree of pelvic floor muscle thickness is associated with recovery of continence following RP (15).

However, PFMT is shown to have numerous additional actions, including increased urethral resting pressure, extension of urethral functional length, and improved resting tension of levator ani complex (26). Biochemical actions are also seen, with randomized study demonstrating decreased myostatin concentrations in men undergoing PFMT after prostatectomy (27). Myostatin level increases in periods of skeletal muscle inactivity and is also proposed to inhibit external sphincter proliferation (27).

Although there is a paucity of data to understand the impact of PFMT on neurovascular physiology in men, research demonstrates that PFMT increases vascular flow in pelvic tissues (28). Given previously described research related to the impact of neurovascular bundle preservation on continence, such findings may suggest additional mechanisms of action through which PFMT may be beneficial.

PFMT outcomes

PFMT is widely considered an important part of the treatment algorithm in treatment of PPI, recognized as such by the AUA, SUFU, and EUA (7,29). Although numerous studies have demonstrated a positive impact from PFMT, understanding the true benefit is difficult given variability and methodologic weaknesses across studies. As detailed previously, reported studies lack standardization with respect to continence assessment or definition of success. This limitation may often be exacerbated by patient recall bias in their retrospective assessment of pre-operative continent status. Further, there is a lack of randomized controlled trials (RCT) or studies with sufficient sample size.

Within these limitations, multiple studies have demonstrated a benefit of PFMT to continence (23). These improvements are seen across multiple outcome measures, including 24-hr pad test, bladder diaries, and questionnaire assessments. The degree of benefit is also significant in numerous studies. For example, in a RCT Filocamo *et al.* reported continence in 96% versus 65% of patients undergoing early PFMT versus control at 6-month follow-up (30). Similarly, Manassero and colleagues reported persistent incontinence in 33% versus 60% of patients undergoing early PFMT versus control at 6-month follow-up (31). Finally, complete cure rates appear to be higher in patients receiving PFMT, with 76% of PFMT patients reporting 0 pad use at 6 months compared to 32% of age-matched controls. These results appear to be sustained at 12 months, with 89% of PFMT patients reporting complete dryness compared to 67% of controls (30).

Questions exist with respect to whether the positive impact of PFMT is durable. Certainly, there is significant data to suggest that PFMT results in improved continence rates in the early post-operative period (7,32). However, other studies demonstrate that continence rates at 1-year may be similar in comparison of patients receiving PFMT versus control (23). For this reason, it has been recommended that patient education highlight earlier return of continence with PFMT (7). That said, previously described randomized studies by both Filocamo and Manaserro demonstrate that differences between treatment and control arms are persistent through 12-month follow-up, supporting long-term benefit (30,31). Given this conflicting data, combined with the minimal risk of PFMT, it can be argued that long-term PFMT should be considered in patients undergoing RP.

In addition to continence outcomes, PFMT has been shown to benefit QOL and other well-being metrics. Outcomes measures reported in the assessment of PFMT following RP include MMSE and ICIQ modules and demonstrate favorable outcomes associated with PFMT (32). That said, an isolated study has shown that PFMT fails to improve QOL (33).

Much more limited data exists to understand the benefit of PFMT following other prostate surgeries. Study exploring the role of PFMT to treat incontinence following TURP have yielded mixed results. Porru *et al.*

assessed the use of pre-operative PFMT training with a post-operative home exercise program and demonstrated improvements in both pelvic muscle strength as well as QOL scores in patients receiving PFMT compared to controls (34). However, a 2011 study comparing rates of urinary incontinence in patients receiving one-on-one PFMT compared to those following general lifestyle recommendations demonstrated no statistically significant differences in subjective rates of urinary continence through 12-month follow up (35).

Similarly, studies examining the use of PFMT in patients undergoing HoLEP demonstrate an unclear benefit. One recent study compared continence rates between patients undergoing pre-operative pelvic floor muscle exercises (PFME) to those initiating PFME following surgery. While incontinence rates were significantly better in patients receiving pre-operative PFME at 3 months, no statistically significant differences were found between groups at any other point through 6-month follow up (36).

Technical considerations

The general shared goal of reported PFMT programs is to increase pelvic floor muscle strength. However, there are significant differences between protocols, including timing of initiation, treatment frequency, duration, and training regimen.

Treatment initiation

Reported studies include initiation of PFMT both prior to or after surgery, with findings suggesting a tangible benefit in continence outcomes and quality of life. Centemero and colleagues found improved early continence and QOL outcomes associated with pre-operative PFMT as compared to post-operative unsupervised PFMT (37). Such benefits were further validated in a 2019 study by Milios and colleagues, which demonstrated earlier return to continence, decreased 24-hour pad weight, and superior pelvic floor function measures in RP patients undergoing pre-operative PFMT compared to controls (38). Beyond potential outcomes differences, it is suggested that PFMT education may be easier pre-operatively. For this reason, the AUA Guideline recommends that PFMT may be offered to patients prior to RP (7). We have seen this in our practice as post-operative pain or other factors may make generalized education sessions more challenging.

Treatment frequency and duration

Upon review of the current literature, significant variation exists in both treatment frequency and duration. Reported programs generally involve the performance of PFMT daily or every other day, but also include regimens with greater breaks between treatment intervals (39,40). In addition, while many regimens recommend once daily PFMT, others involve more frequent sessions (2–3 times daily). Similarly, available literature demonstrates great variability in the duration of PFMT, which generally range from 1 to 12 months (23,32,35,40). Limited data exists to understand whether treatment duration impacts continence outcomes.

Irrespective of PFMT duration, close follow-up of continence outcomes is critical to ensure that patients can be offered additional treatment options when necessary. Given the gradual improvement of continence commonly observed following RP, deferment of surgical intervention for continence has been historically delayed until after 12-month follow-up. However, a more recent study demonstrates that a more limited number of RP patients will regain continence after 6-month follow-up, and supports the Guideline recommendation that patients with severe incontinence or those experiencing lack of symptom improvement at 6 months should be offered surgical intervention (7,41). Despite these recommendations, a recent retrospective analysis reveals that the majority of patients will not undergo a surgical procedure until 24 months following RP (42). Combined, these data highlight the importance of close follow-up of continence status even in patients undergoing PFMT regimens of longer duration.

Treatment regimen

Similarly, PFMT regimen protocols vary considerably (32). While some regimens include maximal contractions, others may recommend submaximal contractions. Similarly, some regimens place a focus on sustained contractions, while others emphasize quick contractions. and exercise positions (supine, sitting, standing). There is also variability in optimal exercise position including supine, standing, or sitting. In addition, some PFMT regimens may emphasize supplementary physiotherapy techniques such as stretching exercises, while others may not.

Treatment supervision

Various forms of treatment supervision are available to aid in muscle identification and patient instruction. Accordingly, various forms of biofeedback have been commonly used at program initiation to help facilitate proper muscle identification and recruitment (23). Although limited data exists to understand the impact of these tools on IPT, systematic analysis has identified that the use of biofeedback may be predictive of successful outcomes (43).

In addition, the use of supervised versus unsupervised PFMT throughout the program itself is an important consideration that may impact outcomes. Supervised PFMT most commonly involves in-person visits to assess both subjective outcomes and muscle strength, as well as reinforce educational training. Beyond these direct benefits, such supervision may also aid in treatment compliance.

Once again, limited data exists to understand the impact of PFMT supervision. In a systematic review, Baumann *et al.* reported that PFMT had a beneficial effect on urinary incontinence, with risk differences ranging from 12% to 25% (44). These differences were seen through 6 months following surgery. Nilssen and colleagues reported that physiotherapist-guided PFMT (versus control) improved post-operative continence but not QOL (33). Irrespective of the benefit of supervised PFMT, it is important that unsupervised training be optimized through the development of robust educational resources that facilitate proper muscle identification. In a study by Stafford and colleagues, transperineal ultrasound was utilized in combination with MRI imaging to further understand displacement of pelvic floor muscle displacement. Their findings demonstrated muscle displacement patterns consistent with those previously validated in women, in addition to novel muscle actions of the striated urethral sphincter and bulbocavernosus muscle specific to men (45). Such research has helped shape physiotherapy approaches in supervised PFMT protocols.

Other considerations

Given the benefits of PFMT in the treatment of IPT, one clinical question worth considering is whether PFMT in combination with an anti-incontinence surgery (AIS) may be beneficial. Such treatment may be appropriate as an adjunct to AIS to potentially improve outcomes or as a method of addressing recurrent or persistent SUI following AIS. Although there is a paucity of data to explore this question, data focused on female SUI may provide insight. Accordingly, one recent multi-institutional clinical investigation randomized women with SUI into groups treated with mid-urethral sling in combination with PFMT versus surgery alone with 12-month follow-up. These authors demonstrated a statistically significant difference in reported incontinence symptoms for patients receiving combination PFMT (46). Similarly, PFMT is the most commonly offered treatment for recurrent SUI following prior anti-incontinence surgery although success rates are not known (47). An understanding of the efficacy of PFMT in men with recurrent SUI following AIS would helpful, especially given that a large number of these patients with persistent bothersome incontinence often consider surgical revision or an alternative surgical procedure (48).

Role of PFMT in urge urinary incontinence

Although SUI is the predominant form of incontinence to occur following prostate surgery, *de novo* or worsening urge urinary incontinence (UUI) may also occur, globally manifesting as a syndrome of overactive bladder (OAB). The incidence of *de novo* OAB following RP has been reported in the range of 19% to 37% (49,50). As expected, studies reporting on the incidence of irritative symptoms also demonstrate significantly worse short-term overall continence rates in patients who develop *de novo* OAB following RP as compared to those who do not (50). Thus, *de novo* OAB following RP is not only a common sequela following RP, but also one that may significantly impact QOL.

Development of these symptoms are not exclusive to RP. Available literature highlights a 10% incidence of development of *de novo* UUI following TURP (51). Further, worsening UUI after TURP may occur, although these findings are complicated by the fact that pre-existing detrusor overactivity (DO) has been shown to be concomitantly present up to 50% of men with bladder outlet obstruction (BOO) and will persist in approximately 20% to 40% of men following TURP (52,53).

The etiology for the development of these symptoms is likely multifactorial in nature. Historically, the pathophysiology of OAB has been thought to relate to DO. Indeed, urodynamic assessment of post-prostatectomy patients have demonstrated a high prevalence of uninhibited detrusor contractions. The pathophysiology of DO development due to RP is unclear and could occur through direct or secondary processes. For example, one secondary etiology that has been proposed is via a urethrogenic mechanism related to intrinsic sphincter deficiency. Based on prior animal models, entry of urine into the proximal urethra is found to result in a micturition reflex, prompting detrusor contractions (54). Thus, patients with SUI may stimulate afferent nerves resulting in DO with OAB symptoms. This theory was confirmed in a recent study which demonstrated that patients with low baseline maximum urethral closure pressures (MUCP) in combination with subsequent further decreases in post-operative MUCP served as a strong predictor for development of *de novo* OAB (50).

In patients who have undergone surgery for BPH, the pathophysiology is complicated by an often concurrent presence of pre-operative DO related to obstruction. A predominant mechanism posed by the scientific community is that detrusor hypertrophy secondary to BOO results in abnormal afferent and efferent signaling (55). In addition, similar to RP, *de novo* mechanisms relate to surgery itself may contribute to OAB symptoms. Regardless, given that OAB and BPH and commonly seen together, an understanding of the comprehensive treatment of both conditions is critical to achieve successful outcomes.

Combined, given the incidence and mechanism of OAB occurring following prostate surgery, understanding the role of PFMT in regimens is important. A discussion of the differences in PFMT regimens for UUI is outside the review focus. Nonetheless, it is important to note that investigations assessing the use of PFMT in patients with persistent urge incontinence at 1 to 7 years following RP, demonstrate a 55% improvement in symptoms compared to matched controls (56). Combined, these data highlight the need to also follow OAB symptoms following prostate surgery and to encourage more research to understand the role of PFMT in their treatment.

Future avenues and conclusion

Upon review of the current research landscape, PFMT is largely supported in treatment of IPT. While data suggests factors such as earlier treatment initiation may lead to improved outcomes, heterogeneity in protocols, measures of treatment success, and patient numbers lead to an unclear understanding of the true impact of such factors. Nevertheless, benefits to continence and QOL are noted across an expansive body of literature and as such, PFMT is recommended by the AUA and EUA as an important part of the treatment algorithm for PPI. Additional research is needed to more extensively assess PFMT's role in treating IPT, particularly following surgery for BPH. Further, research to understand the role of adjunctive PFMT or as primary treatment for UUI in men with IPT may be helpful in reshaping current treatment paradigms.

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Footnote

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