Bridging the gap: pelvic floor physical therapy in the treatment of chronic anal fissure

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CHAPTER 3

Pelvic floor physical therapy for pelvic floor hypertonicity: A systematic review of treatment efficacy

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Abstract

Background

Hypertonicity of the pelvic floor (PFH)[1] is a disabling condition with urological, gynaecological, and gastrointestinal symptoms, sexual problems, and chronic pelvic pain, impacting quality of life. Pelvic floor physical therapy (PFPT) is a first-line intervention, yet no systematic review on the efficacy of PFPT for the treatment of PFH has been conducted.

Objectives

To systematically appraise the current literature on efficacy of PFPT modalities related to PFH.

Methods

PubMed, Embase, Emcare, Web of Science and Cochrane databases were searched from inception until February 2020. A manual search from reference lists of included articles was performed. Ongoing trials were reviewed using clinicaltrial.gov. Randomized controlled trials (RCTs), prospective - and retrospective cohorts and case-study analyses were included.

Outcome measures were pelvic floor muscle tone and function, pain reports, sexual function, pelvic floor symptom scores, quality of life and patient's perceived effect.

Results

The literature search resulted in 10 eligible studies including 4 RCTs, 5 prospective studies and 1 case study published between 2000 and 2019. Most studies had a high risk of bias associated with the lack of a comparison group, insufficient sample sizes and non-standardized interventions. Six studies were of low and 4 of medium quality. All studies were narratively reviewed. Three of 4 RCTs found positive effects of PFPT compared to controls on five out of 6 outcome measures. The prospective studies found significant improvements in all outcome measures that were assessed. PFPT seems to be efficacious in patients with chronic prostatitis, chronic pelvic pain syndrome, vulvodynia, and dyspareunia. Smallest effects were seen in patients with interstitial cystitis and painful bladder syndrome.

Conclusion

The findings of this systematic review suggest that PFPT can be beneficial in patients with PFH. Further high-quality RCTs should be undertaken to confirm the effectiveness of PFPT in the treatment of PFH.

[1]An update on the terminology by the International Continence Society was conducted and published in 2021 after this systematic review. 'Hypertonicity' is changed into 'increased pelvic floor muscle tone' and is further used in this thesis.
Frawley H, Shelly B, Morin M, et al. An International Continence Society (ICS) report on the terminology for pelvic floor muscle assessment. Neurourol Urodyn. Jun 2021;40(5):1217-1260.

Introduction

The pelvic floor is a multifunctional complex of muscle fibers, fascia, ligaments, and connective tissue that form a hammock at the bottom of the abdomino-pelvic cavity. The muscles of the pelvic floor consist of superficial muscles including the m. bulbospongiosus, m. ischiocavernosus, the perineal muscles and external anal sphincter muscle. The deep pelvic floor muscles are the levator ani composed of the puborectalis, pubococcygeus and iliococcygeus. The pelvic floor provides anatomical support for the pelvic and abdominal viscera and is involved in urinary, defecatory and sexual function.[1-4] The pelvic floor is capable of generating and controlling intra-abdominal pressure together with other muscles surrounding the abdominal cavity and contributes to lumbar spine stiffness.[5,6]

Pelvic floor hypertonicity (PFH) is often associated with urological, gynaecological, gastrointestinal, and sexual problems as well as chronic pelvic pain. Prevalence ranges from 50-90%.[7,8] These complaints have a profound impact on quality of life.[9-12]

Several terms are used for PFH in the literature, such as pelvic floor spasm, non-relaxing pelvic floor, and overactivity. Currently, the International Urogynecological Association (IUGA)/International Continence Society (ICS) defines the term "non-neurogenic hypertonicity" as an increase in muscle tone related to the contractile or viscoelastic components that can be associated with either elevated contractile activity and/or passive stiffness in the muscle.[13] In addition, the hypertonic muscle tissue may contain myofascial trigger points (MTrPs).[14] A MTrP is a discrete, hyperirritable nodule in a taut band of a skeletal muscle which is palpable and tender during physical examination. An active MTrP is clinically associated with spontaneous pain in the surrounding tissue and/or to distant sites in specific referred pain patterns.[15,16]

PFH can be a primary problem or a secondary adaptation to an acute or chronic injury to one or more musculoskeletal components in the pelvic floor and surrounding structures. Pelvic surgery, traumatic vaginal delivery, traumatic injury of the back or pelvis, gait disturbances, pelvic pain, experienced threat and (chronic) stress are found to be associated with PFH.[17-20]

PFH is assumed to be related to learned behaviour, otherwise acquired in adulthood through voluntary holding to inhibit micturition or defecation or to avoid incontinence. This might be related to habit, lifestyle and/or stressful occupation.[9]

A history of physical or sexual abuse or insecure attachment is common among women with PFH and is associated with impaired sexual arousal, desire, and orgasm.[21,22]

Laan et al.[23] conceptualized PFH as a symptom of chronic activation of the defensive

stress-system and should thus be regarded as a physical manifestation of emotional dysregulation.

Clinically, PFH is diagnosed by digital palpation of the pelvic floor. This includes assessment of muscle tone (resistance provided by a muscle when a pressure or a stretch is applied to it) and muscle function (voluntary contractility, strength, endurance, repeatability, co-contraction, and relaxation ability).[8,13,24,25]

There is no single accepted or standardized way of measuring muscle tone and there are no normative values.[13] Digital palpation can be combined with the use of surface electromyography (s-EMG) and dynamometry.[8,26] To access pain and MTrPs, patient-reported outcome measures can be used and include numerical rating scales, visual analog scales (VAS) [27,28] and simple verbal pain rating scales.[13]

Pelvic floor physical therapy (PFPT) is considered to be an important part of treatment of PFH and includes strategies to optimize lumbopelvic, spinal and pelvic floor muscle function and to improve urinary, defecatory and sexual function.[29-31] The aim of PFPT for PFH is to increase awareness and proprioception, to improve muscle relaxation and elasticity of the pelvic floor and to reduce pain. Interventions consist of education about the pelvic floor and related symptoms, behavioural modifications, exercises aimed at pelvic floor awareness and relaxation combined with soft-tissue manipulation and myofascial release.[30,32-35] Another frequently used treatment modality is s-EMG to register pelvic floor muscle activation with intravaginal or-anal electrode probes.[36,37] Electrogalvanic stimulation is used to improve muscle proprioception and relaxation of the pelvic floor muscles and is used as form of neuromodulation for pain relief.[38-41]

To date, efficacy of this range of treatments is not yet well established. Investigation by systematically reviewing the effectiveness of PFPT for PFH as a stand-alone entity has not yet been performed. The goal of this review was to systematically appraise the current literature on the effectiveness of PFPT for the treatment of PFH.

Material and Methods

Search strategy

This systematic review adhered to guidelines detailed in the Preferred reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement.[42]

A comprehensive literature search was conducted using the following electronic databases: MEDLINE, Embase, Emcare, and the Cochrane Central Register of Controlled Trials (Wiley Interface, current issue) from inception until February 2020.

Protocol registry (http://www.clinicaltrials.gov) was screened for upcoming trials. The search strategy was developed by a health science librarian with experience in systematic review searching. Different relevant search terms (thesaurus terms and terms in title, abstract or both) concerning PFH and PFPT were used. The following medical subject headings and text words were used: hypertonicity of the pelvic floor, overactive pelvic floor, non-relaxing pelvic floor, micturition disorder, defecation disorder, sexual dysfunction, chronic pelvic pain, physical therapy, myofeedback and electrogalvanic stimulation. The reference lists of eligible studies and relevant systematic reviews were searched for additional articles that were not found in the main search. Search strings are listed in Appendix 1.

Inclusion and exclusion criteria

Randomized control trials (RCTs), cross-over studies, prospective and retrospective cohort studies and case studies involving PFPT in patients with PFH were included in the review. Inclusion criteria were men and/or women (>18 years) with pelvic floor problems and complaints suggestive of PFH; muscle tone diagnosed by palpation and/or s-EMG; adequate description of the intervention. Studies with the following outcome measures were eligible: pelvic floor muscle tone, pain, sexual function, quality of life, pelvic floor symptoms and patient's perceived effect. Studies had to be original, available as full-text and written in English. Studies with patients with neurological diseases, low pelvic floor muscle tone, medication, surgery, sacral neuromodulation, and percutaneous tibial nerve stimulation were excluded.

Data collection and analysis

Two authors independently selected studies by screening titles and abstracts followed by full text screening. Any discrepancies were resolved by discussion until consensus. The following data were extracted: first author, year of publication, country, inclusion and exclusion criteria, sample size, participants characteristics (such as age, gender, sample size), study design, details of the pelvic floor interventions, outcomes measurements, and outcome. Level of bias was evaluated using the Cochrane Collaboration's Risk of Bias criteria. For each of these risk domains, studies were categorized as at low, uncertain, or high risk of bias based on random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective outcome reporting and other bias.[43]

Outcome measures

All outcome measures of included studies are listed in Table 1.

Table 1. Outcome measures

Muscle tone and function	◊ Modified Oxford-scale[50] ◊ 7-point digital palpation scale muscle tone (-3 to +3)[45] ◊ 4-point digital palpation score for muscle flexibility and muscle relaxation (0-4)[45] ◊ Vulvalgesiometer [45] ◊ Rest s-EMG-values[44,45,48] ◊ Modified Oxford-scale (0-5)[45,46] ◊ The New PERFECT-scale [48]
Pain	◊ Digital palpation of the pelvic floor muscles (levator, obturator internus, diaphragm urogenital) [51] ◊ Visual analog scales (VAS)[35,46,47,49] ◊ the National Institutes of Health-Chronic Prostatitis Symptom Index (NIH-CPSI)[35,44,49,51] ◊ Pelvic pain symptom scale (PPSS)[35,49] ◊ Likert visual analog scale[50-52] ◊ VAS-scores to assess vulvar pain[45] ◊ Degree of pain during sexual intercourse[48]
Sexual Function	◊ Female Sexual Function Index (FSFI)[46,48,51,52] ◊ Cervantes scale measuring sexual response cycle on Quality of Life (QoL)[48] ◊ Sexual health domain of the PPSS[35,49] ◊ Sexual Health Inventory for Men (SHIM)[51]
Pelvic floor symptoms	◊ O'Leary-Sant IC Symptom/Problem Index (ICSI/ICPI)[50-52] ◊ NIH-CPSI [35,44,49,51] ◊ American Urological Association (AUA) symptom and bother score[47] ◊ VAS-urgency[47] ◊ Likert visual analog scale urgency[50,52] ◊ Likert visual analog scale frequency[52] ◊ Pelvic pain symptom scale (PPSS)[35,49]
Quality of life	◊ Cervantes QoL[48] ◊ VAS-QoL[45] ◊ NIH-CPSI domain QoL[35,44,49,51] ◊ 12-item Short Form survey (SF-12)[50-52]
Patient's perceived effect	◊ Global Response Assessment (GRA)[35,49,51,52]

Treatments

The duration of treatment varied between 5-12 sessions, with sessions lasting between 30-75 minutes, over a period varying from 5 days to 3 months. PFPT protocols in the studies consisted of at least 3 of the following interventions: education about anatomy and function of the pelvic floor and related symptoms;[44-47] digital vaginal palpation of the pelvic floor for proprioception and to guide home exercises;[46,48] manual techniques to release MTrPs of the pelvic floor and soft-tissue massage, including stretching,

external manipulation of the pelvic floor and surrounding muscles;[35,45,46,48-52] insertion techniques using dilatators,[45] muscle exercises focused on awareness and relaxation;[35,44,46,48,49,51,52] infrared thermotherapy,[48] home exercises[35,45-49,51,52] and bladder training.[47] Four studies used s-EMG[44,45,47,48] and 2 studies used electrogalvanic stimulation.[45,46] Treatment in the control-arm of the 4 RCTs consisted of no-treatment,[46] western massage of lower back muscles,[51,52] heat applied to lower back and myofascial release of the abdominal diaphragm, piriformis and iliopsoas muscles.[48]

Results

Search results

In total, 570 studies were identified through electronic searches of which 237 duplicates were removed. Of the remaining 333 studies, 298 were excluded based on title and abstract screening. Thirty-five references were read in full, after which 25 references were excluded (see Figure 1 for exclusion reasons). A total of 10 studies met the inclusion criteria. Four studies were RCTs,[46,48,51,52] there was one case study[35] and 5 prospective cohort studies.[44,45,47,49,50] No ongoing studies were found. Studies represented a total of 581 participants, samples sizes in the studies varied from 19 to 138 patients. Patients with sexual problems were investigated in 2 RCTs[46,48] and in one prospective cohort study.[45] These studies involved patients with dyspareunia and provoked vestibulodynia (PVD). Patients with interstitial cystitis and painful bladder syndrome (IC/PBS) were investigated in 2 RCTs[51,52] and 1 prospective study.[50] Patients with chronic prostatitis and chronic pelvic pain syndrome (CP/CPPS) were studied in one RCT,[51] 3 prospective studies[44,47,49] and in the case study.[35] Given the marked heterogeneity of the studies, with different indications, outcome measurements and interventions, all studies were narratively reviewed.

Study quality assessment

A summary of study design, patient characteristics, sample size, interventions, outcome assessments and findings are listed in Table 2.

The quality assessment (see Figure 2) related to selection bias indicated a high risk of bias for six studies due to the absence of randomization or a comparison group. Blinding of participants and personnel for treatment received was feasible in none of the studies. Blinding of outcome assessment was at high risk in eight studies.[35,44-48,50,51]

Attrition bias (dropout) was high in three studies.[35,47,50] Risk of reporting bias was high due to insufficient information about the exact treatment protocol in two studies,[35,50] and high due to insufficient information about interpretation of the results.[52] Eight of the 10 studies described their treatment protocols in detail.[44-49,51,52] Sample-size calculation was reported in the 4 RCTs.[46,48,51,52] Other risks of bias concerned loss of funding or insurance to complete the study. We considered six studies to be of low quality, with only zero to two low bias risks.[35,44,45,47,49,50] The other four studies were of medium quality.[46,48,51,52]

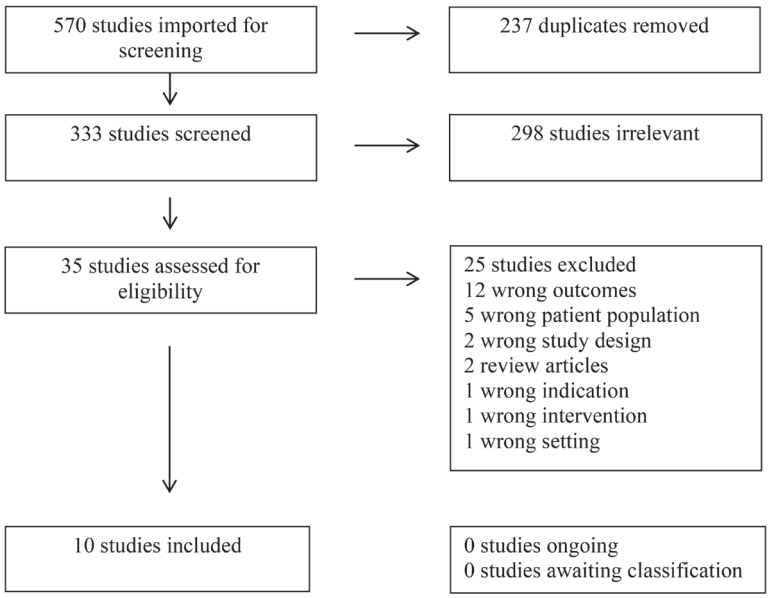

Figure 1. PRISMA flowchart

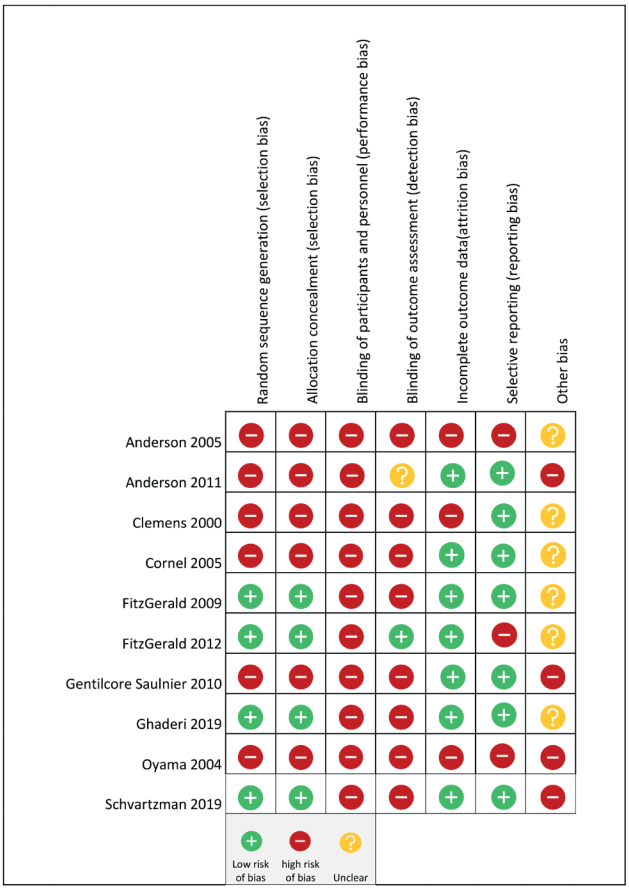

Figure 2. Risk of bias assessment

Outcome assessments

Pelvic floor muscle resting tone and function

Changes in muscle tone as a result of PFPT were directly measured in one RCT[48] and in 3 prospective cohort studies.[44,45,50] The RCT[48] involved patients with dyspareunia and found that PFPT did not significantly decrease resting activity from baseline to post-treatment using s-EMG. In one prospective study[44] in men with CPPS, the mean value of the muscle tone measured with s-EMG decreased significantly from pre- to post-treatment. The second prospective cohort study[45] in women with PVD found a significant reduction in muscle tone, measured with the 7-point digital palpation scale,

a significant increase from pre- to post-treatment in pelvic floor muscle flexibility and in the ability to relax the pelvic floor muscles after contraction measured with 4-point digital palpation scale. S-EMG demonstrated a higher tonic rest activity at pre-treatment in the superficial layer of pelvic floor muscles in the patient group compared to controls but not in the deeper layer of the pelvic floor muscles. The last prospective study[50] in women with IC showed significant improvement in muscle tone after PFPT in all pelvic floor muscles except for the coccygeus, using the modified Oxford Scale. Pelvic floor muscle function was measured in 2 RCTs[46,48] and one prospective study.[45] One RCT[48] involving patients with dyspareunia found that PFPT significantly increased sustained contractions from baseline to post-treatment and the number of peaks were significantly higher in the PFPT-group using s-EMG and compared to control who received heat applied to lower back and myofascial release of the abdominal diaphragm, piriformis and iliopsoas muscle. A significant improvement was found in post-treatment pelvic floor muscle function measured with New-PERFECT scores in the PFPT- group and relative to baseline. The second RCT[46] involved patients with dyspareunia and found significant improvement in pelvic floor muscle strength and endurance in the PFPT group in comparison with a no-treatment control group using the modified Oxford-scale. One prospective cohort study[45] found a significant increase in pelvic floor muscle strength from pre-to post-treatment but not compared to control measured with the modified Oxford scale.

Pain

Pain scores were assessed in all studies. In one RCT[51] in patients with CP/CPPS and IC/PBS, PFPT resulted in significant relief of tenderness/pain in 4 muscle groups (levator ani posterior and anterior, obturator internus and urogenital diaphragm) from pre-to post-treatment in both groups measured with digital examination. In the IC/PBS group a significant relief of tenderness/pain was found compared to controls who received full body global therapeutic massage. This study also found reduced pain scores measured with Likert pelvic pain score to be significantly reduced from pre-to post-treatment in both groups but not compared to controls. The second RCT[48] found a significant reduction in post-treatment dyspareunia pain scores using VAS in the PFPT group relative to controls. The third RCT[46] found post-treatment VAS pain scores in the genital area before, during, and after vaginal intercourse to be significantly decreased compared to no-treatment controls, which sustained after

follow-up of three months. Only 1 RCT[52] was unable to show a decrease in pelvic/bladder discomfort and/or pain after PFPT compared to controls who received full body global therapeutic massage. One prospective study[50] in women with IC, found a significant decrease in pelvic pain measured with Likert scores compared to baseline. The second prospective cohort study,[45] in women with PVD demonstrated significant reduce of pain in the superficial pelvic floor muscles to a painful pressure stimulus induced with a vulvalgesiometer. Vulvar pain intensity ratings were also significantly decreased after treatment and no longer differed from non-affected controls. The third prospective study,[47] in men with CPPS, found significantly lower pelvic pain-scores after PFPT measured with VAS. The fourth prospective study[44] in men with CP/CPPS found a significant decrease in the subdomain pain of the National Institutes of Health-Chronic Prostatitis Symptom Index (NIH-CPSI) after PFPT. The fifth prospective study[49] in men with CP/CPPS also found significant improvement in pain from pre- to post-treatment in the subdomain of the NIH-CPSI and Pelvic Pain Symptom Scale (PPSS). Finally, the case study[35] demonstrated a more than 25% reduction in pelvic pain symptom scores using VAS-scores.

Sexual function

Sexual function was investigated in all 4 RCTs,[46,48,51,52] in one prospective study[49] and the case study.[35] One RCT[51] found significantly higher post-treatment Female Sexual Function Index (FSFI) total scores for women in the IC/PBS patient group compared to pre-treatment, no significant differences were found relative to control. In men with CP/CPSS, no significant differences in sexual function were found from pre-to post-treatment and relative to controls using the Sexual Health Inventory for Men. In the second RCT[52] no significant changes in FSFI total scores were observed from pre-to post-treatment, the same was true for controls. In the third RCT[46] in women with dyspareunia, the FSFI total scores were significantly improved after PFPT compared to no treatment controls. In the fourth RCT[48] in women with dyspareunia, the FSFI-scores improved significantly from pre-to post-treatment, FSFI-lubrication and pain improved significantly compared to controls. Cervantes QoL-sexuality improved significantly from pre-to post-treatment but not compared to controls. The prospective study[49] found significant improvement in sexual function measured with the sexual health domain of the PPSS. The case study[35] demonstrated an improvement in sexual function measured with PPSS of more than 50% in 51% of the patients after PFPT.

Improvement of pelvic floor symptoms

Symptom improvement was investigated in 2 RCTs,[51,52] 4 prospective studies[44,47,49,50] and the case study.[35] One RCT[51] found equal and significant improvement in urinary symptoms in the CP/CPSS group measured with the NIH-CPSI. Interstitial Cystitis Symptom Index/Interstitial Cystitis Problem (ICSI/ICPI) scores also showed improvement in urinary symptoms but only in the IC/PBS patient group. Another RCT[52] was unable to demonstrate a decrease in urgency and frequency ratings and ICSI/ICPI scores after PFPT. In a prospective study[49] in patients with CP/CPPS, NIH-CPSI total scores significantly decreased with approximately 30% after treatment. The second prospective study[44] in CP/CPPS patients showed significant symptom improvement in the subdomain NIH-CPSI-micturition. The third prospective study[47] found significant improvement in the American Urological Association Symptom and Bother Score and VAS urgency and VAS voiding frequency scores in patients with CP/CPPS. Significant improvement in symptoms measured with ICSI/ICPI was seen in the fourth prospective study[50] in patients with IC. At long-term follow-up, the improvement in ICPI and ICSI scores remained statistically significant. The case study[35] found that overall 72% of patients reported marked (46%) or moderate (26%) improvement after PFPT. Urinary symptoms decreased significantly in patients reporting marked improvements. More than half of the patients treated with PFPT had a 25% or greater decrease in urinary symptom scores, as assessed by the PPSS.

Quality of life

Quality of life was measured in 3 RCTs,[48,51,52] and 4 prospective studies[44,45,49,50] and the case study.[35] One RCT[48] in patients with dyspareunia found significant improvement in QoL from pre-to post-treatment but not compared to controls measured with the Cervantes scale. Another RCT[52] in IC/PBS patients found no significant improvement relative to controls in quality of life using the 12-item Short Form Survey (SF-12). In the RCT[51] with CP/CPPS and IC/PBS patients no differences were found between treatment groups in the QoL-domain of the SF-12, whereas a significant pre-post treatment improvement was found using both the SF-12 and NIH-CPSI, but in the CP/CPPS group only. One prospective study[45] found a significant decrease in the perceived negative impact of PVD on QoL measured with a VAS-scale. Two prospective studies[44,49] in men with CP/CPPS found a significant improvement in the NIH-CPSI subdomain QoL scores. Another prospective study[50] in women with

IC showed significant improvements in the physical component summary score and mental component summary score of the SF-12. The case study[35] found significant improvement in quality of life domain of the NIH-CPSI after PFPT.

Patients' perceived effect

Patients' perceived effect was measured in 2 RCTs[51,52] one prospective study[49] and the case study.[35] In a RCT[52] comparing PFPT with lower back massage, a significantly larger proportion of patients than controls reported having benefited from treatment (59% vs 26%, respectively). Likewise, another RCT[51] found a significantly larger proportion of patients (57%) reporting benefit relative to controls (21%). In one prospective study,[49] 59% of the patients with CP/CPPS reported symptoms as moderately or markedly improved. In the case study,[35] 72% of patients had higher global response assessment scores indicating global improvement.

Table 2. Study characteristics of the included studies.

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
Fitzgerald et al.(2009)	RCT N=47	Women and men with IC/PBS and CP/CPPS PFPT: 41.1(11.4) Controls: 44.9(14.0)	PFPT Internal(pelvic) and external MTrP and connective tissue manipulation PF, hip girdle and abdomen Neuromuscular education Proprioceptive awareness exercises/ home exercises	PF digital palpation tenderness/pain	Pre-to post-treatment: IC/PBS (p<.001) CP/CPPS (p<.001) PFPT vs control: IC/PBS (p<.05) CP/CPPS: ns
			Control Full body Western massage	Likert pelvic pain	Pre-to post-treatment: IC/PBS (p<.01) CP/CPPS (p<.001) PFPT vs control: IC/PBS: ns CP/CPPS: ns
			10 weekly 1-hour sessions	NIH-pain	Pre-to post-treatment: CP/CPPS (p<.001) PFPT vs control: ns
				SHIM	Pre-to post-treatment:ns PFPT vs control:ns
				FSFI	Pre-to post-treatment: IC/PBS (p<.01) PFPT vs control: ns
				ICSI	Pre-to post-treatment: IC/PBS (p<.05) CP/CPPS (p<.01) PFPT vs control: IC/PBS (p<.05) CP/CPPS ns

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
				ICPI	Pre-to post-treatment: IC/PBS (p<.01) CP/CPPS (p<.01) PFPT vs control: IC/PBS (p<.05) CP/CPPS: ns
				NIH-CPSI total	Pre-to post-treatment: CP/CPPS (p<.001) PFPT vs control: ns
				NIH-urinary	Pre-to post-treatment: CP/CPPS (p<.001) PFPT vs control (p<.01)
				NIH- QoL	Pre-to post-treatment: CP/CPPS (p<.05) PFPT vs control: ns
				Likert urinary urgency score	Pre-to post-treatment: IC/PBS (p<.01) PFPT vs control: ns
				Likert urinary frequency score	Pre-to post-treatment: IC/PBS (p<.05) PFPT vs control: ns

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
				SF-12 physical scale	Pre-to post-treatment: IC/PBS ns CP/CPPS (p<.05) PFPT vs control: IC/PBS ns CP/CPPS ns
				SF-12 mental scale	Pre-to post-treatment: IC/PBS ns CP/CPPS ns PFPT vs control: IC/PBS ns CP/CPPS ns
				GRA	PFPT vs control: IC/PBS (p<.05) CP/CPPS ns
Schvartz-man et al.(2019)	RCT N=42	Pre- and postmenopausal women with dyspareunia PFPT: 51.9 (5.3) Controls: 50.6 (4.7)	PFPT PF digital palpation using NEW PERFECT scale Myofascial release PF PF infrared thermotherapy Hold/relax exercises Myofascial release of abdominal diaphragm, piriformis and iliopsoas S-EMG biofeedback training	New PERFECT scale	Pre-to post-treatment: P-mean (p<001) E-mean (p<.001) R-mean (p<.001) F-mean (p<.001) E-mean: NA C-mean (p≤.001) T-mean: ns PFPT vs control: P-mean (p<.005) E-mean (p<.005) R-mean (p<.05) F-mean (p<.01) E-mean: NA C-mean (p<.001) T-mean: (p<.05)

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
			Control Heat applied to lower back and myofascial release of abdominal diaphragm, piriformis, m. iliopsoas	S-EMG resting tone (uV)	Pre-to post-treatment ns
				S-EMG sustained contraction duration	PFPT vs control ns Pre-to post-treatment ns
			7 one-hour sessions	VAS pain during sexual intercourse	PFPT vs control (p< .05) Pre-to post-treatment p<.001 PFPT vs control p<.001
				FSFI	Pre-to post-treatment: Desire (p<.05) Arousal (p<.05) Lubrication (p<.05) Orgasm (p<.001) Satisfaction (p<.001) Pain (p<.001) Total Score (p<.001) PFPT vs control: Desire ns Arousal ns Lubrication (p<.05) Orgasm ns Satisfaction ns Pain (p<.05) Total Score ns

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
				Cervantes QoL	Pre-to post-treatment: Menopause Health (p<.001) Sexuality (p<.001) Couple relationship ns Physical ns Total Score (p<.001) PFPT vs control: Menopause Health ns Sexuality ns Couple relationship ns Physical ns Total Score ns
Ghaderi et al.(2019)	RCT N=64	Premenopausal women with dyspareunia PFPT: 34.9 (9.2) Controls: 35.7 (8.0)	PFPT Explanation of pelvic anatomy and function PF digital palpation proprioception Manual techniques PF Intravaginal EGS (110Hz, 80ms) PF home exercises	Modified Oxford -scale	PFPT vs control: PF muscle strength: (p<.001) PF muscle endurance (p<.05)
			Control No treatment	VAS pain	PFPT vs control: (p<.05) Significant difference remains at 3-months follow-up
			10 sessions in 3 months	FSFI	PFPT vs control: Desire (p<.05) Arousal (p<.05) Lubrication (p<.05) Orgasm (p<.05) Satisfaction (p<.05) Pain (p<.05) Total Score (p<.05)

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
Fitzgerald et al. (2012)	RCT N=81	Women with IC/ PBS PFPT: 43.1 (15.1) Controls: 43.0 (12.9)	PFPT Internal(pelvic) and external MTrP and connective tissue manipulation PF, hip girdle and abdomen Neuromuscular education Proprioceptive awareness exercises/ home exercises	Likert bladder pain score	PFPT vs controls ns
				FSFI Total Score	PFPT vs controls ns
			Control Full body global therapeutic massage		
			10 weekly 1-hour sessions	ICSI	PFPT vs controls ns
				ICPI	PFPT vs controls ns
				Likert urgency score	PFPT vs controls ns
				Likert frequency score	PFPT vs controls ns
				SF-12 physical scale	PFPT vs control ns
				SF-12 mental scale	PFPT vs control ns
				GRA	PFPT vs control ($p<.005$)

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
Gentilcore –Saulnier et al.(2010)	Prospective cohort study N=22	Women with and without PVD PFPT: 22.0 (2.0) Controls: 21.0 (1.0)	PFPT Explanation of pelvic anatomy and function Digital intravaginal techniques Insertion techniques using dilatators S-EMG- biofeedback training and EGS (15Hz,250msec) PF home exercises and dilator insertion	Vaginal palpation general tone	Pre-treatment group difference (p<.05) Post-treatment group difference ns PFPT pre-post-treatment (p<.01)
			Control No treatment	Vaginal palpation flexibility at the vaginal opening	Pre-treatment group difference (p<.01) Post-treatment group difference ns PFPT pre-post-treatment (p<.01)
			8 one-hour treatments in 12 weeks	Vaginal palpation relaxation capacity after contraction	Pre-treatment group difference (p<.05) Post-treatment group difference ns PFPT pre-post-treatment (p<.05)

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
				Vaginal palpation strength	Pre-treatment group difference ns Post-treatment group difference ns PFPT pre-post-treatment ($p<.05$)
				S-EMG PFM tonic activity at rest	
				Deep PF muscles	Pre-treatment group difference ns Post-treatment group difference ns PFPT pre-post-treatment ns
				Superficial PF muscles	Pre-treatment group difference ($p<.05$) Post-treatment group difference ns PFPT pre-post-treatment ns
				S-EMG PF maximum voluntary contractile activity	Pre-treatment group difference ns Post-treatment group difference ns PFPT pre-post-treatment ns

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
				S-EMG At rest and during painful pressure stimulus	Pre-treatment group difference ($p<.005$)
					Post-treatment group difference ns
					PFPT pre-post-treatment ($p<.01$)
				S-EMG PF pain responses	
				Deep PF muscles	Pre-treatment group difference ns
					Post-treatment group difference ns
				Superficial PF muscles	PFPT pre-post-treatment ns
					Pre-treatment group difference ($p<.05$)
					Post-treatment group difference ns
					PFPT pre-post-treatment ($p<.0001$)
				Pain intensity	Pre-treatment group difference ($p<.01$)
					Post-treatment group difference ns
					PFPT pre-post-treatment ($p<.01$)

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
				Pain unpleasantness	Pre-treatment group difference ns Post-treatment group difference ns PFPT pre-post-treatment (p<.001)
				QoL	PFPT pre-post-treatment (p<.01)
Oyama et al. (2004)	Prospective pilot study N= 21	Women with IC PFPT: 42 (21-64)	PFPT Intravaginal massage and MTrP-release No control group	Modified Oxford scale muscle tone m iliococcygeus m pubococcygeus m obturator internus m coccygeus	 Pre-to post-treatment (p <.05) Pre-to post-treatment (p <.05) Pre-to post-treatment (p <.05) Pre-to post-treatment ns
			10 sessions for period of 5 weeks	Likert pain	Pre-to post-treatment (p < .01) Pre-treatment-to follow-up (p<0.01)
				Likert urgency	Pre-to post-treatment (p<.001) Pre-treatment-to follow-up (p<0.005)
				ICPI	Pre-to post-treatment (p<.05) Pre-treatment-to follow-up (p<0.05)

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
				ICSI	Pre- to post-treatment (p<.05) Pre-treatment-to follow-up (p< .05)
				SF-12 physical scale	Pre-to post-treatment (p<.05) Pre-treatment-to follow-up ns
				SF-12 mental scale	Pre-to post-treatment (p<.05) Pre-treatment-to follow-up ns
Cornel et al. (2005)	Prospective cohort study N= 31	Men with CP/CPPS PFPT: 43.9 (23-70)	PFPT Explanation of pelvic anatomy and function s-EMG biofeedback training PF exercises	s-EMG rest uV	Pre-to post-treatment (p<.001)
			No control group	NIH-CPSI pain	Pre-to post-treatment (p<.001)
			6-8 sessions initially once a week later on every 2-4 weeks	NIH-CPSI micturition	Pre-to post-treatment (p<.001)
				NIH-CPSI total	Pre-to post-treatment (p<.001)
				NIH-CPSI QoL	Pre-to post-treatment (p<.001)

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
Clemens et al. (2000)	Prospective cohort study N=19	Men with CP/CPPS PFPT: 36 (18-67)	PFPT Explanation of pelvic anatomy and function s-EMG biofeedback training Bladder training Hold/relax PF home exercises	VAS pain score	Pre-to post-treatment (p<.001)
				AUA bother score	Pre-to post-treatment (p<.001)
			No control group	AUA symptom score	Pre-to post-treatment (p<.001)
				VAS urgency	Pre-to post-treatment (p<.005)
			6 biweekly 1-hour sessions	VAS voiding frequency	Pre-to post-treatment (p<.005)
Anderson et al. (2011)	Prospective cohort study N=116	Men with CP/CPPS PFPT: 48 (19-80)	PFPT Internal manual techniques PF home exercises Psychologist daily instructions on reducing nervous system	VAS pelvic pain	Pre-to post-treatment (p<.001)
			No control group	PPSS sexuality	Pre-to post-treatment (p<.001)
				PPSS symptom severity	Pre-to post-treatment (p<.001)

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
			5 (30 to 60 min) sessions for 6 days	NIH-CPSI Total Score	Pre-to post-treatment ($p<.001$) Pre-treatment-to follow up ($p<.001$)
				NIH-CPSI QoL	Pre-to post-treatment ($p<.001$)
				GRA	59% of patients reported symptoms as moderately or markedly improved
Anderson et al.(2005)	Case study N= 138	Men with CP/CPPS PFPT: 40.5 (16-79)	PFPT Internal manual techniques Deep tissue mobilisation Relaxation exercises Daily PF home relaxation exercises	VAS-pelvic pain	Pre-to post-treatment: Markedly improved group ($p<.01$) Moderately improved group ns
			No control group	PPSS pain	Pre-to post-treatment: Markedly improved group ($p<.01$) Moderately improved group ns
			8 biweekly sessions and 4 weekly sessions	NIH CPSI pain	Pre-to post-treatment: Markedly improved group ($p<0.001$) Moderately improved group ($p<.05$)
				PPSS sexual function	63% of the patients had a 25% or greater improvement in sexual function; 56(43%) achieved a 50% or greater response after PFPT

Table 2. Continued

Study	Design/N	Population/ Mean age SD/ range)	Interventions/Duration	Outcome Measures (muscle tone/ function, pain, sexual function, pelvic floor symptoms, QoL, PPE)	Results
				PPSS urinary symptoms	Pre-to post-treatment: Markedly improved group ($p<.001$) Moderately improved group ns
				NIH-CPSI Total score	Pre-to post-treatment: Markedly improved group ($p<.001$) Moderately improved group ($p<.01$)
				NIH-CPSI urinary symptoms	Markedly improved group ($p<.05$)
				NIH-CPSI QoL	Moderately improved group ns
					Markedly improved group ($p<.001$) Moderately improved group ($p<.05$)

RCT=Randomized Controlled Trial; PFPT=Pelvic Floor Physiotherapy; PF= pelvic floor; IC/PBS=Interstitial Cystitis/Painful Bladder Syndrome; CP/CPPS=Chronic Prostatitis/Chronic Pelvic Pain Syndrome; MTrP=Myofascial Trigger Point; PPE=patient's perceived effect; QoL=Quality of Life; SHIM=Sexual Health Inventory for Men; FSFI=Female Sexual Function Index; ICSI=Interstitial Cystitis Symptom Index; ICPI=Interstitial Cystitis Problem Index; NIH/CPSI=National Institute of Healh Chronic Prostatitis Symptom Index; GRA=Global Response Assessment; NEW-PERFECT=Performance/Endurance/Repetition/Fast/Elevation/Co-contraction/Timing; NA=not applicable; s-EMG=surface Electromyography; MVC=Maximum Voluntary Contraction; EGS=Electrogalvanic Stimulation; TENS=Transcutaneous Electroneurostimulation; SF-12=12-item Short Form Survey; VAS=Visual Analogue Scale; PVD=Provoked Vulvodynia; AUA=American Urological Association Symptom and Bother Score; PPSS=Pelvic Pain Symptom Scale.

Note. ns=non-significant

Discussion

Three of 4 RCTs found positive effects of PFPT compared to controls on five of six outcome measurements (pelvic floor muscle resting tone and function, various features of pain, sexual function, pelvic floor symptoms, and patient's perceived effect). QoL remained unchanged in 2 of 3 RCTs. The 5 prospective studies found significant improvements from pre- to post-treatment on all the outcome measures that they assessed (pelvic floor muscle resting tone and function in 3 studies; pain in all studies; sexual function in one study; pelvic floor symptoms in 4 studies, QoL in 4 studies and patients perceived effect in 1 study). Finally, the case study found positive effects on all outcome measures that were assessed (pain, sexual function, symptoms, QoL and patients perceived effect). Taken together, the findings of this systematic review suggest that PFPT can be beneficial in patients with PFH.

However, it should be noted that the RCT[52] with the largest sample size demonstrated an effect of PFPT in only 1 of 5 outcome measures, namely patient's perceived effect. This was 1 of 2 RCTs[51,52] that measured the least effect of PFPT in patients with IC/PBS. It is not entirely clear why this particular RCT yielded negative results. Possibly, PFH in these patients is secondary to a visceral abnormality and therefore they may benefit less from PFPT than other PFH patient groups. The treatment modalities of PFPT used in this protocol may have been insufficient for this patient group, or perhaps the pain and urological complaints in this patient group was unrelated to PFH. This was also the study in which a substantial proportion of the participants (62%) reported at least one adverse event, the most common adverse event being pain in the bladder or pelvis. The high pain ratings may have negatively influenced the other outcome measurements. The other RCT[51] had post treatment data of only 11 participants with IC/PBS and should therefore be considered less reliable.

Treatment of PFPT proved to be most efficacious in improving muscle resting tone and function and pain. The 5 studies that measured muscle resting tone and function directly, all found significant improvements,[44-46,48,50] and for pain 9 of 10 studies found pain to significantly decrease with PFPT. Interestingly, the 2 RCTs[46,48] in women with dyspareunia found treatment effects in muscle function, a reduction in pain, as well as improvements in sexual function. Muscle function may be an important variable involved in sexual function. In an experimental study in women with PVD, Naess and Bø[53] found maximal voluntary pelvic floor muscle contraction to reduce vaginal resting pressure and resting s-EMG activity. Their findings suggest that improving maximal voluntary pelvic floor muscle contractions are instrumental in treating PFH. In a study

in patients with PVD[45] pain and muscle resting tone improved but unfortunately, sexual function was not investigated. Three studies[45,46,48] showed that PFPT decreased vulvar pain and pain during intercourse. These findings suggest that PFH is a maintaining factor in vulvar pain syndromes. Sexual function was also improved in patients who did not present with sexual problems as their primary complaint.[35,49]

QoL improved significantly in 6 of 8 studies,[35,44,45,48-50] but no improvement was seen in the 2 RCTs that measured QoL.[51,52] These were the RCTs in patients with IC/PBS, the majority of whom had high pain ratings during treatment. Possibly other contributing factors may be involved that affect their QoL, such as depression and anxiety as a consequence of chronic pain.[54] An outcome measure related to QoL, self-reported global perceived effect, improved significantly in all four studies that assessed this variable.[35,49,51,52] Surprisingly, the RCT[52] with the largest sample of IC/PBS patients did report greater global perceived effect than the controls. Even though their symptoms did not improve significantly, patients apparently did feel that the treatment was worthwhile. The authors of the study neither noted nor discussed this discrepancy. Other than a possible placebo effect, we have no explanation for this finding.

Several limitations of the studies in this systematic review impede the interpretation of the findings, such as the heterogeneity of patient groups and outcome measures, the small number of RCTs that met our inclusion criteria and the wide range of treatment modalities. In addition, an RCT is a prerequisite for preventing selection bias, performance bias and detection bias which was a common limitation in most of the studies reviewed. Treatment programmes varied considerably in their content and duration and some data were incompletely reported. Most studies did not present follow-up data of adequate duration. In addition, none of the 10 studies were of high quality.

Although muscle resting tone improved in most studies that measured this, these findings should be interpreted with caution. Muscle resting tone was mostly quantified by digital palpation using various scales. These scales require a subjective interpretation on the part of the assessor and in some studies, the physical therapist providing the treatment was also the one assessing improvement. This may have biased the findings towards a positive outcome. In three studies muscle resting tone and function was established using more objective measures such as s-EMG,[44,45,48] but caution is warranted in clinical use and interpretation of this measure as well. Many factors influence amplitude, skin conductance and artefacts. Other common problems

with s-EMG include a wide variation in equipment and electrodes, protocols and non-standardized normal rest s-EMG values.[55] It would be advisable to use s-EMG measures in conjunction with other muscle resting tone measures.[13,48]
Overall, it is clear that better outcome measures are needed. Another issue concerns the use of questionnaires. The wide range of conditions in which PFH seems to be involved as well as the wide range of PFH symptoms render the decision about which questionnaires to include in a study, a difficult one. Only validated patient related outcome measures will bring this field further along.

Conclusion

The findings of this systematic review suggest that PFPT can be beneficial in patients with PFH. Given the low to moderate study quality, more high-quality RCTs with standardized treatment protocols, validated outcome measures, sufficient sample sizes and long-term follow-ups should be undertaken to confirm the effectiveness of PFPT in the treatment of PFH.

Appendix 1.

Search strategy

((((“Pelvic floor”[ti] OR “Pelvic Diaphragm”[ti] OR “Pelvic Floor”[majr] OR “Pelvic Floor/physiopathology”[mesh] OR “Pelvic Floor Disorders”[majr] OR (“Practice Guideline”[ptyp] AND “pelvic”[ti]) OR “pelvic”[ti]) AND (Overactivity OR hypertonicity OR hypertonic OR hypertonic* OR tone OR tonicity OR tonic OR relaxation OR Non-relaxing OR Nonrelaxing OR spasm OR spasms OR stiffness OR stiff OR contracture OR contracting OR cramp OR cramps OR cramp OR “levator ani”[tw] OR “levator ani syndrome” OR “levator syndrome”[tw] OR “muscle activity”[tw] OR “Practice Guideline”[ptyp] OR “tenderness”[tw])) OR “pelvic floor hypertonia” OR “pelvic floor hypertonicity” OR “pelvic floor hypertonus”) AND (micturition OR micturit* OR defecation OR defaecation OR defecat* OR defaecat* OR sexual function OR sexual dysfunction OR sexual function* OR sexual dysfunction* OR prolapse OR prolaps* OR stress Urinary incontinence OR Urge urinary incontinence OR mixed incontinence OR incontinence OR incontin* OR overactive bladder OR urgency OR frequency OR obstructed micturition OR constipation OR constipat* OR dyssynergia OR dyssynerg* OR obstipation OR obstipat* OR vulvodinia OR vulvodynia OR vulvodin* OR vulvodyn* OR dyspareunia OR vaginism OR vaginismus OR vaginism* OR erectile dysfunction OR chronic testicular pain OR chronic pelvic pain OR chronic pelvic pain syndrome OR CPPS OR ejaculation OR premature ejaculation OR premature ejacul* OR Provoked vestibulodynia OR Dysfunctional voiding OR Voiding dysfunction OR Obstructed defaecation OR Obstructed defecation OR Coccygodynia OR Anal pain OR Chronic anal fissure OR Chronic anal fissures OR Proctalgia OR Ejaculation precox OR Ejaculation praecox OR Scrotal pain) NOT (((“Child”[mesh] OR “child”[ti] OR “children”[ti] OR “girl”[ti] OR “girls”[ti] OR “boy”[ti] OR “boys”[ti] OR pediatr*[ti] OR paediatr*[ti]) NOT (“Adult”[mesh] OR “adult”[ti] OR “adults”[ti])) OR “Pharmaceutical Preparations”[majr] OR “medication”[ti] OR “medications”[ti] OR “drug”[ti] OR “drugs”[ti] OR “Drug Therapy”[majr] OR pharmaco*[ti] OR “Botulinum Toxins”[majr] OR “Botulinum Toxins”[ti] OR “Botulinum Toxin”[ti] OR “botox”[ti] OR “Cholinergic Antagonists”[majr] OR “Cholinergic Antagonists”[ti] OR “Cholinergic Antagonist”[ti] OR anticholinergic*[ti] OR anti-cholinergic*[ti] OR ((“Nervous System Diseases”[majr] OR “Nervous System Diseases”[ti] OR “Nervous System Disease”[ti] OR “neurological diseases”[ti] OR “neurological disease”[ti]) NOT (“Spasm”[majr] OR “spasm”[ti] OR “spasms”[ti])) OR ((“Surgical Procedures, Operative”[majr] OR “surgery”[ti] OR surgical*[ti]) NOT “after”[ti]) OR “Implantable Neurostimulators”[majr] OR “Implantable Neurostimulators”[ti] OR “Implantable Neurostimulator”[ti] OR neuromodulat*[ti] OR rehabilitat*[ti] OR “Rehabilitation”[majr] OR “rehabilitation”[Subheading] OR “physical therapy modalities”[majr] OR “physical therapy”[ti] OR “physiotherapy”[ti] OR physiotherap*[ti] OR “exercise”[majr] OR “exercise”[ti] OR “exercises”[ti] OR “exercise therapy”[majr] OR “biofeedback, psychology”[majr] OR “biofeedback”[ti] OR “bio-feedback”[ti] OR bio-feedback*[ti] OR “myofeedback”[ti] OR myofeedback*[ti] OR “myo-feedback”[ti] OR myo-feedback*[ti] OR “electrostimulation”[ti] OR electrostimulat*[ti] OR “electric stimulation”[majr] OR “electric stimulation”[ti] OR “electrical stimulation”[ti] OR “life style”[majr] OR “life style”[ti] OR “lifestyle”[ti] OR “Conservative Treatment”[majr] OR “conservative management”[ti] OR “conservative treatment”[ti] OR “muscle therapy”[ti] OR “Electromyography”[majr] OR “electromyography”[ti] OR electromyogr*[ti] OR “EMG”[ti] OR “EMGs”[ti] OR “magnetic resonance imaging”[majr] OR “magnetic resonance”[ti] OR “Ultrasonography”[majr] OR ultrasoun*[ti] OR ultrason*[ti] OR “mapping”[ti]) AND english[la]) AND (“2009/01/01”[PDAT] : “3000/12/31”[PDAT])

References

1. Strohbehn K. Normal pelvic floor anatomy. *Obstet Gynecol Clin North Am*. Dec 1998;25(4):683-705. doi:10.1016/s0889-8545(05)70037-1.
2. Rocca Rossetti S. Functional anatomy of pelvic floor. *Arch Ital Urol Androl*. Mar 31 2016;88(1):28-37. doi:10.4081/aiua.2016.1.28.
3. Eickmeyer SM. Anatomy and Physiology of the Pelvic Floor. *Phys Med Rehabil Clin N Am*. Aug 2017;28(3):455-460. doi:10.1016/j.pmr.2017.03.003.
4. Ashton-Miller JA, DeLancey JO. Functional anatomy of the female pelvic floor. 2007;1101:266-96.
5. Pool-Goudzwaard A, van Dijke GH, van Gurp M, Mulder P, Snijders C, Stoeckart R. Contribution of pelvic floor muscles to stiffness of the pelvic ring. *Clin Biomech (Bristol, Avon)*. Jul 2004;19(6):564-71. doi:10.1016/j.clinbiomech.2004.02.008.
6. Hodges PW, Sapsford R, Pengel LH. Postural and respiratory functions of the pelvic floor muscles. *Neurourol Urodyn*. 2007;26(3):362-71. doi:10.1002/nau.20232.
7. Voorham-van der Zalm PJ, Lycklama ANGAB, Elzevier HW, Putter H, Pelger RCM. "Diagnostic investigation of the pelvic floor": a helpful tool in the approach in patients with complaints of micturition, defecation, and/or sexual dysfunction. *J Sex Med*. Apr 2008;5(4):864-871. doi: 10.1111/j.1743-6109.2007.00725.x.
8. Morin M, Binik YM, Bourbonnais D, Khalife S, Ouellet S, Bergeron S. Heightened Pelvic Floor Muscle Tone and Altered Contractility in Women With Provoked Vestibulodynia. *J Sex Med*. Apr 2017;14(4):592-600. doi:10.1016/j.jsxm.2017.02.012.
9. Butrick CW. Pelvic floor hypertonic disorders: identification and management. *Obstet Gynecol Clin North Am*. Sep 2009;36(3):707-22. doi:10.1016/j.ogc.2009.08.011.
10. Walker EA, Gelfand AN, Gelfand MD, Green C, Katon WJ. Chronic pelvic pain and gynecological symptoms in women with irritable bowel syndrome. *J Psychosom Obstet Gynaecol*. Mar 1996;17(1):39-46. doi:10.3109/01674829609025662.
11. Tripoli TM, Sato H, Sartori MG, de Araujo FF, Girao MJ, Schor E. Evaluation of quality of life and sexual satisfaction in women suffering from chronic pelvic pain with or without endometriosis. *J Sex Med*. Feb 2011;8(2):497-503. doi:10.1111/j.1743-6109.2010.01976.x.
12. Katz L, Tripp DA, Nickel JC, Mayer R, Reimann M, van Ophoven A. Disability in women suffering from interstitial cystitis/bladder pain syndrome. *BJU Int*. Jan 2013;111(1):114-21. doi:10.1111/j.1464-410X.2012.11238.x.
13. Bo K, Frawley HC, Haylen BT, et al. An International Urogynecological Association (IUGA)/International Continence Society (ICS) joint report on the terminology for the conservative and nonpharmacological management of female pelvic floor dysfunction. *Int Urogynecol J*. Feb 2017;28(2):191-213. doi:10.1007/s00192-016-3123-4.
14. Zermann DH, Ishigooka M, Doggweiler R, Schmidt RA. Neurourological insights into the etiology of genitourinary pain in men. *J Urol*. Mar 1999;161(3):903-8.
15. Shah JP, Thaker N, Heimur J, Aredo JV, Sikdar S, Gerber L. Myofascial Trigger Points Then and Now: A Historical and Scientific Perspective. *PM R*. Jul 2015;7(7):746-761. doi:10.1016/j.pmrj.2015.01.024.

16. Simons D, Travell J, Simons L. Travell & Simons' myofascial pain and dysfunction: The trigger point manual. Baltimore: Williams and Wilkins. 1999;Williams & Wilkins.
17. Butrick CW. Persistent Postoperative Pain: Pathophysiology, Risk Factors, and Prevention. *Female Pelvic Med Reconstr Surg*. Sep-Oct 2016;22(5):390-6. doi:10.1097/SPV.0000000000000298.
18. Tu FF, Holt J, Gonzales J, Fitzgerald CM. Physical therapy evaluation of patients with chronic pelvic pain: a controlled study. *Am J Obstet Gynecol*. Mar 2008;198(3):272 e1-7. doi:10.1016/j.ajog.2007.09.002.
19. Paras ML, Murad MH, Chen LP, et al. Sexual abuse and lifetime diagnosis of somatic disorders: a systematic review and meta-analysis. *JAMA*. Aug 5 2009;302(5):550-61. doi:10.1001/jama.2009.1091.
20. van der Velde J, Everaerd W. The relationship between involuntary pelvic floor muscle activity, muscle awareness and experienced threat in women with and without vaginismus. *Behav Res Ther*. Apr 2001;39(4):395-408. doi:10.1016/s0005-7967(00)00007-3.
21. Beck JJ, Elzevier HW, Pelger RC, Putter H, Voorham-van der Zalm PJ. Multiple pelvic floor complaints are correlated with sexual abuse history. *J Sex Med*. Jan 2009;6(1):193-8. doi:10.1111/j.1743-6109.2008.01045.x.
22. Cichowski SB, Dunivan GC, Komesu YM, Rogers RG. Sexual abuse history and pelvic floor disorders in women. *South Med J*. Dec 2013;106(12):675-8. doi:10.1097/SMJ.0000000000000029.
23. Laan E, van Lunsen RHW. Overactive Pelvic Floor; Female sexual functioning. *Springer*. 2016:17-31.
24. D'Ancona C, Haylen B, Oelke M, et al. The International Continence Society (ICS) report on the terminology for adult male lower urinary tract and pelvic floor symptoms and dysfunction. *Neurourol Urodyn*. Feb 2019;38(2):433-477. doi:10.1002/nau.23897.
25. Simons DG, Mense S. Understanding and measurement of muscle tone as related to clinical muscle pain. *Pain*. Mar 1998;75(1):1-17. doi:10.1016/s0304-3959(97)00102-4.
26. Morin M, Gravel D, Bourbonnais D, Dumoulin C, Ouellet S. Reliability of dynamometric passive properties of the pelvic floor muscles in postmenopausal women with stress urinary incontinence. *Neurourol Urodyn*. 2008;27(8):819-25. doi:10.1002/nau.20603.
27. Dworkin RH, Turk DC, Wyrwich KW, et al. Interpreting the clinical importance of treatment outcomes in chronic pain clinical trials: IMMPACT recommendations. *J Pain*. Feb 2008;9(2):105-21. doi:10.1016/j.jpain.2007.09.005
28. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual Analog Scale for Pain (VAS Pain), Numeric Rating Scale for Pain (NRS Pain), McGill Pain Questionnaire (MPQ), Short-Form McGill Pain Questionnaire (SF-MPQ), Chronic Pain Grade Scale (CPGS), Short Form-36 Bodily Pain Scale (SF-36 BPS), and Measure of Intermittent and Constant Osteoarthritis Pain (ICOAP). *Arthritis Care Res (Hoboken)*. Nov 2011;63 Suppl 11:S240-52. doi:10.1002/acr.20543.
29. Whitehead WE, Bharucha AE. Diagnosis and treatment of pelvic floor disorders: what's new and what to do. *Gastroenterology*. Apr 2010;138(4):1231-5, 1235 e1-4. doi:10.1053/j.gastro.2010.02.036.
30. Stein A, Sauder SK, Reale J. The Role of Physical Therapy in Sexual Health in Men and Women: Evaluation and Treatment. *Sex Med Rev*. Jan 2019;7(1):46-56. doi:10.1016/j.sxmr.2018.09.003.

31. Faubion SS, Shuster LT, Bharucha AE. Recognition and management of nonrelaxing pelvic floor dysfunction. *Mayo Clin Proc*. Feb 2012;87(2):187-93. doi:10.1016/j.mayocp.2011.09.004.

32. FitzGerald MP, Kotarinos R. Rehabilitation of the short pelvic floor. II: Treatment of the patient with the short pelvic floor. *Int Urogynecol J Pelvic Floor Dysfunct*. Oct 2003;14(4):269-75; discussion 275. doi:10.1007/s00192-003-1050-7.

33. Bonder JH, Chi M, Rispoli L. Myofascial Pelvic Pain and Related Disorders. *Phys Med Rehabil Clin N Am*. Aug 2017;28(3):501-515. doi:10.1016/j.pmr.2017.03.005.

34. Rosenbaum TY, Owens A. The role of pelvic floor physical therapy in the treatment of pelvic and genital pain-related sexual dysfunction (CME). *J Sex Med*. Mar 2008;5(3):513-23; quiz 524-5. doi:10.1111/j.1743-6109.2007.00761.x.

35. Anderson RU, Wise D, Sawyer T, Chan C. Integration of myofascial trigger point release and paradoxical relaxation training treatment of chronic pelvic pain in men. *J Urol*. Jul 2005;174(1):155-60. doi:10.1097/01.ju.0000161609.31185.d5.

36. Keshwani N, McLean L. State of the art review: Intravaginal probes for recording electromyography from the pelvic floor muscles. *Neurourol Urodyn*. Feb 2015;34(2):104-12. doi:10.1002/nau.22529.

37. Voorham JC, De Wachter S, Van den Bos TWL, Putter H, Lycklama ANGA, Voorham-van der Zalm PJ. The effect of EMG biofeedback assisted pelvic floor muscle therapy on symptoms of the overactive bladder syndrome in women: A randomized controlled trial. *Neurourol Urodyn*. 2017;36(7):1796-1803.

38. Cadeddu F, Salis F, De Luca E, Ciangola I, Milito G. Efficacy of biofeedback plus transanal stimulation in the management of pelvic floor dyssynergia: a randomized trial. *Tech Coloproctol*. Jun 2015;19(6):333-8. doi:10.1007/s10151-015-1292-7.

39. Schmitt JJ, Singh R, Weaver AL, et al. Prospective Outcomes of a Pelvic Floor Rehabilitation Program Including Vaginal Electrogalvanic Stimulation for Urinary, Defecatory, and Pelvic Pain Symptoms. *Female Pelvic Med Reconstr Surg*. Mar/Apr 2017;23(2):108-113. doi:10.1097/SPV.0000000000000371.

40. John H, Ruedi C, Kotting S, Schmid DM, Fatzer M, Hauri D. A new high frequency electrostimulation device to treat chronic prostatitis. *J Urol*. Oct 2003;170(4 Pt 1):1275-7. doi:10.1097/01.ju.0000085582.54511.de.

41. Rowe E, Smith C, Laverick L, Elkabir J, Witherow RO, Patel A. A prospective, randomized, placebo controlled, double-blind study of pelvic electromagnetic therapy for the treatment of chronic pelvic pain syndrome with 1 year of followup. *J Urol*. Jun 2005;173(6):2044-7. doi:10.1097/01.ju.0000158445.68149.38.

42. Moher D, Shamseer L, Clarke M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Syst Rev*. Jan 1 2015;4(1):1. doi:10.1186/2046-4053-4-1.

43. Higgins JPT, Altman DG, Sterne JAC. Chapter 8: Assessing risk of bias in included studies. In: Higgins JPT, Green S (editors). Cochrane Handbook for Systematic Reviews of Interventions. The Cochrane Collaboration 2011 Version 5.1.0. Available at: www.handbook.cochrane.org. Accessed 28 Jan 2020.

44. Cornel EB, van Haarst EP, Schaarsberg RW, Geels J. The effect of biofeedback physical therapy in men with Chronic Pelvic Pain Syndrome Type III. *Eur Urol*. May 2005;47(5):607-11. doi:10.1016/j.eururo.2004.12.014.

45. Gentilcore-Saulnier E, McLean L, Goldfinger C, Pukall CF, Chamberlain S. Pelvic floor muscle assessment outcomes in women with and without provoked vestibulodynia and the impact of a physical therapy program. *J Sex Med*. Feb 2010;7(2 Pt 2):1003-22. doi:10.1111/j.1743-6109.2009.01642.x.

46. Ghaderi F, Bastani P, Hajebrahimi S, Jafarabadi MA, Berghmans B. Pelvic floor rehabilitation in the treatment of women with dyspareunia: a randomized controlled clinical trial. *Int Urogynecol J*. Nov 2019;30(11):1849-1855. doi:10.1007/s00192-019-04019-3.

47. Clemens JQ, Nadler RB, Schaeffer AJ, Belani J, Albaugh J, Bushman W. Biofeedback, pelvic floor re-education, and bladder training for male chronic pelvic pain syndrome. *Urology*. Dec 20 2000;56(6):951-5. doi:10.1016/s0090-4295(00)00796-2.

48. Schvartzman R, Schvartzman L, Ferreira CF, Vettorazzi J, Bertotto A, Wender MCO. Physical Therapy Intervention for Women With Dyspareunia: A Randomized Clinical Trial. *J Sex Marital Ther*. 2019;45(5):378-394. doi:10.1080/0092623X.2018.1549631.

49. Anderson RU, Wise D, Sawyer T, Glowe P, Orenberg EK. 6-day intensive treatment protocol for refractory chronic prostatitis/chronic pelvic pain syndrome using myofascial release and paradoxical relaxation training. *J Urol*. Apr 2011;185(4):1294-9. doi:10.1016/j.juro.2010.11.076.

50. Oyama IA, Rejba A, Lukban JC, et al. Modified Thiele massage as therapeutic intervention for female patients with interstitial cystitis and high-tone pelvic floor dysfunction. *Urology*. Nov 2004;64(5):862-5. doi:10.1016/j.urology.2004.06.065.

51. FitzGerald MP, Anderson RU, Potts J, et al. Randomized multicenter feasibility trial of myofascial physical therapy for the treatment of urological chronic pelvic pain syndromes. *J Urol*. Aug 2009;182(2)(2):570-80. doi:10.1016/j.juro.2009.04.022.

52. FitzGerald MP, Payne CK, Lukacz ES, et al. Randomized multicenter clinical trial of myofascial physical therapy in women with interstitial cystitis/painful bladder syndrome and pelvic floor tenderness. *J Urol*. Jun 2012;187(6):2113-8. doi:10.1016/j.juro.2012.01.123.

53. Naess IA-O, Bø K. Can maximal voluntary pelvic floor muscle contraction reduce vaginal resting pressure and resting EMG activity? *Int Urogynecol J*. 2018 nov;29(11):1623-1627. doi: 10.1007/s00192-018-3599-1.

54. Dybowski C, Lowe B, Brunahl C. Predictors of pain, urinary symptoms and quality of life in patients with chronic pelvic pain syndrome (CPPS): A prospective 12-month follow-up study. *J Psychosom Res*. Sep 2018;112:99-106. doi:10.1016/j.jpsychores.2018.06.013.

55. Voorham-van der Zalm PJ, Voorham J, van den Bos TWL, Ouwerkerk TJ, et al. Reliability and differentiation of pelvic floor muscle electromyography measurements in healthy volunteers using a new device: the Multiple Array Probe Leiden (MAPLe). *Neurourol Urodyn*. 2013 32(4):341-8. doi: 10.1002/nau.22311.