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Traditional Biofeedback vs. Pelvic Floor Physical Therapy—Is One Clearly Superior?

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Abstract

Purpose of Review Pelvic floor physical therapy is a worldwide accepted therapy that has been exclusively used to manage many pelvic floor disorders in adults and children. The aim of this review is to suggest to clinicians an updated understanding of this therapeutic approach in management of children with non-neuropathic voiding dysfunction.

Recent Findings Today, pelvic floor muscle training through biofeedback is widely used as a part of a voiding retraining program aiming to help children with voiding dysfunction which is caused by pelvic floor overactivity. Biofeedback on its own, without a pelvic floor training component, is not an effective treatment. Biofeedback is an adjunct to the pelvic floor training.

Summary In the current review, we develop the role of pelvic floor physical therapy in management of children with non-neuropathic voiding dysfunction and compare it with biofeedback therapy alone.

Keywords Biofeedback · Pelvic floor physical therapy · Voiding dysfunction · Dysfunctional voiding · Children

Introduction

Lower urinary tract (LUT) and voiding dysfunction (VD) are an essential diagnosis in the field of pediatric urology and comprise up to 40% of referrals [1]. Clinical evaluation and treatment of these patients require a great extent of time and resources for the healthcare system as well as considerable efforts for children's caregivers. Studies revealed that VD can become a lifelong condition and result in various complications if left untreated [2]. Therefore, it is crucial to identify the optimal management of this condition to allow the best allocation of health system resources and likewise improve these patients' quality of life.

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According to the International Children's Continence Society (ICCS) terminology, VD is an umbrella term that includes variety of voiding signs and symptoms [3]. ICCS has classified the symptoms according to their relation to the storage and/or voiding phase of bladder function. Storage symptoms include increased or decreased voiding frequency, urgency, nocturia, urinary incontinence, and enuresis. While voiding phase symptoms consist of hesitancy, straining, weak stream, intermittency, and dysuria. In addition, patients can present with genital and/or bladder pain, recurrent urinary tract infection (UTI), holding maneuvers, urinary retention, and feeling of incomplete emptying [3, 4•].

Regarding the etiology of VD, three general categories have been introduced: (1) anatomic, (2) neuropathic, and (3) non-neuropathic. Anatomic causes like posterior urethral valves and neuropathic etiologies, such as spinal dysraphisms, are not in the scope of this article. However, it is important to keep these entities in mind when evaluating a child with VD because mismanagement of these conditions can lead to permanent renal or LUT damage. The non-neuropathic causes of VD generally comprise of overactive bladder, voiding postponement, and dysfunctional voiding (DV) [5•].

Generally, the diagnosis of non-neuropathic VD is made via non-invasive approaches such as uroflowmetry-electromyography (EMG) to measure flow rate and EMG activity during voiding and obtain flow curve shapes, pelvic

floor ultrasound to indicate post-void residue (PVR) and bladder capacity, and importantly bladder and bowel diary and LUT function questionnaires which are objective tools in documentation of bladder function [3].

The primary step in treatment of VD is patient and family education on voiding habits, pelvic floor function, hydration, and timed voiding. There are several pharmacological treatments that have been developed; however, these have shown several adverse effects in children [6, 7]. Biofeedback therapy and pelvic floor muscle retraining have become increasingly important. They now are the first-line therapy in most cases of non-neuropathic VD after failure of simple conservative managements.

Furthermore, bowel function plays a key role in managing LUT function [5•]. However, constipation is still underrecognized by caregivers as well as physicians when evaluating a child with voiding problems. In a study on frequency of constipation in children with nocturnal enuresis, it was found that one-third of children with enuresis had constipation concomitantly, although, only 14% of their parents reported stooling problems [8]. Successful management of constipation can improve different aspects of VD. For instance, it was shown that treatment of constipation can result in resolution of daytime incontinence and enuresis in 89% and 63% of patients, respectively [9]. In addition, improvement of bowel function can reduce incidence of UTI in patients with vesicoureteral reflux (VUR) [10]. Biofeedback therapy and pelvic floor physical therapy (PFPT) have demonstrated unique approaches to improve both bladder and bowel function by training the pelvic floor to function properly [5•].

Initially, biofeedback therapy was introduced as a promising way to improve pelvic floor function by correcting the improper behavior. However, nowadays many studies have revealed that there are various approaches to retrain pelvic floor function and biofeedback is only one of these treatment methods. Therefore, PFPT has been introduced as a broad term and treatment protocol for various LUT dysfunctions. In the current review, we develop the role of PFPT in management of children with non-neuropathic VD and compare it with biofeedback therapy alone.

Traditional Biofeedback

Biofeedback is defined as a training technique which has an external electrical sensor to show signals on physiological functions in order to manipulate the recorded activity and enable an individual to gain some elements of voluntary control at will. Maizels et al., for the first time in urology, introduced biofeedback as a new approach for the treatment of sphincteric dysfunction of voiding in 1979 [11]. As the results of biofeedback therapy for several pelvic floor disorders in adult patients were favorable, use of biofeedback in pediatric patients seems to be promising [12, 13]. Biofeedback as a rehabilitative training program is used in different fields in order to improve educational performance [14, 15]. The success of the treatment in biofeedback therapy depends on patients' effort, motivation to the program, an appropriate developmental age (older than 5 years), and a safe and practical environment with a specially educated professional [4•]. Additionally, the expertise of the therapist has a significant impact on the treatment outcome [16].

The aim of biofeedback therapy for non-neuropathic VD in children is to increase children's awareness about the pelvic floor muscle's (PFM) function and to develop better voluntary control of these muscles and external urethral sphincter during voiding [17]. With this approach, the children could become informed about the physiological activities that happen during filling and voiding phases by using audio and visual means [18]. Instructing the children about the abdominal and PFMs interaction is the essential point for obtaining the coordinated pattern that is needed for relaxed voiding [19]. Uroflowmetry, auditory stimulus and non-invasive abdominal or perineal EMG like biofeedback can help patients to better understand this interaction and how to control their voluntary external urethral sphincter and PFMs during voiding. This education is the main goal of this treatment program [4•, 5•, 20]. It is suggested that the pattern of discoordination between the detrusor and the external urinary sphincter is measured by uroflowmetry and EMG [21]. The basic principles of biofeedback have remained unchanged since its beginning. However, biofeedback therapy and PFM retraining have two main beneficial effects. First, biofeedback improves urine flow rates by using a visual display of the flow that patients watch in order to create a correct bell-shaped flow curve during active voiding. Second, there surface electrodes provide feedback of pelvic and abdominal muscle activity which is observed on a screen. Hence, the patients should learn specific exercises to contract and relax PFM at proper time. Furthermore, optimal positive reinforcement, parents and children motivation, and a close relationship between the therapist and patients are necessary for success [16].

As the complete evaluation of muscle training in children (a change in the awareness of action, strength, endurance, timing of contraction, coordination, tonic function, or reflex activation) has not been reported yet in the literature, repeated urine flow and PVR volume measurements are needed to evaluate improvement of PFM relaxation [22].

It has been demonstrated that biofeedback therapy is a successful training method for treatment of children with DV secondary to paradoxical tightening or failure to relax the PFM and external urethral sphincter during voiding [5•]. Sugar and Firlit reported their experience with urodynamic biofeedback where all included patients converted to synergistic voiding within 48 h of the therapy [23]. In another study by Hoebeke et al., there was a 92% cure rate in urine flow, bladder capacity, and daytime incontinence after biofeedback

therapy among 50 patients with DV [24]. Vasconcelos and colleagues reported a significant reduction in incontinence episodes, UTI, and PVR after biofeedback therapy in 56 children with DV [25].

Nowadays, the role of biofeedback therapy in pediatric urology has been meaningfully expanded [26, 27]. Animations and video games play a major role in the entertainment of children and adolescents. Therefore, applying this technology to the educational processes could improve the efficacy of biofeedback. Utilizing the interactive video games for treatment of DV in children was first introduced by McKenna et al. in 1999. They reported a success rate of 89 to 100% for different voiding and bowel symptoms after an average of six 1-h outpatient sessions [28]. Kaye and Palmer determined that the efficacy of animated and non-animated biofeedback therapy for DV was similar, but the effects of animated method led to significantly fewer sessions (3.6 vs 7.6, $P < 0.05$) [29]. However, in a recent study by Oktar et al., the effectiveness of animated and non-animated biofeedback therapy in the treatment of children with DV was compared. They reported that there was no significant difference between animated and non-animated biofeedback therapy in terms of clinical success rates [30].

Pelvic Floor Physical Therapy

PFPT is a worldwide accepted therapy for many pelvic floor disorders both in adults and children [31–33]. PFPT as an evidence-based therapy focuses on the prevention and treatment of functional disorders of the abdominal and pelvic regions, including overactive bladder, urinary incontinence (daytime/nighttime wetness, stress, mixed, and urge incontinence), bowel and bladder dysfunction, fecal incontinence, symptomatic pelvic organ prolapse, pelvic floor myofascial pain, sexual dysfunction, and painful bladder syndrome [34–37]. Considering the beneficial features of PFPT such as non-invasiveness, alleviation of symptoms, low risk of side effects, and moderate to low cost, it is often selected as a first-choice treatment accordingly [38].

It is recommended that a multidisciplinary approach from the fields of urogynecology, urology, gastroenterology, neurology, and psychology should collaborate to determine the diagnosis [39, 40]. The treatment plan is merged after the physiotherapeutic diagnostic consultation for PFPT. In accordance with the treatment goals, the patient's level of motivation, capability and cooperation, and with regard to the progression of the treatment, one or more different PFPT techniques will be used [41].

The PFPT program comprises patients/parents education and instruction, behavioral therapy and lifestyle advices, manual therapy techniques, functional exercise training (teaching of the correct contraction, muscle and body awareness, coordination and motor control, muscle strength and endurance, and relaxation), biofeedback, and electrotherapy [42, 43].

Patients/Parents Education and Instruction

Education of the patients/parents in the PFPT for children is the same as the standard urotherapy. The mainstay of physical therapy in treating pelvic floor dysfunction is a patient-specific education plan about each problem category [44, 45]. A detailed and simple explanation of the physiology, anatomy, and function of the pelvic floor, urinary bladder, and gastrointestinal tract along with a statement about the underlying mechanism of the diseased situation is given to the children and their parents/caregivers. Use of teaching assistances such as a pelvic schematic model, diagram, picture, and video is recommended as well [3, 46].

Behavioral Therapy and Lifestyle Advices

Behavioral therapy is a learning process seeking to identify the behavioral factors that cause pelvic floor impairments in order to help change the potentially unhealthy behaviors and habits. The focus of the treatment is often on current problems and how to change them. The success of behavioral therapy depends on the patient's cognitive ability and her/his motivation to change her/his life habits [17, 47, 48]. It is also helpful to review and practice optimal toilet posture. Children are asked to avoid withholding during urination and defecation [45, 48, 49].

Manual Therapy Techniques

Manual PFPT is a clinical approach using expert, specific hands-on techniques, including massage, manipulation or mobilization, stretching, myofascial release, and hold-relax technique. These therapies relate to the structures including abdomen, diaphragm, back, pelvis, hip and pelvic floor, as well as vaginal and anal disorders [50–52]. The vaginal/anal manual PFPT in adult patients are planned to gain better mobility and flexibility of muscles and soft tissues, reduction of tone, contraction of the PFM, and increase in sensation and proprioceptive capabilities [53–55]. Unlike the widely use of manual PFPT in adult patients, a few manual therapy techniques are lately used in children with voiding dysfunction [56–58]. Recently, the effect of Kinesio taping as a physiotherapeutic method was assessed on urinary incontinence in children [59]. Krajczy et al. applied the Kinesio taping on the lower abdominal and sacral regions to regulate the tone of the musculofascial system in these areas. They reported a significant decrease in the number of incontinence episodes after Kinesio taping among children in the experimental group compared with the controls [59]. Further studies are needed

to evaluate the effectiveness of these techniques in children for treatment of pelvic floor disorders.

Pelvic Floor Muscle Exercises

PFM are the base of a group of muscles that is called the "core" (Fig. 1) [60]. They work synergistically with the deep abdominal, back, and diaphragm muscles to support the spine and posture and involve in the respiratory function as well [61]. The PFM contribute to continence, antigravity support, intra-abdominal pressure generation, and lumbopelvic stability. PFM function will increase in some activities such as lifting, nose blowing, laughing, coughing, and sneezing that a rise in intra-abdominal pressure is required [62]. These muscles also have an important role in supporting the pelvic organs, bladder and bowel control, and sexual function, in both men and women [63].

Exercise is the core of physical therapy interventions. It is reported that pelvic floor dysfunction can result in symptoms during movement and this condition limits the ability to stay physically active. With respect to the prior studies that have shown, for example, urinary incontinence may cause a change in movement patterns during physical activities; hence, PFPT may also contain exercises for increasing general function and fitness level [64••].

The aim of the PFM exercises is improvement of posture in addition to strengthening, relaxing, and stretching the muscles that affect the activity of the PFM. Also, improvement of PFM control with respect to the functional goals (identification, strengthening, endurance, tone, timing, and relaxation) in addition to isolated contraction of these muscles in cooperation with synergic muscles and coordination between the PFM and

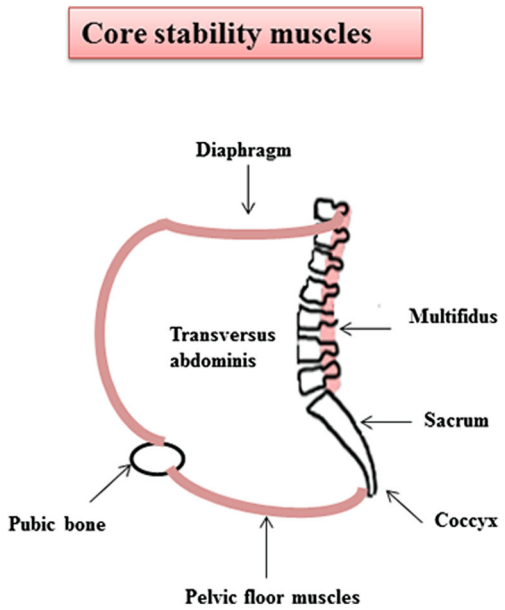

Fig. 1 Core muscles

breathing muscles, all are other treatment purposes of the exercises [65–67].

In 1949, Kegel introduced PFM exercises based on the concept that PFM can be contracted like other skeletal muscles as a primary behavioral technique for treatment of urinary incontinence in women [68]. Several randomized controlled trials have shown that PFM training is more effective than no treatment for stress urinary incontinence [69]. Kegel exercises emphasize on isolated training of PFM and may miss the functional link and coordination of PFM with other core muscles. The synergistic action of abdominal and PFM was recently evaluated [70, 71]. These studies showed that PFM are not an isolated unit; the coordination of PFM with thoraco/abdomino/pelvic muscles contributes to continence, antigravity support, and intra-abdominal pressure.

Considering the ICCS guidelines, the main underlying cause of DV in children is pelvic floor overactivity and inability to relax the external urethral sphincter during voiding [3]. Furthermore, many children with DV may have overactive abdominal muscles preventing PFM from relaxation during voiding [70]. PFM exercises were introduced by Wennergren and Oberg for the first time in pediatric urology; however, the exercise protocol for pediatric patients has not been standardized yet [72]. Learning from adult studies may help to guide which PFM dysfunction contributes to pediatric incontinence and how to treat it [20].

Nowadays, functional exercises can be used to treat lack of strength, mobility, balance and coordination of the abdominal, and PFM in addition to restoration of the normal function of these muscles. Although several studies are performed about the treatment of PFM dysfunction and urinary incontinence in adult patients using PFM exercises alone without biofeedback, there are limited studies in pediatric patients with DV in this regard [73, 74]. In a recent study, posture and balance disorders have been investigated in children with nocturnal enuresis. Pavione Rodrigues Pereira et al. found that forward inclination of the pelvis and worse balance were higher in children with nocturnal enuresis compared with the normal controls [75]. In another survey, the difference between abdominal and spinal musculoskeletal function in children with slow transit constipation was evaluated [76]. The authors aimed to assess whether children with slow transit constipation have different trunk musculoskeletal features that may be related to their defecation difficulties. The results showed that constipated children had reduced trunk control and posture compared with the controls. They suggested that training of trunk muscles and correction of sitting posture should be indicated in these children [76].

Therefore, functional exercises such as motor control, core stability, and balance training in addition to locomotor skills (a stabilized posture, abdominal breathing, and pelvic floor relaxing) are important to support toilet training. In addition, motor relearning approaches including debate and repeated

practice can help the child to maintain in the optimal correct posture in the toilet.

Biofeedback

In the urology or urogynecology textbooks, the phrase of "biofeedback" is often used to categorize a method different from PFPT. Hence, biofeedback is not a therapy on its own; it is complementary to the training, measuring the reaction from a single PFM contraction [64••]. Various types of feedbacks are used in PFPT for management of PFM dysfunction including (a) surface EMG or myofeedback that gives feedback on the generated electrical potential by the abdominal and PFM activity using vaginal/anal electrodes or a surface electrode on the perineum; (b) manometer that gives feedback about the pressure in the vagina/anus as an outcome from muscle activity using a vaginal/anal electrode; (c) ultrasound can provide feedback on how muscles work, determine muscles during activity and their mass. In addition, it gives feedback about any changes in the position of the pelvic organs during muscles activity through a vaginal/anal/abdominal transducer; (d) mirror can provide visual feedbacks about the degree of the abdominal and PFM contraction [77–80].

Electrotherapy

Electrotherapy as a treatment method using electrical energy is an accepted practice in the field of physical therapy [81]. Since the first report of treatment of a patient using electricity by Johann Gottlob Krüger in 1743, several therapeutic electrical devices have been developed. Electrical current can stimulate nerves or muscles and serve as a type of electrotherapy modality to yield pain relief, blood flow improvement, muscle spasm relief, wound healing, and muscle retraining/strengthening [81]. In addition, electrical currents can affect sensory, motor, glandular, and secretory functions. Chemical changes have also been observed following electrical stimulation namely increase in beta-adrenergic activity, reduction of cholinergic activity, and changes in neurotransmitter availability (dopamine, serotonin, vasopressin, and nitric oxide). Moreover, these currents stimulate the release of endorphins and enkephalins in the cerebrospinal fluid. It is reported that the rise in opioid levels can favorably inhibit detrusor overactivity [82].

Over the past decades, electrical currents have been developed and widely used for the management of LUT dysfunction in adults and children [83•, 84]. There are several studies that have shown electrical stimulation is effective for treatment of the LUT dysfunction via increasing the bladder capacity/compliance or reduction in detrusor pressure [85–87]. Hoebeke et al. and Bower et al. used transcutaneous electrical nerve stimulation (TENS) for the first time in the treatment of pediatric LUT dysfunction [88, 89]. Hoebeke et al. reported that among 41 children who underwent TENS, 76% responded after 1 month of therapy with an increase in bladder capacity, decrease in urgency, and decrease in incontinence [88]. In some later studies, parasacral TENS were applied to treat overactive bladder, urinary incontinence, and constipation in children [90]. They reported positive results using this method in treatment of lower urinary tract symptoms in affected patients [91–94].

There are several types of electrical stimulation devices producing different frequencies, waveforms, and effects as well as different types of electrodes. Selection of the appropriate modality in PFPT depends on the region and structure that should be treated and the absence of contraindications as well.

Transcutaneous interferential electrical stimulation has been recently used in pediatric PFPT to treat urinary incontinence and constipation [95–98]. Interferential current is a kind of electrical stimulation that crossed currents with a little different frequencies result in an interference current (beat frequency) in the intersection region allowing deep-seated low frequencies without pain [99]. In a recent study, the effects of interferential current and diaphragmatic breathing exercises in children with bladder and bowel dysfunction were studied [97]. Seventy-nine children with DV and chronic constipation were included and divided into three groups. A significant improvement in defecation frequency and fecal incontinence was observed only in children who underwent both interferential current and diaphragmatic breathing exercises [97].

Functional electrical stimulation is another type of therapeutic currents that stimulates the nerves or the junctions between nerves and muscles in order to generate muscle contraction producing functions such as grasping, walking, standing, and bladder voiding [100, 101]. This current is widely used in PFPT especially in adult patients with or without neuropathic bladder bowel dysfunction through stimulation of the weak muscles to improve their functions [84, 102, 103].

Conclusions

Although, biofeedback therapy has an important role in pediatric urology and its efficacy for treatment of DV has been identified in recent recommendations from the ICCS, but biofeedback on its own, without a pelvic floor training component, is not an effective treatment. It is an adjunct to pelvic floor training program and enables to measure the reaction from a single PFM contraction. Hence, PFPT is a treatment method in different ways that can cover several aspects of

pelvic floor disorders and voiding dysfunction in adults and children.

Compliance with Ethical Standards

Conflict of Interest Seyedeh-Sanam Ladi-Seyedian, Lida Sharifi-Rad, Behnam Nabavizadeh, and Abdol-Mohammad Kajbafzadeh each declare no potential conflicts of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- •• Of major importance

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