Chapter 4

Physiotherapy in Women with Urinary Incontinence

Özlem Çinar Özdemir and Mahmut Surmeli

Additional information is available at the end of the chapter

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Abstract

Urinary incontinence is a complex and serious condition that can affect all age groups around the world. It is not only a serious medical condition but also an undeniable psychosocial problem creating embarrassment and negative self-perception, and it has a severe impact on a patient's quality of life. Today, there are wide different treatment options in urinary incontinence from surgery to conservative modalities. Among these, conservative management approaches are recommended as the first-line treatment to manage with urinary incontinence. The choice of the most suitable option to treat for urinary incontinence differs according to the underlying pathophysiological mechanism defining subtypes of urinary incontinence and severity of symptoms. In this chapter, we addressed the different components of physiotherapy management of urinary incontinence, including pelvic floor muscle training, electrical stimulation, biofeedback, vaginal cones, mechanical devices and magnetic stimulation. We concluded that the optimal physiotherapy care should be individualised to ensure applicability the clinic setting for each patient.

Keywords: urinary incontinence, pelvic floor muscle training, physiotherapy, biofeedback, women

1. Introduction

Urinary incontinence (UI) is defined by the International Continence Society as any involuntary leakage of urine [1]. It is one of the most common health problems seen in women of nearly all ages [2] and affects up to two-thirds of all women [3]. It is more frequent in women, and it is particularly common among those in residential care [4].

Female urinary incontinence is a complex situation [5]. It has been stated that UI might be indicative of a symptom, sign or condition. The symptom may indicate a state of loss of urinary control; the sign is the objective demonstration of urine leak, and the condition is the urodynamic demonstration and characterisation of urine loss [6].

UI should not be classified only as a serious medical condition leading to lower urinary tract infections and perineal rash but also as an undeniable psychosocial problem (**Figure 1**), creating embarrassment and negative self-perception [7]. This in turn affects a wide aspect of daily life, including the social, psychological, occupational, domestic, physical and sexual activities of women [2]. UI has been found to result in reduced social interactions and physical activities [8] and is commonly associated with poor self-rated health [9], impaired psychological well-being, sexual relationships, decreased quality of life (QoL) [10] and increased depressive symptoms [11]. It may restrict employment and educational or leisure opportunities leading to embarrassment and exclusion [12].

There is a wide range of literature on the prevalences of UI [13, 14]. This can be explained by the differences in the definition of UI, in epidemiologic methodology, and in the demographic characteristics among the studies [13–15]. About 25% of young women, 44–57% of middle-aged and postmenopausal women, and about 75% of older women experience some involuntary urine loss [16]. In the 5th International Consultation on Incontinence (2012), it is stated that the prevalence of UI in the population varies between 30% and 60% in middle-aged and older women and it increases with age. In addition, the prevalence of daily UI changes from 5 to 15%, and it rises over 15% in women aged above 70 years [14]. Although these ranges of prevalence of UI are usually underestimated in the clinical setting, since patients often fail to bring the condition to the attention of their physicians. It is estimated that only one in four symptomatic women seeks help for this problem [17].

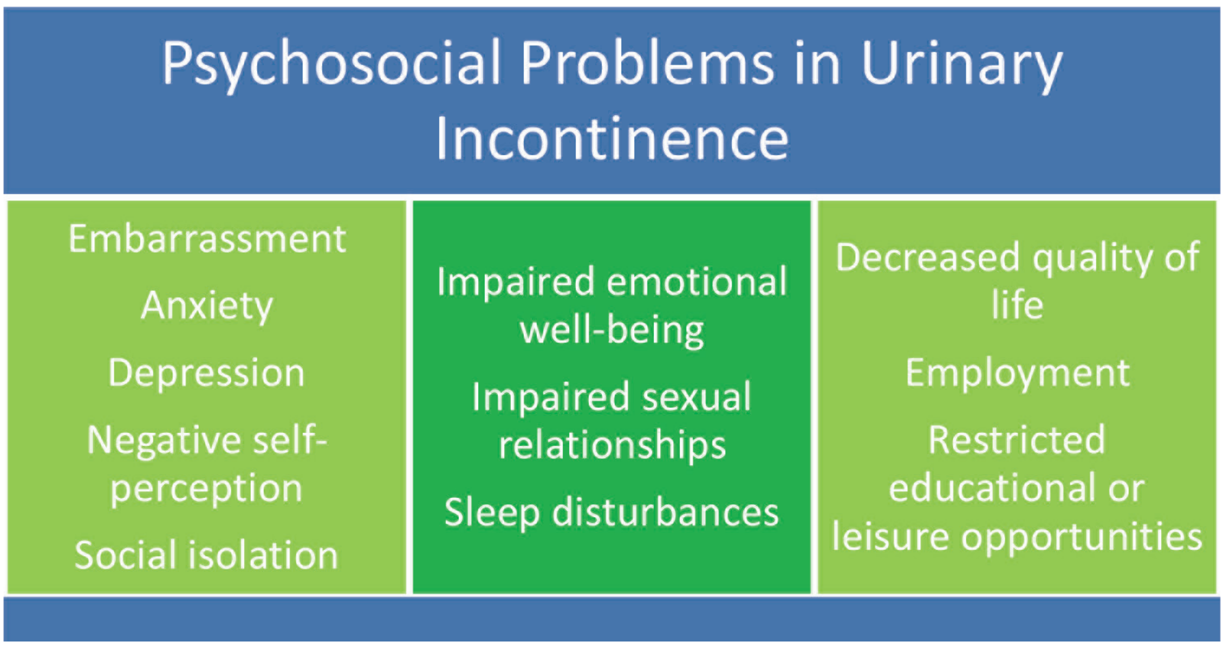

Figure 1. Psycho-social problems seen in urinary incontinence.

UI affects not only the sufferers but also their family, friends and the general public, due to its associated medical costs and social stigma [18]. UI is generally not related directly to survival but affects the QoL of the patients, causes mental distress and reduces day-to-day activities. When the treatment for UI results in the alleviation or cure of the condition, the distress can be eliminated and return to a normal life is possible [19]. In general, the choice of treatment primarily depends on the balance between efficacy and the associated complications. A variety of effective conservative treatment modalities are available to manage symptoms of UI [20].

There are several risk factors associated with UI in women (**Figure 2**). These include age, obesity, race/ethnicity, childbirth, oral hormonal therapy, prior hysterectomy, cognitive impairment, mobility impairment, diabetes [21], history of pelvic and perineal surgery [5] pregnancy, pelvic floor trauma after vaginal delivery and menopause [22]. UI may also occur as a result of a number of abnormalities of function of the lower urinary tract, or as a result of other illnesses [23], use of diuretics, sedentary lifestyles, caffeinated and carbonated drinks, severe and/or chronic cough resulting from, for example, chronic bronchitis or smoking, bladder stones, short urethra and hypoestrogenemia. These conditions may lead to urinary leakage under different situations [24].

The different types of incontinences are distinguished by their baseline mechanisms [16]. There are three major subtypes of UI: stress urinary incontinence (SUI), urge urinary incontinence (UUI) (urgent need to void) and mixed urinary incontinence (MUI) [25]. SUI is characterised by involuntary loss of urine without any previous feeling of a need to void, which occurs while under a physical stress like cough, lifting something heavy or any other physical activities [5]. UUI is characterised by an involuntary leakage accompanied by or immediately preceded by urgency that is difficult to defer followed by an irresistible need to void [25], resulting in uncontrollable leakage of urine [5]. MUI refers to the involuntary leakage associated with variable proportions of urgency and also with exertion, effort, sneezing or coughing

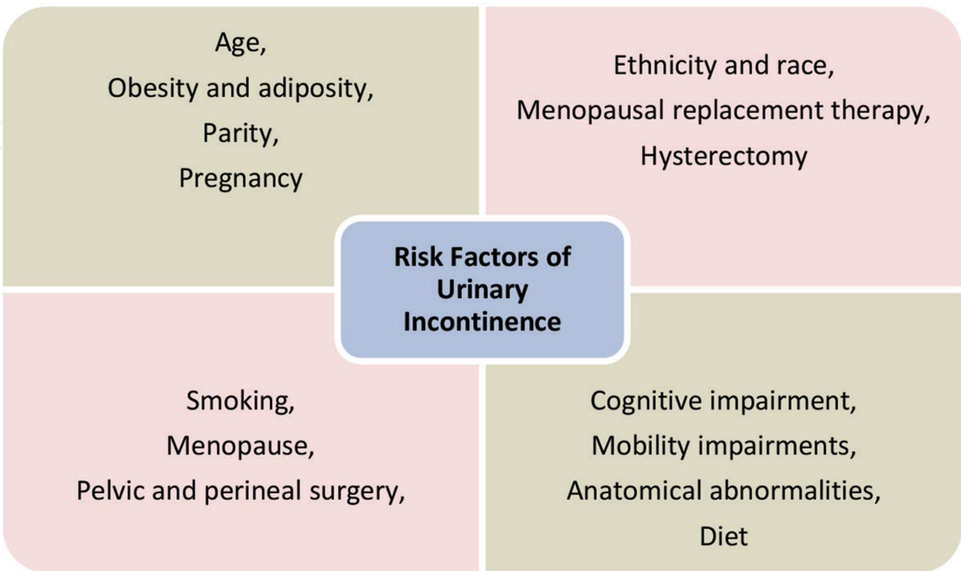

Figure 2. Risk factors for urinary incontinence.

[25–27]. These definitions reflect the consensus definitions developed by the International Urogynecological Association and International Continence Society [27]. There are also less common categories of UI. These include total incontinence which is associated with urinary tract fistula or ectopic ureter, functional incontinence, which is associated with psychiatric or mobility disorders, overflow incontinence, post-micturition dribble, radiotherapy and climacturia [28], nocturnal enuresis, continuous UI and UI due to idiopathic or neurogenic detrussor [29]. Different types of incontinence, their definitions and possible causes are given in **Table 1** [14, 30].

There exists a wide range of treatment options to treat UI from surgical interventions to conservative modalities. Current guidelines recommend conservative management that is defined as interventions that do not involve treatment with drugs or surgery targeted to the type of incontinence [23, 31], as the first-line therapy in UI [13, 31, 32]. Therefore, there is an option for conservative management, and physiotherapy, particularly for women who have not completed their childbearing and for those with mild symptoms [33]. Physical therapy modalities have been in use for several decades to treat UI and other lower urinary tract symptoms. They have been adopted by several disciplines and are implemented in many different ways [34].

Types of urinary incontinence		
Types	**Definitions**	**Pathophysiology and causes**
Stress urinary incontinence	Loss of urine during physical movements (coughing, sneezing, jumping, lifting, exercising)	Weakness of pelvic floor muscles or urethral sphincters, post-urologic surgery
Urge urinary incontinence	Leakage of urine at unexpected times accompanied by, or immediately preceded by a strong desire to void	Detrusor overactivity (uninhibited bladder contractions), neurologic disorders
Mixed urinary incontinence	Involuntary leakage associated with symptoms of urgency; loss of urine with exertion, effort, sneezing or coughing	Mixed etiology of stress and urge urinary incontinence
Overflow incontinence	Unexpected leakage of small amounts of urine because of a full bladder	Anatomic obstructions of urethra, a contractile bladder, neurogenic problems
Functional incontinence	Urinary accidents associated with the inability to toilet because of impairment of cognitive and or physical functioning	Severe cognitive, mobility or psychological impairments
Nocturnal enuresis	The complaint of loss of urine during sleep	Genetics, nocturnal polyuria, idiopatic
Continuous incontinence	The complaint of continuous leakage	Diabetes, multiple sclerosis, blockage of urinary tracts
Total incontinence	The continuous and total loss of urinary control	Neurogenic or cognitive problems, vesicovaginal fistula, spinal cord injuries

Table 1. Types of urinary incontinence, their definitions and pathophysiologic mechanisms with possible causes.

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The main purpose of the conservative management is to strengthen the pelvic floor and modulate behaviours that influence bladder function, whereas pharmacological therapies targets innervating the bladder and sphincter [16, 22]. The aim of conservative rehabilitation therapy is to stabilise the urethra by increasing pelvic floor muscle (PFM) strength (force-generating capacity). Pelvic floor muscles (PFM) strength is important to support and stabilize bladder neck and urethra [15].

The researchers and patients see improvements in UI in different ways. Sufferers define improvement according to reduced lifestyle limitations or healing overall perception of bladder symptoms, especially recovery of urine leakage. In the view of the researchers, an improvement is a decrease in the amount of urine lost during pad tests, or any statistically significant decrease in the frequency of UI episodes [35].

There are some conservative therapy modalities to obtain improvement in patients with UI. Among these techniques, pelvic floor muscle training (PFMT), electrical stimulation (ES), biofeedback, magnetic stimulation (MS) and vaginal cones (VCs) are mostly used as a therapy method before surgical options in some situations. Training and strengthening the PFMs is recommended as the first-line management for women with SUI, UUI and MUI [15, 23].

2. Pelvic floor muscle training

Pelvic floor muscle exercises (PFME) offers a possible reprieve from UI [36]. Therefore, PFMT remains a key factor in the prevention and treatment of UI [14]. This conservative therapy appears to have no significant side effects and help in improving symptoms. It can therefore be considered as the first choice of treatment for UI in women. The guideline states that pelvic floor exercises have been found to be effective in the treatment of incontinence in more than 50% female patients [23, 37]. It is commonly recommended for the treatment of patients with SUI or MUI [38]. Less commonly, it can be used for UUI [39]. It has been demonstrated that PFME can improve the strength of the female PFMs contraction, increase intraurethral pressure and elevate the urethra to maintain continence [40, 41]. Through the agency of all these benefits, symptoms of SUI in women result in improvement. In addition, fast-repeated contractions of the levator ani musculature have been demonstrated to stimulate the sacral reflex arch to suppress urinary urgency and frequency and improve UUI symptoms [41, 42].

PFMT for the management of UI has been described in several ancient texts of China, India, Greece and Rome [37, 43]. It was thought that strengthening this group of muscles would promote health, longevity, spiritual development and sexual health. The first report of PFMT in modern medicine dates back to 1936, when a paper by Margaret Morris described tensing and relaxing of the PFMs as a preventative and treatment option for urinary and faecal incontinence [37]. Subsequently, PFMT was introduced to the British physiotherapy profession. However, PFMT was popularised by Arnold Kegel for the management of UI in 1948 and has since remained as a first-line conservative measure [44–46]. In his paper “Progressive resistance exercise in the functional restoration of the perineal muscles", he reported the successful treatment in patients with SUI [47], and the term Kegel exercise, as a common misnomer for pelvic floor exercises, came into existence [37]. As mentioned above, PFMT commonly recommended and used for the treatment for SUI or MUI especially with SUI symptoms [44, 48, 49] and pelvic organ prolapse (POP) [50], as the first choice of treatment for SUI/MUI [38]. Less commonly, it is used for the treatment of UUI [32, 39, 48, 49].

PFMT is mostly aimed to improve the function of the PFM in terms of strength which is the maximum force generated by a muscle in a single contraction, endurance which is the ability to perform repetitive contractions or to sustain a single contraction over time and coordination that is muscular activity prior to effort and on exertion, or any combinations of these, thus providing thereby maximum support to the pelvic organs, especially the bladder neck and the proximal urethra, before and during an increase in intra-abdominal pressure, to prevent urine leakage [39]. PFM strength training results in an improved support to the bladder neck and proximal urethra, which have been observed to be poorly supported in some patients with UI. This is achieved by elevating the position of the levator ani muscle through muscle hypertrophy and increased muscle stiffness [39, 51].

There are 12 striated muscles arranged in three layers in the pelvic floor. These three layers consist of the endopelvic fascia, the levator ani muscles and the perineal membrane, respectively. The endopelvic fascia is the connective tissue floor of the pelvis, extending between the viscera to the pelvic walls. It is considered as first layer of pelvic floor. The levator ani muscles and their fascia are considered as second layer which is also referring as the pelvic diagram. It serves as horizontal sheet with anterior hiatus in the midline. The urethra, the vagina and the rectum pass through within this hiatus. If this layer is disrupted during parturition, there will have a consequent effect on all the three structures. The last layer is the perineal membrane (or in other words urogenital diaphragm) and lies at the hymeneal ring. In females it does not complete due to the position of the vagina. Thus, this membrane provides some weak support for the urethra. Lying under the perineal membrane are the ischiocavernosus, bulbocavernosus and superficial transverse perineal muscles [52].

The PFMs consist of muscle fibres, of which 70% are slow-twitch type 1, that is, fatigue-resistant fibres maintaining static tone and 30% are fast-twitch type 2 that is fatigue-prone fibres being capable of active contraction. In some situations like aging, inactivity and nerve innervation damage, there might be a decrease in the proportion of the fast-twitch fibres [53]. Doing exercise can increase PFM strength, durability and responsiveness [47, 54].

In order to prevent UI, PFMT works in several ways. In females, the bladder neck and urethra are supported by the PFMs. Just before intra-abdominal pressure begins to increase, PFMs is activated and this activation is maintained during increased intra-abdominal pressure. Contraction of PFMs pressures the urethra to the pubic symphysis. Consequently, the urethral resistance increases and this increased resistance prevents involuntary loss of urine. It is demonstrated that urethral and bladder neck descent and leakage of urine can be prevented by a well-timed contraction when intra-abdominal pressure increases. The repetitive exercises which are done regularly cause muscle hypertrophy, improve the urethral resistance and help to prevent POP [50].

PFMs integrity appears to play an important role in the continence mechanism. Therefore, there is a biological rationale in improving the use of PFMT in preventing and treating UI in women [47]. There are two main biological reasons for using PFMT. Firstly, a voluntary contraction before and during a cough has been shown to effectively reduce urinary leakage during cough (a manoeuvre termed "The Knack") [55]. Secondly, increase in PFMs strength is thought to beef up long-lasting structural support to the pelvis by ascending the levator plate. This is also enhanced by hypertrophy of the muscles which increases further the stiffness of the PFMs and connective tissues [51]. Thus, perineal descent during increased intra-abdominal pressure could be prevented by improving the PFM strength. Improvement in the PFM strength may also facilitate PFMs before and during the effort, thereby reducing SUI in women. Given the above biological rationale, while treating SUI, the focus of any PFMT should be improving the timing of the contraction, strength and stiffness of the PFMs [48].

PFME, which includes repetitively selective voluntary contraction and relaxation of the specific PFMs [27], is used to increase the strength of the PFMs and periurethral muscles. This in turn improves the efficiency of the supportive function by immobilising the urethra and improves the sphincteric function by increasing the intraurethral closure pressure during physical activities [51, 56]. The movement is a voluntary inward and upward contraction and squeeze of the pelvic floor. The basic principles of muscle training according to the American College of Sports Medicine are based on progressive overload, specificity and periodisation, which need to be incorporated into any resistance training programme in order to achieve maximum results [48]. As the pelvic floor is entirely composed of striated muscles, the principles of strength training for the striated muscle can also be applied to PFMs [37, 48]. During the PFMT, the purpose of progressive overload is to gradually increase the intensity of the exercises and the number of repetitions throughout the exercise programme. By submaximal loads, the speed of the repetitions should be adjusted according to the desired goal. For endurance improvement and power training or lengthened for strength, the rest periods should be shortened. In the end, the overall volume of training should be increased gradually [37].

Different studies have recommended different number of contractions ranging from 8 to 12 contractions three times a day to 20 contractions four times a day and up to as many as 200 contractions per day [37]. To obtain increased muscle strength of PFMs, it is necessary to apply a method, named as the progression model. This method requires doing repetition from 8 to 12 times with maximum contractions at moderate velocity and 1 or 2 min breaks between sets. Moreover, number of initial trainings which were two to three times in a week should be increased to four to five times per week. Additionally, as a person can achieve the current workload for one to two repetitions over the determined number, the initial work load should be increased about 2–10%. In order to increase muscle endurance, the progression model suggests the need for light to moderate loads (40–60% of maximal load) with high repetitions (>15) and short rest periods (<90 s) for endurance training. In PFMT, progression can be achieved by changing positions from gravity-free to antigravity or through the introduction of cones into the exercise sessions. Finally, if it is desired to obtain better outcomes according to progression model, velocity and coordination training ("The Knack") should include the use of repetitive, voluntary PFMs contractions in response to specific situations; for example, prior to and during coughing, lifting an object or jumping [48]. The National

Institute for Health and Care Excellence (NICE) recommends PFMT comprising at least eight contractions three times daily for at least 3 months as the first-line therapy for the women with SUI [23]. The American College of Obstetricians and Gynaecologists also recommends PFMT as the first-line therapy for the women with SUI and states that PFMT is more effective than ES or VCs [57].

There are different recommended postures that are adopted during the prescribed exercise regimen. These postures include sitting, kneeling, standing, lying down and standing with legs astride. There are huge variations in the recommended duration of the prescribed regimen starting from 1 week to 6 months, with 3 months being most frequently recommended. Across studies the number of contractions ranges from 8 to 12 contractions three times a day, to 20 contractions four times a day, to as many as 200 contractions per day [37]. NICE recommends a trial of supervised pelvic floor exercises, consisting of at least eight contractions three times a day for a minimum of 3 months, as the first-line treatment for UI [37, 58]. The recommended supervised PFMT by The International Consultation on Incontinence Committee for women with SUI is 8–12 weeks before reassessment with a possible referral for further management, if the patient does not improved desirably [37, 59]. The intensity of the contraction seems to be more important than frequency of training [60].

To obtain better outcomes from PFMT, PFMs may be activated together with the abdominal muscle. It is known that active contraction of the transversus abdominis (TA) muscle is associated with co-activation of the PFMs. However, PFMs are not raised in all women by the TA muscle contraction. In recent studies, it is suggested that the relationship between PFM and TA muscle vary between continent and incontinent women. In incontinent women with SUI, TA muscle contraction with the PFM being displaced less during the contraction of TA muscle as compared to the continent women [37].

Among the conservative treatment options, this conservative therapy appears to have no side effects and enables improvement in symptoms; it can therefore be considered as a first choice of treatment for UI in women [37].

3. Electrical stimulation

Another popular intervention used by physiotherapists to reduce UI is ES. It is one of the first-line conservative treatment option for female UI and widely used in the management of it. ES physiologically produces muscle hypertrophy, normalises the reflex activity of the lower urinary tract and increases circulation to muscles and the capillary system [7, 61]. It may also increase conscious awareness of the action of PFMs to provide an improved ability to perform a voluntary muscle contraction. With regard to a recent systematic review, ES does not differ from sham stimulation or PFME in terms of improvement in UI [62]. However, ES is a priority for women with difficulty in contracting the PFMs initially [7, 61].

ES is a therapeutic option for patients with UI and based on the application of electrical impulses to the peripheral nerves [63]. In 1963, ES of the muscles of the pelvic floor was first offered by Caldwell to address urinary and faecal incontinence. Since then, clinical trials

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showed some efficacy in treating UI particularly in SUI, UUI and MUI [31, 64]. It includes the application of ES to the suprapubical, transvaginal, sacral and tibial nerves [64] and denoted as functional ES [31]. The process of sacral nerve stimulation includes implantation of a wire electrode in one of the sacral foramina, usually S3, which is then connected to a stimulator device. In most cases, it is useful for refractory UI and idiopathic urinary retention [65, 66]. ES of the tibial nerve is a peripheral non-implantable method, which can be applied percutaneously with a needle or transcutaneously with a stick-on electrocardiograph-type electrode [31, 65]. In this, S2-S4 crossroads of the sacral nerve plexus delivers neuromodulation to pelvic floor through the less invasive route of the posterior tibial nerve. There are projections in this area to the sacral nerve plexus. A feedback loop is generated, modulating bladder innervations [31, 67]. The main of suprapubical ES is to make a direct stimulation of S3 nerve roots, in order to inhibit the detrusor activity, equivalently to the sacral ES, but is less invasive [31, 68].

ES is generally directed with a removable device through vaginal or anal stimulation [69]. The electrodes can be implantable or non-implantable, and the ES can be of long or short duration [31]. The electrodes are placed in the vaginal or rectal canals in such a way as to acquire direct contact with a remarkable amount of afferent nerve fibres of the pudendal nerve [70]. It is necessary to partially or totally innervate the pudendal nerve so that nerve stimulation can occur [70, 71]. The advantage of this therapy is that it does not ask for voluntary patient effort; however, the passive muscle contractions are generally weaker than the voluntary ones [63].

The mechanism of action of this modality relies on the ES to induce hypertrophy of skeletal PFM [25, 72], which cannot be achieved by voluntary muscle contractions via reflex contractions, while activating the detrusor inhibitory reflex arc [25, 72]. The important outcomes of electrical stimulation are the reorganisation of spinal reflex and regulation of cortical activity, which are related to the mechanism of action of this therapy [73]. The mechanism of action of ES is to promote bladder relaxation by inhibiting the parasympathetic motor neurons. Other studies reported that transvaginal ES causes contractions of the pelvic floor, increasing the number of muscle fibres with rapid contraction, which are responsible for continence in conditions of stress [31, 65].

The aim of ES in the treatment of patients with SUI appears to improve the function of the PFMs [74] by stimulating its contraction, with the goal of achieving a training effect to ensure that the pelvic floor will provide adequate support with the advancement in PFM strength to prevent urine loss during an increase in intra-abdominal pressure [75]. While for women with UUI, the intention seems to be to inhibit detrusor overactivity [74].

The principle of ES for the treatment of SUI based on the delivery of electrical impulses to directly trigger reflex contraction of the PFMs through the pudendal nerve and by activating three concomitant central actions. These concomitant actions are activation of hypogastric inhibitory fibres to the bladder, central inhibition of pelvic outflow to the bladder and central inhibition of the ascending afferent pathway from the bladder. Voluntary pelvic floor muscle contraction does not lead to the activation of this reflex pathway [72, 76].

ES can evoke direct contractions of the PFM in patients with detrusor overactivity or symptoms of urgency and UUI. The contractions stimulate afferent fibres of the pudendal nerve going to the sacral spinal cord [2], and this stimulation induces a reflex contraction of the striated paraurethral and periurethral muscles, accompanied by a simultaneous reflex inhibition of the detrusor muscle [69, 72, 76, 77]. This response leads to a reflexive decrease in the feeling or sensation of urgency and inhibits parasympathetic activity at the level of the sacral micturition centre in the sacral cord that eventually reduces involuntary detrusor contractions and reflexively activates the striated periurethral musculature [2]. Peripheral innervation of the PFMs must at least be partly intact to gain a therapeutic effect of pelvic floor stimulation in women with detrusor overactivity [78].

There are major inconsistencies that exist between several electrostimulation protocols, partly due to a lack of understanding of the physiological principles of electrostimulation and the way it could contribute to recuperation from SUI in women. Different forms of electrostimulation are distinguished in physical therapy, brief maximal stimulation, which is usually performed at a physical therapy centre and prolonged, low-intensity electrostimulation, which can also be performed at home. The potential side effects of electrostimulation include pain and tissue damage; electrostimulation is contra-indicated if patient is using a pacemaker or in case of pregnancy [61]. Stimulation parameters have been defined on the basis of neurophysiological and clinical studies (**Figure 3**) [72, 79].

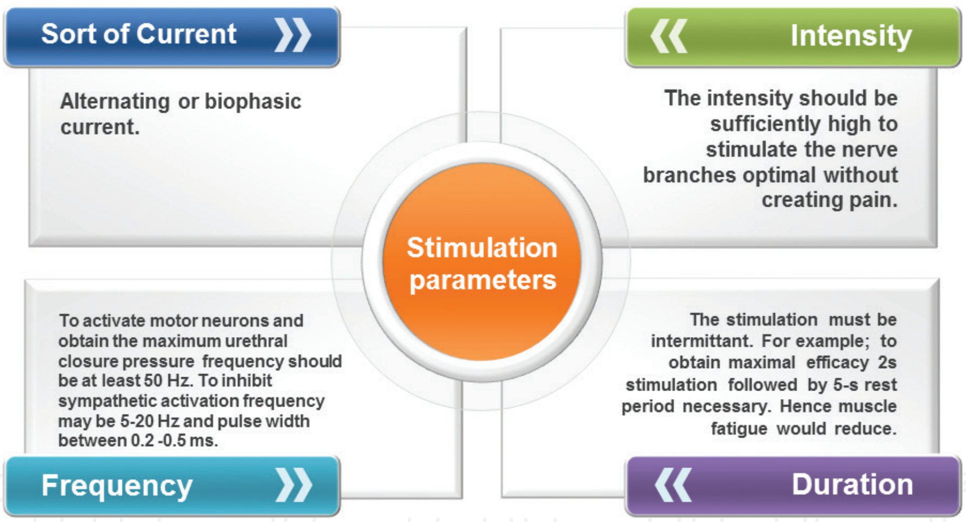

Figure 3. Stimulation parameters of electrical stimulation.

3.1. PFME and electrical stimulation

Patients with very weak PFMs often have difficulty identifying and activating their muscles to improve symptoms of SUI. In this situation, ES can be useful to activate PFMs. To improve the efficacy of PFMT, it is combined with ES. Hence, combination of these might facilitate training by helping patients to better identify and strengthen their muscles, leading to better treatment outcomes [34]. The sense of contracting the PFMs is a useful reminder to the patient of the sensation that should be perceived, and they are encouraged to actively try to contract the PFM during ES [33, 79].

It may be that electrical stimulation is particularly appropriate for patients who are initially unable to contract their PFM, but once active contraction is achieved, PFME may be more effective [80, 81].

In most physiotherapy practices, electrical stimulation is used for partially paralysed muscles and to stimulate the activity when the patients are unable to contract it voluntarily. Most physiotherapists prefer stop using ES and continue with regular muscle training when the patient can contract voluntarily [82].

In general, there are two main mechanisms by which ES is believed to work. One of these ES in the form of neurostimulation aims to stimulate motor efferent fibres of the pudendal nerve, which elicits a direct response from the effector organ, for instance, a contraction of the PFMs [70, 83, 84]. Other mechanism of these, ES in the form of neuromodulation aims to remodel reflex loops, for instance, the detrusor inhibition reflex by stimulating afferent nerve fibres of the pudendal nerve that influence these reflex loops via the spinal cord [70, 85].

4. Biofeedback

One of the recent definitions of biofeedback is giving an indication on bodily processes using an external sensor within a group of experimental procedures, mostly in order to readjust the measured quality [82]. Another definition is coexisting, simultaneous or terminal biological feedback of biological signals allowing a person to determine and modify a bodily function of which they are usually unacquainted [86, 87].

Assisting patients for the determination and also their exercise the PFM properly is accepted as the main objective of biofeedback [34]. Although it is not a therapy in itself, it is possible to be applied in the treatment of patients with SUI for several reasons. Firstly, it provides them an indication of their PFM activity at rest, in contraction and relaxation modes; secondly, it gives not only the strength of individual contractions of the PFMs but also the strength of the contracting PFMs or the way in which certain muscles contract and the direction of contraction. Since biofeedback gives information related with the learning and controlling the functions of the activity of striated muscles through varied audio-visual techniques, it can also be used to educate a certain patient suffering SUI, about the selective contraction of their PFMs. Introducing a sensor or electrode into the vagina or rectum is the most common method to provide biofeedback. By this way, the vaginal or rectal pressure or the electromyogram (EMG) signal of the sphincter muscle is recorded. The visual or acoustic information about the pressures measured and/or the EMG signals are sent to the patients, thus enabling them to see the magnitude of the force being generated by the PFMs and to know if this force has reached its maximum level. The technique can also be used to visualise progress, which obviously motivates patients to keep exercising (biofeedback device is shown in **Figure 4**). Biofeedback is not a therapy to be applied solely; however, it is possible that a combination of biofeedback and PFMT is beneficial for decreasing the reluctant leakage of urine in SUI suffering patients. The efficacy and professional knowledge of a physical therapist plays a significant role on the effective results of biofeedback usage [61].

Figure 4. Biofeedback device.

Even though biofeedback technology is accepted as a proven technique assuring proper muscle control, it needs specific equipment as well as professional expertise, which results in longer time period and higher financial cost [34]. The contribution of the field of psychology has been required for the development of the biofeedback equipment; hence, varied forms of stress are needed to be measured through sweating, heart rate and blood pressure. Using vaginal palpation and clinical observation during the instruction of accurate contraction was indispensable for Kegel's training protocol [47]. During Kegel's exercise, as biofeedback, a combination of PFMT and vaginal squeeze pressure measurement was used. Nowadays, in clinical practice, wide ranges of biofeedback apparatus are in use [82]. Biofeedback devices vary considerably. They can be inserted into the rectum or vagina or placed on the perineum. Many of the biofeedback devices addressed in this review are either air- or water-filled balloons inserted into the rectum or vagina to measure pressure. Vaginal, anal and intra-abdominal pressure can be measured regulated by the balloon catheters' quantity and induction. The other main group of biofeedback devices measures electrical activity (i.e. electromyography) via surface metal electrodes on vaginal or anal probes. Displaying movement, such as moving bladder neck upwards, is another claim of biofeedback, which can be provided by ultrasound real time images [87].

A number of studies have tried to figure out which method is more beneficial to teach pelvic floor muscle control: biofeedback training or digital palpation with verbal feedback. However, they are not consistent, and there is need to studies coming up with a clear benefit biofeedback to a PFMT program [34, 87]. Biofeedback could be implemented for patients who cannot identify their muscles well by other methods. Additionally, it is suggested that behavioural methods can be used more widely particularly in settings where biofeedback is not accessible [34].

Biofeedback-assisted exercises present the advantage of additional acoustic and visual guidance for the patient, which makes it easier for them to learn and perform the exercises appropriately [88, 89]. Another advantage of biofeedback is to help the women who have difficulty in isolating their PFM during training. Furthermore, patients who can identify the PFM often find that the required daily exercise routine is burdensome. Most of the patients fail to comply with the PFMT for a long-term [89, 90]. ES is a non-invasive, passive treatment that produces a muscle contraction [89, 91]. PFM contraction by indirect nerve stimulation and polysynaptic reflex responses is caused by transvaginal electrical stimulation (TES) [89, 90, 92]. As long as performed accurately, PFMT results more effective than ES because of the indirect stimulation and reflexive contraction. Biofeedback-assisted PFMT and TES have been used together to improve therapeutic effect [89].

4.1. PFME along with biofeedback

In the field of urology or urogynaecological, the term “biofeedback” is often used to classify a method different from PFMT. Biofeedback is helpful for training and evaluating response from a single PFMs activity. In the area of PFMT, with both vaginal and anal surface EMG, urethral and vaginal squeeze pressure measurements have been utilised with the purpose of making the patients to know better their muscle functions and to enhance and motivate patients’ effort through training [82, 93]. PFME are possible to be supported by biofeedback, since it gives relative information on unconscious physiological processes. Provided information establishes the primary support for active self-control processes under observation [69].

In SUI treatment, biofeedback could be used in combination with PFMT to demonstrate PFM activity at rest, on activity and in relaxation period. In addition, it represents the ability of a person (by electromyogram) or overall (pressure measurement) PFM contraction. However, combination of PFME with biofeedback is not more effective than PFMT which is done solo [75, 94, 95]. Although each treatment modalities are useful by itself, it is probable that biofeedback added value in SUI patients suffering unawareness and/or control of the pelvic floor, quick improvement from the beginning phase and motivate the patients for the exercise [60, 75].

The exact contraction may be verified by using biofeedback or manual palpation. In women, biofeedback is applied by using small electrodes which are placed around the anus or by using an internal vaginal electrode. Biofeedback allows women to see their muscle output during an exercise instantly. However, information available in the literature suggests that PFME with biofeedback is not as effective as PFME applied alone. On the other hand, combining PFME with biofeedback can be clinically beneficial and acceptable treatment procedure for certain groups of woman. A practical strategy may be to begin with PFME with biofeedback for those who might have difficulty in understanding how to contract or are unable to contract the PFM. Biofeedback can also be used to teach the correct form of PFME [7].

5. Vaginal cones

PFMT is the main approach of conservative (non-surgical) treatment in SUI. It is based on strength training or identification or both for the PFM to overcome weakness by increasing the support of urethra and bladder, and improving sphincteric action of muscles around the urethra [96].

On the other hand, this muscles group seems rather difficult to be determined and controlled by women. Moreover, these muscles are below par to the training completion; hence, it will probably require other intervention modalities [25]. In addition, incorrect PFMs contractions can make the incontinence worse [97]. While considering these reasons, weighted VCs were developed as a method of strengthening and testing the function of the PFM [98].

Plevnik introduced the usage of VCs in 1985 [98]. His aim was to strengthen PFMs with the VCs by inserting them in the vagina higher to the pelvic floor musculature [63]. Theoretically, when a cone is placed in the vagina, the PFMs need to be contracted to prevent the cone slipping out [96]. The sensation of losing the cones from the vagina provides a strong sensory feedback and prompts a PFM contraction in order to retain the cone [74]. In order to keep the cone inside the vagina, these muscles are needed to be contracted. Same sized but different weighted set of VCs are given to the patient and she is asked to insert a cone of increasingly heavier weight until she can hold the earlier lighter one [61, 63]. Developing muscular overload is provided by the cones. During the exercise process, the patient inserts the selected cone intravaginally, above the level of the levatores muscle plate, using a standardised procedure, and tries to hold the cone in place for up to 15 min by contracting her PFMs [61, 99]. If a positive result is obtained twice in a row, the training can be continued with the subsequent heavier cone. A training based on this principle is believed to strengthen the PFMs under simultaneous proprioceptive feedback [61].

There are some perceived advantages of the cones over traditional methods of training the PFMs [96, 100–102] and these are demonstrated in **Table 2**.

The probability of maintaining sensory-motor biofeedback brings about the certain advantages of strengthening the PFMs by using VCs [103]. This sensory-motor biofeedback can possibly maximise the neural gains as the greatest activation and synchronisation of the motor units [104]. And hence, the vaginal cone usage would support an accelerated improvement in muscle strength through neural mechanisms, followed by muscle hypertrophy in response to resistance training with progression of the cone weight [104, 105].

Although working out with cones has been criticised as not being suitable for all women especially with a narrow and scarred vagina or individual admissibility and weight of the cone may not represent the strength of PFM, weighted VCs has been shown to increase the strength of the PFM and has been found to have similar efficacy in comparison with PFME and ES. However, it enjoys the benefit of requiring less time to train for its application with need of only one or two consultations, being able to be used without supervision, providing a form of biofeedback and helping muscle synchronisation with increases in abdominal pressure [96, 104]

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1	Advantages of the cones
2	The exercise is individualised for each woman
3	Less time is needed to teach women to use the cones than to teach PFMT
4	It does not take much time to insert and remove cones
5	The use of VCs can be self-taught, and they can be used without supervision and vaginal examination
6	The graded increases in cone weight represent improvement in muscle strength and motivates women to continue
7	Usually only one consultation is needed
8	Cones can be used in self-instruction of conventional PFMT
	The cones provide a form of biofeedback as the sensation of one slipping out induces a PFM contraction which may both strengthen muscles and help to synchronize muscle contraction with increases in abdominal pressure

Table 2. Advantages of the weighted vaginal cones.

6. Mechanical devices

Vaginal support prostheses have been in use for a long time. Although these devices are primarily used for POP, there has been some interest in developing those specific for SUI. Some potential advantages of these vaginal support devices include their potential to be applicable to the majority of the incontinent patients, mild side effects and non-requirement of any specific testing (e.g. urodynamic testing). Conversely, these devices do not definitively treat the problem, and if the problem worsens, the patient health may require a surgical intervention. Furthermore, these devices have no correction effect on intrinsic sphincter deficiency in reality, and may not help patients with hypermobility. There is a recent Cochrane review looked at seven trials involving over 700 women [106]. Three are small trials comparing mechanical devices (intravaginal such as pessary, sponge or tampon-like device) with no treatment suggested that use of a mechanical device might be better than no treatment; however, results were not conclusive. Urethral plugs passively occlude and/or coapt the urethra, but require removal for voiding. Overall results of the studies of Staskin and associates were generally favourable [107]. Although urethral inserts can work for most of the women with pure SUI, the shortcoming that these devices must be removed and reinserted with each void is not accepted by most of them [25].

7. Magnetic stimulation

Magnetic stimulation is a novel approach, coming up in recent years. The United States Food and Drug Administration approved MS as a conservative treatment for UI in 1998 [29, 108]. Ever since, to evaluate its efficacy in UI, more than 50 clinical experiments have been conducted worldwide [29, 109]. However, the multitude of information was overwhelming. According to clinicians, there is a need to compile these informations so that evidence-based decisions could be taken [29].

To use of MS there must be special chair. An electric current is passed around a metal coil, generating an electromagnetic field. When the person exposed to this field, electric current is generated in tissues. Thus, PFMs is stimulated by the MS in a similar way to ES. In this case, the patients are required neither to undress nor to insert electrodes, as the electromagnetic fields spread easily through tissues causing ES [110, 111]. It has an armed treatment chair for the patient to sit comfortably and a compact control unit (**Figure 5**). It contains a generator, control buttons, a monitoring screen and modem, and is equipped with automatic payment system for treatment sessions. The stimulation coil is situated underneath the treatment chair to ensure direct focus on PFMs [108, 111].

Figure 5. Equipment of magnetic stimulation.

It has not been established that the optimal frequency and pulse duration in MS yet. However, using more than 50 Hz has been reported as necessary to achieve an adequate PFMs contraction for treatment of SUI [109], and 38–40 Hz and less than 10–20 Hz for UUI [29, 112, 113].

Conservative therapy should be considered prior to the initiation of medical or surgical treatment of UI. Because of its demonstrated efficacy, low risk and apparent low cost, published clinical guidelines recommend that conservative management. Pelvic floor muscle training is recommended as first-line conservative management for treating urinary incontinence. Additional physical therapies, such as electrical stimulation, biofeedback or magnetic stimulation can be considered in women who cannot actively contract their pelvic floor muscles, in order to aid motivation and adherence to therapy. Physiotherapists need to understand the nature of the urinary incontinence, the influence prognostic factors and the principal of therapy modalities.

Author details

Özlem Çinar Özdemir* and Mahmut Surmeliv

*Address all correspondence to: ozlemcinar314@hotmail.com

School of Physical Therapy and Rehabilitation, Abant Izzet Baysal University, Bolu, Turkey

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