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Treating Urinary Incontinence with Electrical Stimulus: A Review

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Abstract

Urinary incontinence markedly affects women's quality of life. There are several methods to mitigate or reduce this problem such as medication, surgery, or exercises. Of various types of urinary incontinence, overactive bladder consists of one category, which is often resistant to various treatments. Electrical stimulation methods have been considered a treatment option of overactive bladder. We here briefly summarize various treatment options for urinary incontinence, with special reference to the role of electrical stimulation methods for this disease. Electrical stimulation methods include vaginal electrical stimulation (VES), posterior tibial nerve stimulation (PTNS) and sacral nerve stimulation (SNS). The three methods have shown good results, and these findings will contribute to achieving a better quality of life for patients.

Keywords

Urge Urinary Incontinence, Overactive Bladder, Posterior Tibial Nerve Stimulation, Sacral Nerve Stimulation

1. Introduction

Urinary incontinence is a common morbidity with a prevalence of about 20% - 30%, more prevalent in women, with 30% of females in contrast to 1.5% - 5% in males [1]. It consists of four main different entities including stress urinary incontinence, urge urinary incontinence, overflow incontinence and functional incontinence.

Urge incontinence is a manifestation of overactive bladder (OAB). OAB has a prevalence of about 20% in 40-year-old women. It is characterized by urgency, frequency, nocturia and urge incontinence. It is manifested with detrusor over-

activity which can be demonstrated and diagnosed using urodynamics. The main risk factor for OAB is age [1] and it has not been found associated with pregnancies or vaginal deliveries. It significantly affects quality of life including increased health care visits, higher rates of depression and anxiety, poorer quality of sleep, increased falling and subsequent injury, increased rate of urinary tract infection and reduced work productivity. The estimated direct annual cost of OAB in the United States is over 50 billion dollars [2] [3]. OAB is characterized by urgency, frequency, nocturia and urge incontinence. Frequency is the most common symptom (85%), followed by urgency (54%) and urge incontinence (36%). The prevalence of OAB is higher in Hispanic and Black women than in Caucasian [3].

The treatment for OAB is mostly conservative, ranging from different medications, physical therapy through electric nerve stimulation and Onabotulinumtoxin A injections [2].

The aim of this paper is to review the different treatment options for the OAB.

2. First-Line Treatment

2.1. Lifestyle Changes

Certain lifestyle changes including avoiding caffeinated beverages, drinking at night and bladder training are a part of the first-line therapy for overactive bladder. Keeping a bladder diary can also be useful in understanding the patterns of urination and drinking allowing recognition of a pattern which can be changed.

2.2. Physical Therapy

Pelvic floor muscle training (PFMT) is the first line used for both stress and urge urinary incontinence. This training consists first of an effective pelvic floor muscle contraction lifting the muscles in a cranial and forward direction, increasing the urethral pressure, and preventing urine leakage. Ultrasonography and MRI have demonstrated the effectiveness of these movements during active contraction and the impact on the urethral position. Women treated with physical therapy reported cure or improvement, better quality of life, fewer leakage episodes per day and less urine leakage on short office-based pad tests than controls [4].

2.3. Vaginal Electrical Stimulation (VES)

The VES is a device allowing for pelvic floor muscle training and treatment of urinary incontinence which uses electric stimulation for pelvic floor training and is one of the uses of electricity for the treatment of urinary incontinence. It consists of non-implantable pelvic floor electrical stimulation delivered by a vaginal probe connected to an external generator (**Figure 1**). The goal is to exercise and tighten or contract the nerves and muscles to strengthen the pelvic floor [5]. The VES involves placing electrodes vaginally, percutaneously or transanal, and the electrical current is applied to them with a wire connected to an external

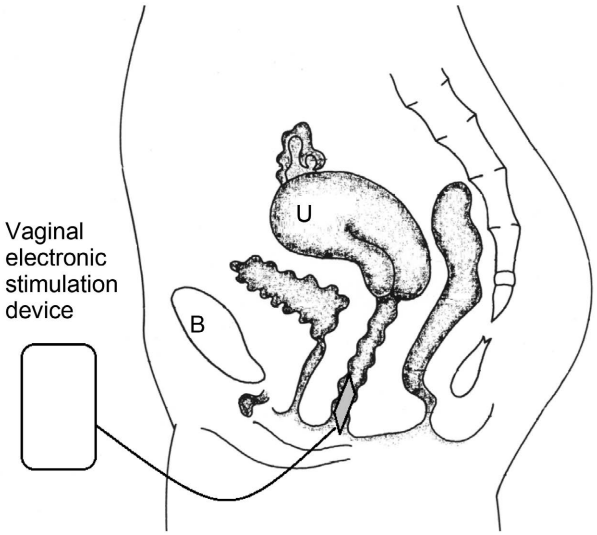

Figure 1. Vaginal electrical stimulation device use. B-Bladder, U-Uterus.

stimulator battery. The treatment can vary from 20-minute sessions twice a week to daily sessions [5].

For urge incontinence, the objective is to fortify the inhibitory system by inhibiting neurons that operate at low frequencies, the stimulation is administered at 5 - 20 Hz. For stress incontinence, the goal is to activate the motor neurons, so it operates at 20 - 50 Hz. And for mixed incontinence, it can be alternated between the two ranges described above [6].

With this treatment, similar but extended benefits as with Kegel exercises are obtained as it focuses on the correct muscles, without any effort from the patient. This alternative strengthens and tones the sphincter and pelvic floor muscles and improves the patient's muscle awareness [5]. Possible side effects include vaginal irritation, occasional episodes of pain, tingling of the thigh, vaginal infection, urinary tract infection, and/or local reaction to the electrode gel [5].

Electrical stimulation is contraindicated when the patient has at least one of these conditions: Complete denervation of the pelvic floor, dementia, demand cardiac (heart) pacemaker, unstable or serious cardiac arrhythmia, pregnancy, active genitourinary tract infection, unstable seizure disorder [5]. The efficacy has been explored by different studies; one study explored the use of pelvic floor stimulation in 40 patients. Out of which 10 had genuine stress incontinence, 15 suffered from urge incontinence due to idiopathic detrusor instability, not responsive to medications and fifteen patients suffered from mixed urinary incontinence. A total of 25 patients were improved by the treatment with eight patients remaining symptom free for over six months [7]. Another study compared pelvic floor exercises, electrical stimulation, vaginal cones or no treatment in 118 patients for six months. A statistically significant reduction on the number of stress urinary episodes and improvement in the quality of life in all subjects compared to the control group [8]. One last study consisted of 359 women with

either stress, urge or mixed urinary incontinence. They were treated with stimulation for 20 - 30 minutes per day, 5 days a week for 10 weeks. The study demonstrated an overall cure rate of 63.5%, and an improvement rate of 15.6%. The patient satisfaction rate was 83.6% and only 1.4% of patients described pain at the highest stimulation intensities [9].

With this evidence, we can conclude that this method has a lot of advantages in terms of social and psychological consequences and quality of life.

2.4. Pharmacotherapy

Medications are the second-line treatment, there are mostly two groups, the antimuscarinic drug group, including Tolterodine and Oxybutynin, and Mirabegron, a selective β3-adrenoceptor agonist [10]. Antimuscarinics are the most common pharmacotherapy for OAB, their mechanism of action is blocking the receptors and stopping the contraction of the bladder. However, the systemic blockade of muscarinic receptors can lead to bothersome side effects including dry mouth, constipation, and headache. Mirabegron is a selective β3-adrenoceptor agonist, with lower side effects compared to antimuscarinic [11]. Mirabegron has also been shown to have higher persistence rates compared with antimuscarinics with the same results and less side effects [10]. In one study [10], patients using mirabegron were more likely to continue the treatment than the ones with antimuscarinics. Data from a US survey (>5000 respondents) suggested that the most common reasons for discontinuation of antimuscarinics were not seeing expected results, use of another medication, coping without medication, side effects, cost and unwillingness to take long-term treatment. Mirabegron provides an alternative treatment with the potential to increase persistence and has important considerations for managing chronic conditions and for payers when considering economic solutions [10].

3. Third-Line Treatment

In cases in which the first and second treatment lines fails, or the side effects are too substantial to continue with the treatment, we move on to the third-line treatment. The third line includes two possible treatments, the first is Botulinum injections to the bladder and the second is electric neuronal stimulation [2].

3.1. Botox Injections to the Bladder

The botulinum toxin is a powerful neurotoxin derived from Clostridium botulinum and selectively blocks presynaptic release of acetylcholine from nerve endings. This reduces contractility and causes a temporary degree of paralysis. This toxin has been used in the medical field for many years and is most known for cosmetic treatments. To treat overactive bladder, it is administered by injection into certain areas of the bladder, using a cystoscope. The injection is made in 20 places at the level of the posterior wall of the bladder, above the trigone. The recommended dose ranges from 100 - 300 units [2].

3.2. Electric Nerve Stimulation

Electric nerve stimulation is another third-line treatment for urinary incontinence that consists of providing electrical stimulus nerves leading to the bladder, including posterior tibial nerve stimulation (PTNS) and Sacral nerve stimulation (SNS).

To understand how nervous stimulation can help in urinary incontinence, we need to analyze first the nervous control of the bladder function:

The control of the bladder involves the somatic efferent and autonomic sympathetic and parasympathetic systems. The filling and emptying of the bladder are organized by three centers along the central nervous system that act with peripheral nerves on receptors in neuromuscular junctions of the muscles in the bladder, bladder neck, urethra, diaphragm, abdomen, and pelvic floor [12].

The sympathetic nervous system regulates the process of urine storage, the parasympathetic nervous system controls the bladder's contractions and passage of urine, and the somatic efferent system permits voluntary control over the external periurethral sphincter [12].

The brain controls the muscles in the body and movements through electrical messages carried by nerves. One big route of nerves runs from the brain to the sacral area. Muscles in the pelvic area such as the pelvic floor, urethral sphincters, bladder, and anal sphincter are controlled by the brain through the nerves. So, the main objective of most of the electrical stimulation is to attack this sacral area and correct the messages that are sent along these nerves [13].

The electrical stimulation may either make the muscles contract and therefore strengthen or encourage the growth of nerve cells causing the muscles to contract [14].

The electrical stimulation of the bladder is done by placing electrodes on the skin affecting continuous nerves that are connected to nerves in the bladder and surroundings. There are three types: vaginal electrical stimulation, as mentioned above, posterior tibial nerve stimulation and sacral nerve stimulation [14].

3.3. Posterior Tibial Nerve Stimulation (PTNS)

Posterior tibial nerve stimulation (**Figure 2**) treatment is a minimal invasive option that does not require surgical intervention and can be used in patients with overactive bladder and urge incontinence.

PTNS is a neuromodulation therapy that delivers harmless electrical impulses to the nerves. The stimulation is done by placing a tiny electrode or needle in the skin of the lower leg, by the ankle, near the tibial nerve. The electrode is connected to an electrical stimulator outside the body that sends pulses stimulating the tibial nerve in the leg. This nerve is connected to the nerve in the lower back, the sacral nerve, that controls the bladder, sphincter, and pelvic floor muscles. In this way, the stimulation blocks the nerve signals that are not working effectively and helps to gradually change the activity of the bladder and reduce incontinence [14] [15].

Figure 2. Posterior tibial nerve stimulation device with the needle placed in the ankle near the tibial nerve.

The treatment takes 30 minutes, and it consists of 12 sessions, once a week. Although some patients may require ongoing treatment to maintain the results [16].

The stimulus used in this method usually goes between 0 to 10 mA with a fixed pulse of 200 microseconds at frequency 20 Hz. The stimulator was left with the patient controlling the power setting for 30 minutes. And the sessions were once a week for 12 weeks [16].

The patients usually feel a pulsing or vibrating sensation around the leg or foot during the procedure but are never painful. There are some side effects, that are rare and not worrying, such as bruises or bleeding where the needle is inserted and tingling or mild pain. These effects are typically resolved quickly without further treatment or follow-up care [17].

Contraindications include having a pacemaker or implantable defibrillator, bleeding disorders, tibial nerve damage, current pregnancy or planned pregnancy in the duration of the treatment, severe lower extremity edema [17].

Most patients report symptom improvement within the first six treatments, but it can take up to 12 weeks to see results. One of the many advantages of PTNS treatments is that they are relatively inexpensive compared to the medications and surgical procedures [17].

One study showed that over 50% of the patients did not require pharmacotherapy, a statistically significant decline in urgency, frequency, incontinence and nocturia, and a significant reduction in costs [18]. Another study also had similar results, showing that the subjects who were treated with PTNS reported improved continence and higher quality of life [19].

So, the conclusion of this study was that both the PTNS plus BT and TTNS plus BT were more effective than BT alone in women with idiopathic OAB. In addition, they point out that TTNS had shorter preparation time, less discomfort level and higher patient satisfaction than PTNS [19].

3.4. Sacral Nerve Stimulation (SNS)

Sacral nerve stimulation consists of installing an electrical stimulator, sort of pacemaker under general anesthesia (**Figure 3**) under the skin above the buttocks.

Figure 3. Sacral nerve stimulation device with the needle placed above the buttocks.

It is attached to electrodes that send pulses to the sacral nerve located in the lower back. The sacral nerve carries signals between the bladder, spinal cord and brain and takes part in the bladder storage and emptying. Using this simulation, the signals to urinate are interrupted [14] [15].

As it is a complex procedure, it is divided into two stages, evaluation, and implant phase. The first stage is performed by placing a thin wire close to the sacral nerve, through a small cut in the lower back. The wire is connected to a stimulator outside the body that the patient will need to wear for up to three weeks. If the treatment has positive results and the symptoms get better, implantation of the device will take place. The device comes with a hand-held programmer to adjust the level of stimulation [15]. One study found that the optimal frequency is above 10 Hz [20]. Possible side effects caused by SNS include pain, wire movement, infection, temporary electric shock-like feeling and bleeding at implant site. Up to two thirds of patients will need another surgery within 5 years to fix the implant or replace the battery. Contraindications for SNS include pregnancy, underage or central nervous system diseases such as multiple sclerosis [15]. Studies showed good results for the SNS with an improvement in the symptoms, one study also showed symptom recurrence in a urodynamic test when the stimulation was inactivated. All patients reported improved results by at least 75% [18]. Long term results have been explored, with 70% showing a 50% reduction in incontinence episodes after one and a half years and 59% showed a 50% reduction after three years [21]. Another study showed 83% success rate and sustainability 18 months after implant [22].

4. Conclusion

While urinary incontinence is common morbidity with substantial cost, different treatments exist. While in the past the main treatment path was antimuscarinic medication, these medications have substantial side effects. The use of electric stimulation, both in the vaginal electrical stimulation method and through

PTNS or SNS, has been shown to have good efficacy and few possible side effects.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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