Fecal Incontinence Responses to Posterior Tibial Nerve Stimulation in Partial Spinal Cord Injured Patients

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ABSTRACT

Purpose of the study: *To investigate the effect of posterior tibial nerve stimulation in patients with fecal incontinence (FI) due to partial spinal cord injuries (SCI).* ***Subjects and methods:*** *Thirty volunteer patients (23 male and 7 female) diagnosed with FI due to spinal cord injuries, mean age 29±2.7 years. They were assigned randomly into two equal groups. The study group (G 1) received posterior tibial nerve stimulation (PTNS) for 30 minutes and pelvic floor exercises while the control group (G 2) received sham PTNS and pelvic floor exercises. The treatment program was conducted three times per week, for twelve weeks. Assessment was done before and after treatment by measuring anal resting pressure, maximum squeeze pressure, Wexner incontinence score and fecal incontienece quality of life scale.* ***Results:*** *Statistical analysis revealed that there was a significant improvement in both groups but in favour of G (1) which showed a highly significant improvement.*
Conclusion: *PTNS can be an effective method for treating FI caused by partial SCI.*
Key words: *Fecal Incontinence, Spinal Cord Injuries, Posterior Tibial Nerve, Anal Pressure.*

INTRODUCTION

Faecal incontinence (FI) is a common defecation disorder resulting from various causes[18]. It may be due to traumatic damage to the anal sphincter mechanism, idiopathic degeneration of the sphincter muscle, spinal injury, or other neurological causes. These conditions may alter normal sensation, feedback, or function of the complex mechanism of anal continence[8]. The majority of individuals with spinal cord injury (SCI) suffer from neurogenic bowel dysfunction including constipation, fecal incontinence and abdominal pain or discomfort[13]. These injuries include disc prolapse with or without accompanying surgical intervention and other spinal pathologies[9].

Neurogenic bowel is defined as a bowel that does not function normally after a spinal cord injury, as messages to and from the spinal cord are interrupted. It has the potential to disrupt almost every aspect of life.The effects of neurogenic bowel on quality of life of spinal cord injury patients are significant[3].

Bowel function is a major physical and psychological problem for persons with spinal cord injury. Following a spinal cord injury, changes in bowel motility, sphincter control and gross motor dexterity interact to make bowel management a major life-limiting problem. Lynch et al.,[14] surveyed 1200 persons with SCI and 1200 age and gender-matched controls to describe bowel function. For persons with SCI, their mean Fecal Incontinence Score (FIS) was significantly higher than controls. It was also noted that for persons with complete SCI, their mean FIS was significantly higher than those persons with incomplete SCI. Quality of life was affected by incontinence in 62% of SCI respondents compared with 8% of controls.

Fecal urgency and time spent at the toilet were also significantly higher for persons with SCI. A significantly higher percentage (39%) of SCI respondents use laxatives compared to 4% of controls. The decreased ability to discriminate gas and liquid for complete SCI patients also makes the chance for fecal incontinence more likely[15].

Electrical stimulation, or neuromodulation, of the pelvic floor has been used in the treatment of idiopathic FI[16]. The effects of electrical stimulation on muscular and nervous tissue have been known for several countries, but the underlying electrophysiological theory to explain these effects was derived after the development of classical electrodynamics and the development of nerve cell models. The nerve cell or a nerve fiber can be artificially stimulated (propagating action potential generated) by depolarization of the cell's (fiber's) membrane. This can be achieved by a direct outward flowing current injection across the membrane or by generation of a suitable extra-cellular potential distribution in the vicinity of the cell that will indirectly result in an outward flowing trans-membrane current and a membrane depolarization[11].

More specific approaches include transcutaneous stimulation of the afferent bundles of the pudendal nerve and sacral root nerve stimulation[22]. Electrical stimulation of peripheral nerves could be used to cause muscle contraction, to activate reflexes, and to modulate some functions of the central nervous system (neuromodulation). If applied to the spinal cord or nerves controlling the lower urinary tract, ES could produce bladder or sphincter contraction, produce micturation and could be applied as a medical treatment in cases of incontinence and urinary retention[10].

Electrical stimulation of the pelvic floor, termed neuromodulation, has been used extensively to reduce symptoms of urinary urgency or frequency or pelvic pain. The mechanism involves decreasing bladder overactivity by stimulating peripheral nerves, which represent the same spinal sacral S3 area of the bladder. Three pathways are debated: (1) at low bladder filling volumes, by direct stimulation of the hypogastric nerve through activation of the sympathetic fibers; (2) at maximal bladder filling, by direct stimulation of the nuclei of the pudendal nerve in the spinal cord; and (3) due to a supraspinal inhibition of the detrusor[11].

Posterior tibial nerve stimulation (PTNS) is a technique of electrical neuromodulation for the treatment of incontinence in patients who have failed behavioral and/or pharmacologic therapies. The posterior tibial nerve (PTN) arises from the ventral branches of the ventral rami of the fourth and fifth lumbar and the first, second and third sacral nerves, and it contains sensory and motor fibers. As the nerve contains fibers from the sacral nerves, stimulation of its peripheral fibers, reaching the ankle area, transmits impulses to the sacral nerves and reflexly neuromodulates the rectum and anal sphincters[21].

Altering the function of PTN with PTNS is believed to improve voiding function and control. While the PTN is located near the ankle, it is derived from the lumbo-sacral nerves (L4-S3) which control the bladder detrusor and perineal floor[24]. The objective of this study was to evaluate the possible effects of the posterior tibial nerve stimulation (PTNS) in patients with FI due to partial SCI.

MATERIALS AND METHODS

Subjects

Thirty volunteer patients (23 males & 7 females) were participated in this study from Cairo University Hospitals under specific criteria:

They had been diagnosed diagnosed by surgeons of Cairo University Hospitals as fecal incontinence due to SCI. Patients selected for PTNS had experienced more than one episode of fecal incontinence per week to liquid or solid stool for more than 1 year and had failed maximal conservative treatment. All patients had an intact external anal sphincter. Patient's age ranged from 25 to 35 years, their body mass index was less than 30 Kg/m2. All patients had partial SCI traumatic in nature The degree of spasticity was determined according to the modified Ashwarth's Scale within range of 1 to 1+ grades. All patients were given a full explanation of the treatment protocol and a consent form had been signed from each patient before participating in this study. Any patient had cancer; sever cardiac diseases, and diabetes was being excluded.

Group (1) (PTNS plus pelvic floor exercises)

Consisted of 15 patients (12 males & 3 females) received PTNS. Unilateral stimulation was performed every other day for 12 weeks, each for 30 minutes, in addition, the patients performed pelvic floor exercises.

Group (2) (pelvic floor muscles exercises)

Consisted of 15 patients (11 males & 4 females) who received sham PTNS (low level electrical stimulation that can be felt but is insufficient to trigger a muscle contraction) for 30 min and trained on pelvic floor muscles exercises the same as the study group for 12 weeks, three sessions per week.

Instruments

(1) Instruments for evaluation:

Anal measurements include resting pressure (highest pressure with the patient relaxed) and maximum squeeze pressure (highest increment pressure during a voluntary contraction of the anal sphincter: a squeeze increment) were done by using Peritron 9300A (Cardio Design Pty Ltd, Australia) for the objective assessment of the strength and endurance of the pelvic floor muscle contraction 5. It was supplied with anal sensor. Technical specification of peritron 9300A which its numerical readout from 0-300, resolution 1 cm water, accuracy ± 1 cm water for 95% of readings, Auto off after 4 min. of no activity and the anal sensor consists of an air-tight seamless silicone rubber sheath over a skeleton that allows the central section to be radially in response to a muscular contraction.

(2) Instrument for treatment:

Posterior tibial nerve stimulation PTNS was done using the Urgent PC Stimulator (Cysto Medix, Gemert, Holland), which consists a stimulator and connecting lead attached to a 34-gauge needle and a neutral surface electrode[6].

Procedures

* Assessment Procedures:

Assessment was done before and after treatment by measuring anal resting pressure, maximum squeeze pressure, Wexner fecal incontinence score and fecal incontinence quality of life scale.

a) The anal resting pressure and maximum squeeze pressure assessment:

By using Peritron 9300A through the following steps:-

1- Position of patient: The patient assumes left lateral position and knees drawn up at about 45 degrees for the highest accuracy and repeatability, the patient must be in the same position each time of evaluation.

2- Insert the sensor until 1 cm of the blue sheath is still visible; the sensor must be inserted to the same amount each time of evaluation.

3-While the patient was relaxed, the anal resting pressure was recorded. Then the patient was asked to squeeze around the sensor and hold this contraction for 8 seconds as to assess the maximum squeeze pressure.

b) Wexner fecal incontinence score:

The Wexner fecal incontinence score is a questionnaire composed of five domains about the characteristics of incontinence: solid, liquid, gas, wears pad, and lifestyle altered. Each item has five grades (0-4). Scores ranged between zero (continent) and 20 (fully incontinent). A Wexner score of 9 or higher indicates a significant impairment of quality of life[20].

c) The Fecal Incontinence Quality of Life Scale:

The Fecal Incontinence Quality of Life Scale is composed of a total of 29 items; these items form four scales: Lifestyle (10 items), Coping/Behavior (9 items), Depression/Self-Perception (7 items), and Embarrassment (3 items). For each question, the scale ranges from 1 to 4 (1 indicating a lower functional status of quality of life). Scales scores are the average (mean) response to items in the scale. The psychometric evaluation of FIQL showed that this fecal incontinence-specific quality of life measure produces both reliable and valid measurement[25].

* Treatment Procedures:

a) Posterior tibial nerve stimulation (PTNS):

Posterior tibial nerve stimulation PTNS was done in the following sequence:

The patient lay supine without anaesthesia. The needle was inserted into the skin at 3-finger breadths cephalad from the medial malleolus, approximately 3 – 4 cm behind the tibia, and was directed towards the ankle joint. The needle was connected to a 9-V AC monopolar stimulator. Stimulation ranged from 0.5 to10 mA with a pulse width of 200 μs and a frequency of 20 Hz. Proper stimulation parameters were recognized by plantar flexion of the ipsilateral toes. During the stimulation, the patients had no sensation or contraction in the pelvis.

b) Pelvic floor exercises:

The session lasted 45 min, divided into 5 min warming up in the form of circulatory connected with breathing exercises, then 5 min recovery stage in the form of relaxation exercises. These exercises were divided into three steps for pubovaginalis (for females), puborectalis and the pubococcygeus muscle.

1- Exercise for puborectalis:

Patients were asked to contract the posterior fibers of pubococygeus muscle 15 repetitions each one consisted of contraction and squeezing for 10 sec., followed by relaxation for 20 sec, after 15 repetitions, they were rested for 5 min.

Command: contract as if you control bowel action, concentrates in this action and holds for 10 sec, then relax for 20 sec.

2- Exercise for pubococcygeus as a whole:

Patients were asked to contract the anterior and posterior fibers of pubococcygeus muscle.

Command: contract as if you control bowel action and urethral orifice, concentrate in this action and hold for 10 sec, then relax for 20 sec.

3- Exercise for pubovaginalis (for female):
Patients were asked to contract the anterior fibers of pubococygeus muscle.
Command: contract as if you control urethral orifice, draw vagina up, concentrates in this action and hold for 10 sec, then relax for 20 sec.

Statistical Analysis

To compare results before and after treatment within each group paired t-test was used and unpaired t-test was used to compare between both groups. For FIQL scale one-way ANOVA was used. The level of significant was set at 0.05.

RESULTS

Thirty patients with fecal incontinence due to partial SCI underwent PTNS and were tested before and after 12 weeks of treatment. Physiologic (resting and maximum squeeze pressures), clinical (Wexner FI score) parameters and FIQL scale. As shown in table (1), the previously mentioned parameters before the application of the treatment protocols in both group 1 & 2. There were non significant differences between both groups (P= 0.623, P=0.1229, P=0.2538 and P= 0.7545 respectively).

Table (1): Shows the mean of anal resting, maximum pressure and Wexner incontinence score in groups (1) and (2) pre-application of treatment.

	Resting anal pressure (Cm H_2O)		Maximum anal pressure (Cm H_2O)		Wexner score	
	G (1)	G (2)	G (1)	G (2)	G (1)	G (2)
Mean ± SD	28 ± 2.9	26 ± 2.74	64 ± 3.67	66 ± 3.2	18 ± 2.3	17 ± 2.4
t- value	1.941		1.591		1.165	
Level of significance	P = 0.623		P = 0.1229		P = 0.2538	

In group (1), who received both PTNS and pelvic floor exercises. There were a highly significant increase in both resting and maximal anal pressures (P < 0.0001). For the Wexner incontinence score, there was a highly significant decrease (P < 0.0001) after 3 months of the treatment protocol, the results showed in table (2) and fig. (1).

Table (2): Shows the mean of anal resting, maximum pressure and Wexner incontinence score in group (1) pre and post application of treatment.

	Resting anal pressure (Cm H_2O)		Maximum anal pressure (Cm H_2O)		Wexner score	
	PRE	POST	PRE	POST	PRE	POST
Mean ± SD	28 ± 2.9	39 ± 1.33	64 ± 3.67	93 ± 2.48	18 ± 2.3	4 ± 1.2
t- value	13.353		25.357		20.901	
Level of significance	P < 0.0001		P < 0.0001		P < 0.0001	

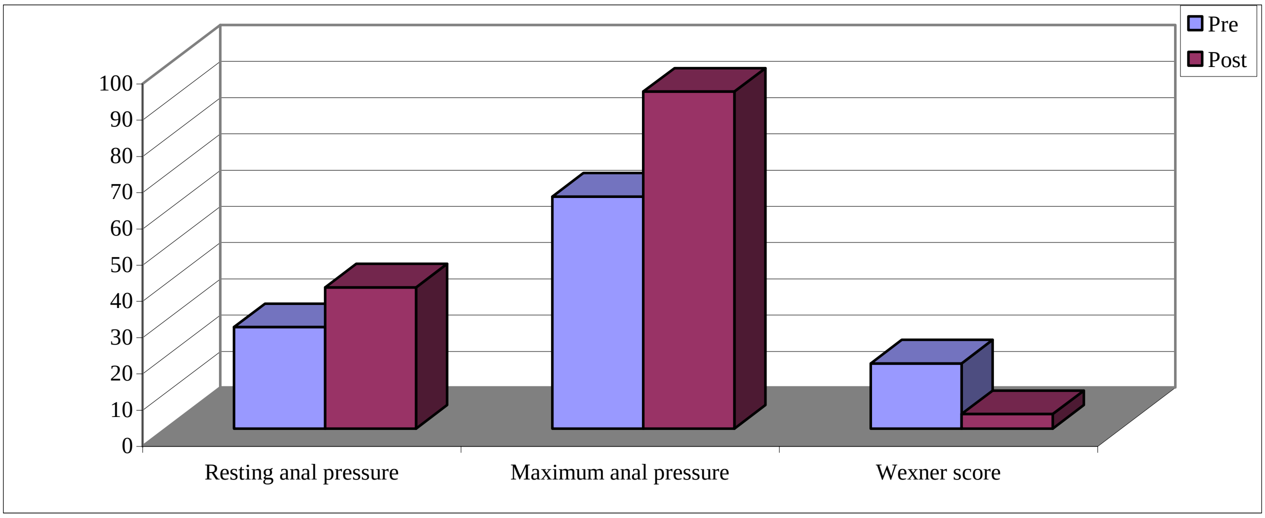

Fig. (1): The resting and maximum squeezing anal pressure in group (1) pre and post treatment.

Table (3): Shows the mean of anal resting, maximum pressure and Wexner incontinence score in group (2) pre and post application of treatment.

	Resting anal pressure (Cm H_2O)		Maximum anal pressure (Cm H_2O)		Wexner score	
	PRE	POST	PRE	POST	PRE	POST
Mean ± SD	26 ± 2.74	32 ± 1.66	66 ± 3.2	80 ± 2.55	17 ± 2.4	6 ± 2.5
t- value	7.254		25.357		12.293	
Level of significance	P < 0.0001		P < 0.0001		P < 0.001	

In table (4), showed the comparison between both groups 1 & 2 after 12 weeks of the treatment protocols and there were a highly significant increase in resting anal pressure and maximal anal pressure (P<0.0001), and a highly significant decrease in Wexner FI score (P=0.0093) in favor to group (1), as in fig (2).

Table (4): Shows the mean of resting and maximum anal pressure and Wexner incontinence score in group (1) and (2) (post application values).

	Resting anal pressure (Cm H_2O)		Maximum anal pressure (Cm H_2O)		Wexner score	
	G (1)	G (2)	G (1)	G (2)	G (1)	G (2)
Mean ± SD	39 ± 1.33	32 ±1.66	93 ± 2.48	80 ± 2.55	4 ± 1.2	6 ± 2.5
t- value	12.746		13.251		2.793	
Level of significance	P < 0.0001		P < 0.0001		P = 0.0093	

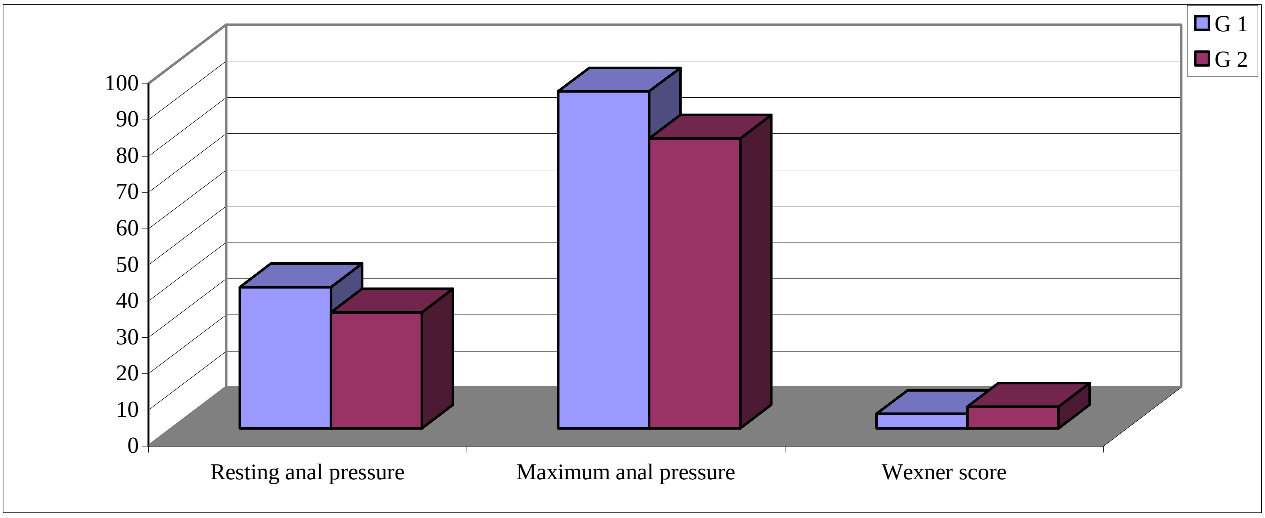

Fig. (2): comparison between both groups 1 and 2 after treatment.

Concerning the result of fecal incontienece quality of life scale (FIQS), there was a highly significant increase of FIQS total scores (9.66 ± 0.85) when compared to the scores of group (2) (8.68 ± 0.65) post-treatment (P<0.0001).

DISCUSSION

Bowel dysfunction in SCI can lead not only to the inconvenience and embarrassment of fecal incontinence but also to ileus, gastric ulcers, gastroesophageal reflux disease, discomfort, anorexia, diverticular disease, hemorrhoids, impaction, constipation, and autonomic dysreflexia 1. Initiation of a strict bowel program can help prevent or minimize the effect of these complications.

The anal sphincter is made up of two regions: the internal anal sphincter (IAS) and the external anal sphincter (EAS). Continence is maintained by the resting tone of the IAS. A centrally mediated reflex causes the EAS and puborectalis to contract during a Valsalva maneuver and coughing, helping to maintain continence. Colonic movement is mediated by a number of inputs. The intrinsic plexus situated between the layers of the muscles forming the walls of the colon, promotes peristaltic movement of luminal contents toward the rectum. The sympathetic input to the colon is carried by the superior and inferior mesenteric nerves (spinal cord levels T9-T12) and hypogastric nerves (T12-L2). The vagus nerve carries parasympathetic input from the esophagus to the splenic flexure. The pelvic nerves (S2-S4) carry parasympathetic fibers to the descending colon and rectum. Somatic input to the rectum and pelvic floor travels in the pudendal nerves (S2-S4)[2].

The extrinsic nervous system acts to modulate the intrinsic system. These complex, integrated activities require reflex and voluntary muscular control, such as defecation, that is mostly affected by SCI. Complete or partial injuries to the cauda equina result in a lower motor neuron (LMN) pattern of injury. The external anal sphincter and pelvic muscle are flaccid, and there is no reflex response to increased intra-abdominal pressure. The loss of parasympathetic control and reflex innervation of the internal anal sphincter causes further reduction in resting anal tone and causes FI. Patients with lower motor neuron (LMN) lesions have an areflexic bowel and reduced sphincter tone[14].

This study investigated the effect of PTNS in patients with FI resulting from partial SCI. Neither patient had permanent paralysis or cauda equine damage. These patients who received PTNS for 12 weeks showed a highly significant decrease (P< 0.0001) in Wexner FI score, and highly significant increase in anal measurements including resting pressure (highest pressure with the patient relaxed) and maximum squeeze pressure (highest increment pressure during a voluntary contraction of the anal sphincter: a squeeze increment) (P< 0.0001). In addition FIQL scores increased in the study group more than the control group with a highly significant difference (P<0.0001) this may be attributed to PTNS which showed a successful treatment method in cases of pelvic floor dysfunction in concerning urinary tract as over active bladder (OAB) including urgency and frequency syndrome, and/or urge incontinence)[18,24]. Unfortionally, there is a lack of studies to investigate the effect of PTNS on FI. The exact mechanism of action of PTNS is unclear but an increase in maximal squeeze pressure has been shown in some studies and the same in this current study, suggesting facilitation of striated muscle function. Increased rectal sensitivity to balloon distention suggests that peripheral neuromodulation affects afferent sensory nerves[7,19].

Also, the mechanism of PTNS can be explained as electrical stimulation, or neuromodulation, of the pelvic floor has been used in the treatment of idiopathic FI. More specific approaches include transcutaneous stimulation of the afferent bundles of the pudendal nerve and sacral root nerve stimulation. The posterior tibial nerve arises from the ventral branches of the ventral rami of the fourth and fifth lumbar and the first, second and third sacral nerves and it contains sensory and motor fibers. As the nerve contains fibers from the sacral nerves, stimulation of its peripheral fibers, reaching the ankle area, transmits impulses to the sacral nerves and reflexly neuromodulates the rectum and anal sphincters[22].

There are various neuromodulation techniques for managing FI. One study examined the use of sacral nerve stimulation (SNS) in patients with FI resulting from partial SCI. SNS led to a significant improvement in FI, as well as in faecal urgency[12].

The results in this study agree with that of Queralto et al.,[18] who used transcutaneous posterior tibial nerve electrical stimulation in the treatment of idiopathic faecal incontinence. They showed a 60% mean improvement in incontinence score in 80% of the patients after 4 weeks.

Twenty-four-hour ambulatory recordings of rectal and anal pressures suggest that peripheral neuromodulation diminishes rectal contractions, enhances anal pressure, slows down wave activity, and decreases the number of spontaneous anal relaxations. Changes in sphincter function, hind gut function, or a combination of these two might lead to improved continence. The balance of autonomic nerve activity is a key determinant of colorectal motility and internal anal sphincter function. Altering this balance may be part of the mode of action peripheral neuromodulation. Laser Doppler measurements of rectal mucosal blood flow, being indirect measures of extrinsic autonomic nerve activity, have shown an increase in rectal mucosal blood flow up to stimulation amplitude of approximately 1V with peripheral neuromodulation[4,23]. In conclusion, our results support the idea that PTNS can be an effective method for treating FI caused by partial SCI. The technique is minimally invasive, inexpensive, easy to perform.

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الملخص العربي

استجابات السلس البرازي لتحفيز العصب القصبي الخلفي في مرضى إصابات الحبل الشوكي الجزئية

الغرض من هذه الدراسة هو دراسة مدى تأثير تحفيز العصب القصبي الخلفي على السلس البرازي في مرضى إصابات الحبل الشوكي الجزئية ، وقد طبقت هذه الدراسة على ثلاثين مريضا (23 من الذكور و 7 من الإناث) يعانون من السلس البرازي وكانت أعمارهم تتراوح من 25 الى35 سنة .و تم تقسيمهم إلى مجموعتين متساويتين. المجموعة الأولى (مجموعة الدراسة) تلقت تحفيز للعصب القصبي الخلفي لمدة 30 دقيقة مع تدريبات لعضلات قاع الحوض . بينما تلقت المجموعة الثانية (المجموعة الضابطة) تحفيز كاذب للعصب القصبي الخلفي مع تدريبات لعضلات قاع الحوض مثل مجموعة الدراسة . وتم تطبيق الدراسة لمدة اثني عشر أسبوعا متتاليا بمعدل ثلاث مرات أسبوعيا . وقد تم التقييم لجميع المرضى في المجموعتين قبل وبعد العلاج ، وشمل التقييم قياس ضغط فتحة الشرج عند الثبات والانقباض ومقياس وزنر للسلس البرازي ومقياس اثر السلس البرازي على نوعية الحياة. ومن نتائج هذه الدراسة وجد انه هناك زيادة ذات دلالة إحصائية ملحوظة و مرضية في كل القياسات التي تم دراستها في مجموعة الدراسة بالمقارنة بنتائج المجموعة الضابطة . ومن الدراسة السابقة فانه يفضل استخدام تحفيز العصب القصبي الخلفي لعلاج السلس البرازي .