Effect of Electrical Stimulation on Overactive Bladder secondary to Diabetic Neuropathy

Angham M. Adel Ahmed [1], Gehan M. Ahmed [2], Mohamed A. Elatrebi [3], Haitham Ramadan [4], Mahmoud Y. Elzanaty [5*]

Abstract

Background: Overactive bladder (OAB) is more common in patients with type II DM than in the general population. **Objective:** the purpose of this study was to identify the effect of Electrical stimulation on over active bladder functions in patients with diabetic neuropathy. **Methods:** Forty diabetic patients with polyneuropathy from both sex and their age ranged from 40 to 60 years participated in this study. The history of urological complications could be traced back to five to seven years. The patients were randomly assigned into two equal groups. Group A received selected physical therapy program, while Group B received the same selected program in addition to electrical stimulation for posterior tibial nerve of right leg. The scheduled sessions for both groups were three times weekly. The duration of the therapeutic interventions was six successive weeks. All patients were assessed by validated Arabic version of overactive bladder symptom score (OABSS) and urodynamic procedure pre and post treatment. **Results:** this study showed a significant decrease of median value of OABSS for group (A) as well as for group (B), while by comparing between both groups post treatment, there was significant decrease of median value of OABSS in favor to group (B). Bladder volume at first desire to void and Maximum cystometric capacity showed no significant difference between pre and post treatment values for group (A), while there was a significant difference between pre and post treatment values for group (B), comparing between both groups post treatment revealed that there was a significant improvement in favor to group (B), bladder stability and compliance showed significant difference between pre and post treatment values for both groups, comparison between both groups post treatment showed a significant improvement in favor to group (B), maximum flow rate showed non-significant difference in both groups. **Conclusion:** Adding Electrical stimulation for posterior tibial nerve to selected physical therapy program has improved overactive bladder in patients with diabetic neuropathy.

Key Words: Diabetic neuropathy, overactive bladder, Electrical stimulation, overactive bladder symptom score, urodynamics.

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Corresponding author: Mahmoud Y. Elzanaty

Affiliations: [1] Lecturer of Physical Therapy for Neurology, Faculty of Physical Therapy, Egyptian Chinese University, Cairo, Egypt; [2] Professor and Head of Department of Physical Therapy for Neurology, Faculty of Physical Therapy, Cairo University, Cairo, Egypt; [3] Head of Urology Department, El-Sahel Teaching Hospital, Cairo, Egypt; [4] Lecturer of Physical therapy for Cardiovascular/ Respiratory Disorder & Geriatrics, Faculty of Physical Therapy, Cairo University, Cairo, Egypt; [5*] Lecturer of Physical Therapy for Neurology, Faculty of Physical Therapy, Cairo and Deraya Universities, Egypt.

E-mail: [5*] mahmoud_pt@yahoo.com

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Introduction

More than 60% of Egyptian diabetes individuals experience neuropathy, according to national data **(Amara et al, 2019).** Depending on which nerves are injured, diabetic neuropathy can impact proximal, distal, somatic, and autonomic nerves, resulting in a variety of symptoms. Additionally, it may be an immediate, self-limiting disease or a persistent condition with significant implications. These factors have made the early detection and diagnosis of DN a crucial but difficult process that include acquiring a thorough medical history, performing clinical and neurological exams, and ruling out non-fitting diagnoses **(Nagpal et al., 2021).**

Patients with type II DM experience overactive bladder more frequently than people without the condition. Additionally, it was noted that diabetic individuals receiving insulin treatment had more urge incontinence than those receiving non-insulin medications. Higher glycosylated haemoglobin levels were employed as an independent predictor of OAB symptoms among DM patients based on this correlation **(Przydacz et al., 2020).**

Neuromodulator, often referred to as sacral nerve stimulation (SNS) and posterior tibial nerve stimulation of the lower urinary tract, is a second-line treatment option for OAB. Theoretically, a neuromodulator should cause the least amount of discomfort, be simple to use, and refrain from making the user feel uncomfortable by stimulating particular body locations, such the vaginal area. It is also recognized as an effective and reasonably priced therapy strategy when compared to other treatments **(Agost-Gonzalez et al., 2021).**

Methods

All the patients were diagnosed as having diabetic neuropathy with OAB according to urologist's referral. The patients were informed about the study before participating in it (consent form) Personal data was recorded in the first meeting before starting the study.

1- Study design

This was a randomized controlled study, pre-test post-test design study.

a) Sample size estimation:

Prior to the study, the sample size was calculated using G-power statistical software (Version 3.1.9.2, Franz Faul, Universitate Keil, Germany), and it was discovered that 20 patients per group with an effect size of 1.62, a critical value of 2.08, and a power of 0.95 were needed for the current study.

b) Randomization:

Select the card method of randomization was used to allocate patients to groups. A box with 48 cards, with the same shape, texture, etc. Take 48 cards of them, and number them 1, 2, to 48, with one number to each card. Place the cards in a box; mix the cards thoroughly and select 40 cards at random without replacement. The numbers on the cards selected denoted the trials that were assigned to Finally, 40 participants were included in this study figure (1).

c) Groups:

In current study, we enrolled 40 type II diabetic patients of both sexes with diabetic neuropathy, whose ages ranged from 40 to 60 years. The patients chosen had an OAB symptom score more than seven (moderate) **(Homma et al., 2006).** Patients were excluded if they had a spinal cord injury, gynaecological issues (such as pelvic organ prolapse and vaginitis), a history of bladder disease or surgery, acute or chronic urinary tract infections, pregnancy, or if they were unable to adhere to home treatment regimens.

The patients were divided randomly into two equal groups: Group A: as the control group that was treated with a selected physical therapy program for overactive bladder in form of (Kegel exercises, bridging exercises and squatting exercises). Group B: was the study group was treated with the same selected physical therapy program in addition to electrical stimulation for posterior tibial nerve of right leg.

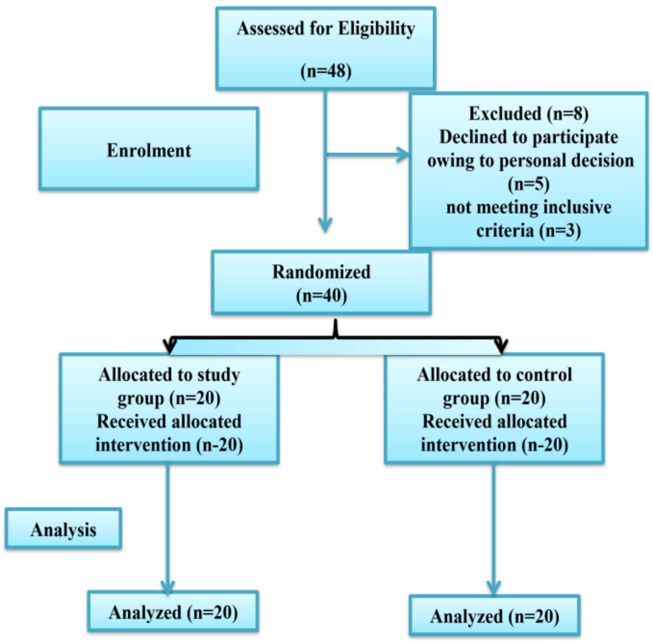

Fig. (1): Flow chart showing the method of the study

2- *Instrumentations*

I. For evaluation:

Two evaluation procedures were done before and after the treatment program:

a) *Arabic validated version of Overactive bladder symptom score (OABSS)* **(Elbaset et al., 2019):**

The OABSS questionnaire, which has an Arabic variant, is used to evaluate OAB symptoms and generate an overall score. The questionnaire includes four questions about OAB symptoms with a range of scores: frequent urination during the daytime receives a score of 0–2, nighttime urination receives a score of 0–3, urgency receives a score of 0–5, and urge incontinence receives a score of 0–5.

b) *Urodynamic system:*

The urodynamic investigation as voiding cytometry was carried out using a urodynamic investigation apparatus (Andromedia Ellipse) made in Germany (SN 20111755). It consists of a mobile patient unit with an integrated water pump and a trolley-mounted unit with an integrated printer and monitor. a puller mechanism mounted on a stand and a uroflow transducer mounted on a stand. The referring urologist performed the measurement. The bladder's pressure-volume relationship was measured using cystometry. This technique offers sufficient details on how the bladder adapts to rising filling volumes and how the detrusor reflex is controlled by the central nervous system **(Baines et al., 2020).**

The procedure performed pre and post treatment with the following variables were measured (bladder volume at first desire to void, maximum cystometric capacity, maximum flow rate, stability and compliance of the bladder).

II. For treatment:

1. Electrical stimulation device:

The Sonopuls-692 device (Enraf Nonius), made in the Netherlands (SN 05663), is a full system for nerve stimulation and pain management. The posterior tibial nerve was stimulated using this device.

The Sonopuls-692 offers 30 preprogrammed suggestions for treatment that are rewritable and movable. The created electrical impulse travels through the main trunk of the tibial nerve to the sacral nerve plexus, where it causes the therapeutic effect.

3- *Procedures*

I- Evaluation

Two evaluation procedures were done pre-and post-treatment after six weeks of treatment.

a) *Overactive bladder symptom score:*

The patients were instructed to circle the score that best applies to their urinary condition during the past week; the overall score is the sum of the four scores with the highest score mean severe case.

b) *Urodynamic procedure: (Cytometry)*

The patients were instructed to make enema the night before the test and empty the bladder as best as possible.

- The patients were asked to lie on their backs on the examination couch. External genitalia were covered with a sterile sheet.
- The Y-piece was affixed to a single lumen catheter during catheterization using a sterile approach. The manometer connecting tube was attached to one prong, and the infusion pump was connected to the other prong via a damping tube.
- To measure intra-abdominal pressure, a rectal balloon catheter was placed. The air was removed from the system. The bladder was filled with warm, sterile normal saline infusion at a medium rate of 50 ml/min as recording got underway. The patient was asked to report any bladder fullness sensations. This occurrence was noted on the voiding cystometry curve (first desire to void).
- The patient was told to hold back the urge to urinate and to report when a strong desire would strike. This occurrence was noted on the voiding cystometry curve, and the infusion will be halted (cystometric bladder capacity).
- The patient was encouraged to urinate after being prodded to cough as a provocation test for detrusor instability. The measurements listed below were taken.

Storage phase

The bladder was filled at a rate of approximately 50 ml/min during this passive or filling phase of cystometry, which explains the correlation between the levels of infused volumes, detrusor pressure, and bladder compliance.

Voiding phase

It detects the following: the voiding time, the flow time, the maximum flow rate, the detrusor pressure at the maximum flow rate, and detrusor contractility. It is the active period during which the patient was directed to urinate.

II-Treatment plans

Two equal groups, Group A (Control group) and Group B, were formed from the patient population (Study group). According to a selected physical therapy protocol for treating overactive bladder in Group A that included Kegel exercises, bridging exercises, and squatting activities **(Pavithralochani et al., 2019).** Patients in Group B (the study group) received posterior tibial nerve stimulation by TENS in addition to the same physical treatment regimen. Sonopuls-692 was used for this treatment (Enraf Nonius). Two sticky electrodes: one attached to the stimulator and implanted roughly ten cm cephalad to the medial malleolus, one posterior and superior to it. Electrical stimulation with a pulse rate of 10 Hz and a 200-second pulse width. The amplitude was toned to correspond to the patient's threshold for discomfort. The therapeutic session lasted for 20 minutes **(Bhide et al., 2020).**

Analysis of the data

The mean age, weight, height, and BMI were compared for both groups using descriptive statistics and an unpaired t-test. Chi squared tests were used to compare the distribution of sex between the two groups. Mann–Whitney the median values of the OABSS and urodynamic procedure were compared between groups using the U test. The Wilcoxon Signed Ranks Test was used to compare the median values of OABSS and urodynamic procedure in each group before and after therapy. All statistical tests had a significance threshold of p 0.05. The statistical package for social studies (SPSS) version 19 for Windows was used to conduct all statistical analyses.

Results

I. General characteristics of the patients

The General characteristics of patients in both groups are presented in table (1). Patients of both groups were matched as regards mean age, weight, height, BMI, gender and duration of illness ($p > 0.05$).

Table 1. *Comparison of General characteristics of patients in both groups*

	Group A Mean ±SD	Group B Mean ±SD	MD	T- value	p-value	Sig
Age (years)	52.8 ± 6.27	54.85 ± 4.64	-2.02	-1.17	0.24	NS
Body mass index (BMI) (Kg/m2)	29.63 ± 3.52	29.26 ± 3.21	0.37	0.34	0.72	NS
Duration of illness (months)	72.65 ± 7.66	73±8.29	-0.13	-0.13	0.89	NS
Gender						
Females	12 (60%)	14 (70%)		($\chi2$ = 0.43)	0.51	NS
Males	8 (40%)	6 (30%)				

SD: standers deviation; P-value: probability value; MD: mean difference; NS: non-significant; χ^2: Chi squared value

II-Effect of treatments in both groups on OABSS and urodynamic study were in table (2).

1- *Comparison between median values of OABSS pre and post-treatment in both groups:*

The median (IQR) value of OABSS pre treatment of the group A was 12.5 (14.75-10.25) and that of the group B was 13 (14-12). There was no significant difference in median value of OABSS between the group A and B pre treatment. The median (IQR) value of OABSS post treatment of the group A was 10 (11.75-9.25) and that of the group B was 5.5 (8-4). There was a significant decrease in median value of OABSS of the group B compared with that of the group A post treatment (p = 0.0001).

2- *Comparison between median values of urodynamic study pre and post-treatment in both groups:*

a- *1st desire to void*

The median interquartile range (IQR) value of 1st desire to void pre treatment of the group A was 135 (157.25-83.5) and that of the group B was 130.5 (180-113). There was no significant difference in median value of 1st desire to void between the group A and B pre treatment (p = 0.34) .The median (IQR) value of 1st desire to void post treatment of the group A was 137.5 (156.25-97.75) and that of the group B was 150 (213132.5). There was a significant increase in median value of 1st desire to void of the group B compared with that of the group A post treatment (p = 0.01)

b- *Maximum cystometric capacity*

The median (IQR) value of maximum cystometric capacity pre- treatment of the group A was 302 (424.5-220.25) and that of the group B was 313 (397.5-230.75). There was no significant difference in median value of maximum cystometric capacity between the group A and B pre- treatment (p = 0.88). The median (IQR) value of maximum cystometric capacity post treatment of the group A was 317.5 (436.25-238.5) and that of the group B was 386 (455.75-351.25). There was a significant increase in median value of maximum cystometric capacity of the group B compared with that of the group A post treatment (p = 0.03).

c- *Stability*

The median (IQR) value of stability pre- treatment of the group A was 1 (1-1) and that of the group B was 1 (2-1). There was no significant difference in median value of stability between the group A and B pre-treatment (p = 0.29). The median (IQR) value of stability post treatment of the group A was 1 (2-1) and that of the group B was 2 (2-2). There was a significant increase in median value of stability of the group B compared with that of the group A post treatment (p = 0.009).

d- Compliance

The median (IQR) value of compliance pre-treatment of the group A was 1 (1-1) and that of the group B was 1 (1.75-1). There was no significant difference in median value of compliance between the group A and B pre -treatment (p = 0.43) The median (IQR) value of compliance post treatment of the group A was 1.5 (2-1) and that of the group B was 2 (2-2). There was a significant increase in median value of compliance of the group B compared with that of the group A post treatment (p = 0.02).

e- Maximum flow rate

The median (IQR) value of maximum flow rate pre-treatment of the group A was 13.9 (17.25-12) and that of the group B was 14.5 (1712.32). There was no significant difference in median value of maximum flow rate between the group A and B pre-treatment (p = 0.82). The median (IQR) value of maximum flow rate post treatment of the group A was 14.5 (15.75-12.25) and that of the group B was 15 (18.75-12.25). There was no significant difference in maximum flow rate between the group A and B post treatment (p = 0.36).

Table 2. Comparison of median values of OABSS and urodynamic study pre- and post-treatment between both groups.

	Group A	Group B	Z- value	P- value
	Median (IQR)	Median (IQR)		
1- OABSS				
Pre-treatment	12.5(14.75-10.25)	13(14-12)		
Post- treatment	10(11.75-9.25)	5.5(8-4)	25	0.0001*
Z- value	3.53	3.93		
P- value	0.0001*	0.0001*		
2-Urodynamic study				
a-1st desire to void				
Pre-treatment	135(157.25-83.5)	130.5(180-113)		
Post- treatment	137(156.25-97.75)	150(213-132)	110.5	0.01*
Z- value	1.56	3.82		
P- value	0.11	0.005*		
b-Maximum cystometric capacity				
Pre-treatment	302(424.5-220.25)	313(397.5-230.75)		
Post- treatment	317.5(436.25-238.5)	386(455.75-351.25)	120.5	0.03*
Z- value	1.28	3.54		
P- value	0.19	0.0001*		
c- Stability				
Pre-treatment	1(1-1)	1(2-1)		
Post- treatment	1(2-1)	2(2-2)	120	0.009*
Z- value	2.23	3.16		
P- value	0.02*	0.002*		
d-Compliance				
Pre-treatment	1(1-1)	1(1.75-1)		
Post- treatment	1.5 (2-1)	2(2-2)	130	0.02*
Z- value	2.64	3.31		
P- value	0.008*	0.001*		
e-Maximum flow rate				
Pre-treatment	13.9 (17.25-12)	14.5(17-12.32)		
Post- treatment	14.5 (15.75-12.25)	15(18.75-12.25)	166.5	0.36
Z- value	0.67	1.62		
P- value	0.49	0.1		

IQR: Interquartile range; **p-value:** Probability; **Z- value:** Wilcoxon signed ranks test value

Discussion

According to OABSS and urodynamic procedures, the current investigation revealed a minor influence of a selected physical therapy program on bladder functioning in individuals with diabetic neuropathy. Due to the fact that pelvic floor muscle training involves the contraction of the puborectalis muscles, as well as the anal and external urethral sphincters, and studies have shown that contraction of these muscles leads to the suppression of detrusor contraction, the results of the current study concur with **Fitz et al., (2017).** Additionally, with properly tightened pelvic floor muscles, the perineo-detrusor inhibitory reflex is activated, in addition to a change in the morphology, location, and neuromuscular function of the pelvic floor muscles.

The results also go hand in hand with **Dugan et al., (2013); Kulaksızoğlu et al., (2015); Bykoviene et al., (2018) and Seyda et al., (2020).**

According to OABSS and urodynamic procedures, the current study's findings demonstrate that adding electrical stimulation for the posterior tibial nerve to a specific physical therapy exercise program significantly improves bladder functioning in individuals with diabetic neuropathy. The current study's findings support **Peters et al (2010) 's** level I evidence that posterior tibial nerve stimulation is safe and helpful for treating OAB. They also support changes in the pelvic floor muscles' morphology, location, and neuromuscular function.

The findings support the assertion made by **Amarenco et al. (2003)** that depolarization of somatic sacral and lumbar afferent axons by stimulation of the posterior tibial nerve reduces bladder function. Through a direct pathway in the sacral cord, afferent stimulation produces central inhibition of the preganglionic bladder motor neurons. Along with **Finazzi-Agro et al (2009) 's** explanation of these results, which involved the plastic remodeling of the cortical network brought on by stimulation of the posterior tibial nerve. The results of the current study also support the findings of **Vandoninck et al. (2003)** who found that the inhibitory and excitatory impulses that control bladder function are not balanced. Neuromodulation's mode of action is also unknown, but it is thought to help the central nervous system return to balance.

The mechanism by which posterior tibial nerve stimulation functions is unknown, but **Tudor et al.**

(2020) concluded that it is likely that posterior tibial nerve stimulation acts through neuronal pathways, possibly mediated through changes in cerebral endorphin levels, depolarization of somatic sacral and lumbar afferent fibers, and activation of efferent fibers to the striated urethral sphincter, all of which inhibit detrusor activity through Following stimulation of the posterior tibial nerve, increased amplitudes of long-latency somatosensory evoked potentials were seen, which may indicate long-term potentiation and plastic reorganisation of the cortical network.

Limitations

The following criteria served as limitations for this study:

• The patient's psychological condition at the time of evaluation and therapy.

• The patient's unwillingness to work with the therapist.

• The patients' daily efforts, which may have an effect on how well they do and how the study turns out.

• Less frequent sessions due to the Covid-19 virus pandemic.

Conclusion

The results of this study showed that patients with diabetic neuropathy had improved bladder functioning after adding electrical stimulation for the posterior tibial nerve to a particular physical therapy program.

Conflict of interest

All authors stated no conflict of interests.

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References

1. Agost-González, A.; Escobio-Prieto, I.; Pareja-Leal, A.M.; Casuso-Holgado, M.J.; Blanco-Diaz, M.; Albornoz-Cabello, M. (2021): Percutaneous versus Transcutaneous Electrical Stimulation of the Posterior Tibial Nerve in Idiopathic Overactive Bladder Syndrome with Urinary Incontinence in Adults: A Systematic Review. Healthcare, 9(7): 879.
2. Amara F, Hafez S, Orabi A, El Etriby A, Abdel Rahim AA, Zakaria E, Koura F, Talaat FM, Gawish H, (2019): Review of Diabetic Polyneuropathy: Pathogenesis, Diagnosis and Management According to the Consensus of Egyptian Experts. Curr Diabetes Rev. 2019;15(4):340-345.
3. Amarenco G, Ismael SS, Even-Schneider A, Raibaut P, DemailleWlodyka S, Parratte B, Kerdraon J. (2003): Urodynamic effect of acute transcutaneous posterior tibial nerve stimulation in overactive bladder. J Urol.;169(6):2210-5.
4. Baines G, Da Silva AS, Araklitis G, Robinson D, Cardozo L. (2020): Recent advances in urodynamics in women. F1000Res.; 9:F1000 Faculty Rev-606.
5. Bhide A, Tailor V, Fernando R, Khullar V, Digesu G. (2020): Posterior tibial nerve stimulation for overactive bladder-techniques and efficacy. International urogynecology journal, 31(5), 865-870.
6. Bykoviene L, Kubilius R, Aniuliene R, Bartuseviciene E, Bartusevicius A. (2018): Pelvic floor muscle training with or without tibial nerve stimulation and lifestyle changes have comparable effects on the overactive bladder: a randomized clinical trial. Urol J;15(4):186-192.
7. Dugan SA, Lavender MD, Hebert-Beirne J, Brubaker L. (2013): A pelvic floor fitness program for older women with urinary symptoms: a feasibility study. PM &R; 2013; 5: 672–676.
8. Elbaset MA, Hashem A, Taha DE, Zahran MH, El-Hefnawy AS. (2019): Validation of the Arabic linguistic version of the Overactive Bladder Symptoms Score questionnaire. Arab J Urol;17(4):265-269.
9. Finazzi-Agro E, Rocchi C, Pachatz C. (2009): Percutaneous tibial nerve stimulation produces effects on brain activity: study on the modifications of the long latency somatosensory evoked potentials. Neurourol Urodyn;28(4):320–324.
10. Fitz F, Sartori M, Girão MJ, Castro R. (2017): Pelvic floor muscle training for overactive bladder symptoms - A prospective study. Rev Assoc Med Bras; 63(12):1032-1038.
11. Homma Y, Yoshida M, Seki N, Yokoyama O, Kakizaki H, Gotoh M, Yamanishi T, Yamaguchi O, Takeda M, Nishizawa O. (2006):Symptom assessment tool for overactive bladder syndrome--overactive bladder symptom score. Urology;68(2):318-23.
12. Kurdoğlu Z, Carr D, Harmouche J, Ünlü S, Kılıç GS. (2018):Short term results of the efficacy of percutaneous tibial nerve stimulation on urinary symptoms and its financial cost. J Turk Ger Gynecol Assoc.19(1):7-10.
13. Nagpal A, Leet J, Egan K, Garza R. (2021). Diabetic Neuropathy: a Critical, Narrative Review of Published Data from 2019. Current Pain and Headache Reports, 25(3), 1-14
14. Pavithralochani, V., Thangavignesh, R., Saranya, P., & Ramanathan, K. (2019). Efficacy of Kegel's Exercise vs Pilates in Subject with Urinary Incontinence during Pregnancy. Research Journal of Pharmacy and Technology, 12(12), 5943-5946.
15. Peters KM, Carrico DJ, Perez-marrero RA, Khan AU, Wooldridge LS, Davis GL.(2010): Randomized trial of percutaneous Tibial nerve stimulation versus sham efficacy in the treatment of overactive bladder syndrome: results from the SUmiT trial. J Urol 183(4):1438–1443.
16. Przydacz, M., Golabek, T., Dudek, P. (2020): Prevalence and bother of lower urinary tract symptoms and overactive bladder in Poland, an Eastern European Study. Sci Rep 10 (1):1-12.
17. Seyda Toprak Celenay, Yasemin Karaaslan, Ozge Coban & Kemal Oskay (2020): A comparison of Kinesio taping and external electrical stimulation in addition to pelvic floor muscle exercise and sole pelvic floor muscle exercise in women with overactive bladder: a randomized controlled

study, Disability and Rehabilitation. P. 1-9.

18. Tudor KI, Seth JH, Liechti MD, Ochulor J, Gonzales G, Haslam C, Fox Z, Pakzad M, Panicker JN. (2020): Outcomes following percutaneous tibial nerve stimulation (PTNS) treatment for neurogenic and idiopathic overactive bladder. Clin Auton Res; 30(1):61-67.
19. Vandoninck V, Van Balken MR, Finazzi Agró E, Petta F, Caltagirone C, Heesakkers JP, Kiemeney LA, Debruyne FM, Bemelmans BL. (2003): Posterior tibial nerve stimulation in the treatment of urge incontinence. Neurourol Urodyn; 22(1):17-23.