Research Article / *Araştırma Makalesi*

Ege Journal of Medicine / *Ege Tıp Dergisi* 2026; 65 (1): 40-48

Preliminary outcomes of sacral neuromodulation applications: Tertiary-center experience in Türkiye

Sakral nöromodülasyon uygulamalarının ön sonuçları: Türkiye'de üçüncü basamak merkez deneyimi

Burcu Ozalp Horsanali[1] Mustafa Ozan Horsanali[2] Meltem Uyar[3] Can Eyigor[3] Husnu Yilmaz[4] Adnan Simsir[5]

[1]Izmir Bakircay University Cigli Training and Research Hospital, Department of Algology, Izmir/Türkiye
[2]Izmir Bakircay University, Faculty of Medicine, Department of Urology, Izmir/Türkiye
[3]Ege University, Faculty of Medicine, Department of Algology, Izmir/Türkiye
[4]Izmir Democracy University Buca Seyfi Demirsoy Training and Research Hospital, Department of Algology, Izmir/Türkiye
[5]Ege University, Faculty of Medicine, Department of Urology, Izmir/Türkiye

ABSTRACT

Aim: Sacral neuromodulation (SNM) is a minimally invasive treatment option for various lower urinary tract symptoms (LUTS) and bowel dysfunctions. Despite its widespread use, the exact mechanism of action and optimal patient selection remain unclear. This study aimed to report the outcomes of SNM in patients treated at tertiary health centers in Türkiye.

Materials and Methods: A retrospective analysis was conducted on 16 patients who underwent SNM for LUTS, bowel dysfunction, or chronic pelvic pain between 2017 and 2022. Patient characteristics, primary diagnosis, implantation duration, complications, and symptom improvement were recorded. Urinary symptoms were assessed using the International Consultation on Incontinence Questionnaire-Short Form (ICIQ-SF). Statistical analyses were performed using SPSS Statistics 26.0.

Results: The mean age of the patients was 42.4 ± 11.9 years, with a mean BMI of 25.5 ± 5.4 kg/m². The mean duration of symptoms was 12.6 ± 10.5 years, and the mean age at implantation was 40.2 ± 11.1 years. SNM was primarily performed for idiopathic lower urinary tract dysfunction (87.5% of patients) and faecal incontinence (12.5%). The mean ICIQ-SF score significantly decreased from 13.64 ± 7.61 before implantation to 7.50 ± 7.51 after implantation ($p = 0.003$). A complication requiring surgical intervention occurred in 12.5% of patients.

Conclusion: This study demonstrates that SNM is effective in improving symptoms associated with LUTS and bowel dysfunction, as evidenced by the significant reduction in ICIQ-SF scores. However, a notable complication rate was observed, highlighting the importance of appropriate patient selection and ongoing follow-up. Further studies with larger cohorts and longer follow-up are warranted to evaluate the long-term outcomes and safety profile of SNM.

Keywords: Sacral neuromodulation, overactive bladder (OAB), urinary incontinence (UI), faecal incontinence (FI), lower urinary tract symptoms (LUTS)

ÖZ

Amaç: *Sakral nöromodülasyon (SNM), çeşitli alt üriner sistem disfonksiyonları için minimal invaziv bir tedavi seçeneğidir. Yaygın kullanımına rağmen, etki mekanizması ve ideal hasta seçimi hâlâ tam olarak net değildir. Bu çalışma, Türkiye'deki üçüncü basamak sağlık merkezlerinde SNM uygulanan hastaların sonuçlarını raporlamayı amaçlamaktadır.*

Corresponding author: Burcu Ozalp Horsanali
Izmir Bakircay University Cigli Training and Research Hospital, Department of Algology, Izmir/Türkiye
E-mail: *burcuhorsanali@hotmail.com*
Application date: 03.06.2025 Accepted: 24.10.2025

Gereç ve Yöntem *2017–2022 yılları arasında üriner disfonksiyon, barsak disfonksiyonu veya kronik pelvik ağrı nedeniyle SNM uygulanan 16 hastanın retrospektif analizi yapıldı. Hastaların demografik özellikleri, tanıları, implantasyon süresi, komplikasyonlar ve semptom iyileşmeleri kaydedildi. Üriner fonksiyonlar, Uluslararası İnkontinans Danışma Anketi-Kısa Formu (ICIQ-SF) kullanılarak değerlendirildi. İstatistiksel analizler SPSS Statistics 26.0 programı ile gerçekleştirildi.*

Bulgular: *Hastaların ortalama yaşı 42,4±11,9 yıl, ortalama vücut kitle indeksi 25,5±5,4 kg/m² idi. Semptom süresi ortalama 12,6±10,5 yıl, implantasyon yaşı ise 40,2±11,1 yıl olarak saptandı. SNM uygulamaları esas olarak idiyopatik mesane disfonksiyonu (%87,5) ve fekal inkontinans (%12,5) nedeniyle gerçekleştirildi. Ortalama ICIQ-SF semptom skoru, implantasyon öncesi 13,64±7,61 iken, implantasyon sonrası 7,50±7,51'ye düşerek anlamlı şekilde azaldı (p=0,003). Cerrahi müdahale gerektiren komplikasyonlar hastaların %12,5'inde gözlendi.*

Sonuç: *Çalışmamız, SNM'nin üriner ve barsak disfonksiyonlarıyla ilişkili semptomları iyileştirmede etkili olduğunu göstermektedir; bu, ICIQ-SF skorlarındaki anlamlı düşüşle desteklenmektedir. Bununla birlikte, dikkat çekici düzeyde komplikasyon oranı, hasta seçiminin ve tedavi sürecinin dikkatli şekilde yönetilmesinin önemini ortaya koymaktadır. Farklı hasta gruplarında SNM'nin uzun vadeli etkinliğini ve güvenilirliğini değerlendirmek için daha geniş örneklem grupları ve daha uzun takip sürelerine sahip ileri çalışmalara ihtiyaç vardır.*

Anahtar Sözcükler: *Sakral nöromodülasyon, aşırı aktif mesane, üriner inkontinans, fekal inkontinans, alt üriner sistem disfonksiyonu*

INTRODUCTION

Sacral neuromodulation (SNM) is a minimally invasive treatment modality that stimulates the sacral nerve roots to treat idiopathic overactive bladder syndrome (OAB), chronic non-obstructive urinary retention, bladder pain syndrome (BPS), neurogenic lower urinary tract dysfunction (NLUTD), and fecal incontinence (FI) that are unresponsive to pharmacological therapy, behavioral interventions, or pelvic-floor muscle training (1). Approximately 325,000 patients have been treated with SNM worldwide since this modality received the CE mark in 1994 (2).

Although the physiological mechanism of SNM has not been completely elucidated, it is thought to exert its effect by modulating neural circuits in both central and peripheral neuronal pathways. There are two hypotheses regarding the therapeutic mechanism of SNM. The primary hypothesis is that SNM elicits afferent neural activity, which in turn inhibits pathological neural signaling associated with OAB. The second hypothesis is that SNM produces neuromodulation in central centers that regulate voiding function (3). However, there is still no consensus on how SNM normalizes lower urinary tract function (4). Because SNM modulates its effects via the spinal cord, it is indicated for patients with intact or partially preserved spinal cord function (5).

Meta-analysis results have reported that the success rate of SNM is 46% for the test phase and 76% for permanent implantation (6). Another review of studies including SNM reported that after 6 months of follow-up, complete continence ("dry rate") ranged from 43% to 56%, adverse events occurred in approximately 50% of patients, and surgical revision was needed in 33–41% of cases (7,8). Reported adverse events of SNM include altered stimulation sensation, loss of efficacy, pain or spasticity in the lower limbs, discomfort at the implantable pulse generator site, bowel dysfunction, and wound infection (9).

Current indications for SNM vary according to guidelines. The American Urological Association (AUA) recommends SNM as a third-line treatment for patients with advanced refractory OAB symptoms, or for patients for whom second-line treatment is unavailable and who are ineligible for alternative surgical procedures (10). The International Continence Society (ICS) offers SNM to patients with OAB with or without urinary incontinence who have failed to respond to, or are intolerant of, conservative medical therapies (1). The European Association of Urology (EAU) offers SNM to patients who have OAB/urge urinary incontinence (UUI) refractory to antimuscarinic therapy (11).

Because the implantation of SNM devices has increased in recent years, but studies remain limited in the literature, we aimed to report our

patients' outcomes of SNM in tertiary health centers in Türkiye.

MATERIALS and METHODS

We retrospectively analyzed 18 patients who underwent SNM for lower urinary tract dysfunction (LUTD) or bowel dysfunction between 2017 and 2022 in our clinic. We excluded 2 patients due to non-effective responses after the test phase. After local ethics committee approval was obtained, patient characteristics and demographic data including age, sex, indications for SNM, age at diagnosis, and comorbidities were collected from our hospital's electronic medical record system. Lower urinary tract symptoms (LUTS) were evaluated using the International Consultation on Incontinence Questionnaire–Short Form (ICIQ-SF). Patients' diagnosis, implantation duration, adverse events, and improvement of symptoms were recorded.

All patients were evaluated with urinalysis to exclude urinary tract infection (UTI), a 3-day bladder diary, and urodynamic studies before SNM implantation. The primary diagnosis of overactive bladder syndrome (OAB) was confirmed on the 3-day bladder diary as ≥8 voids per 24 hours and/or a minimum of two UUI episodes over 3 days. All patients had received pharmacological therapy for bladder dysfunction. In the absence of a response to medical therapy or in cases of chronic urinary retention (CUR), SNM was performed for patients who were ineligible for intradetrusor onabotulinumtoxinA injection or who did not respond to this treatment.

All SNM procedures were performed in two stages. First, the *test phase* (percutaneous nerve evaluation) was conducted under sedation using a C-arm fluoroscopy-guided technique in the operating room. In the test phase, a quadripolar lead was implanted at the S3 sacral nerve root via the sacral foramen under fluoroscopic guidance (Figure-1). Optimal lead placement was determined by observing plantar flexion of the great toe and contraction of the anal sphincter in response to electrical stimulation. The lead was then connected to an external pulse generator. After adjusting stimulation parameters, patients were followed for two weeks to assess response. If the test phase was successful, defined as ≥50% improvement in baseline symptoms, permanent implantation was performed two weeks later.

During the test phase, a pulse width of 210 μs and a frequency of 14 Hz were used to ensure perception of stimulation. Generally, three stimulation programs [3(+) 0(-); 3(-) 0(+); 3(+) 1(-) or 3(-) 1(+)] were applied. If ≥50% symptom improvement was achieved, the permanent lead was connected to the implantable pulse generator (Medtronic InterStim II®, Medtronic, Dublin) placed subcutaneously in the upper buttock. The stimulation program used during the test phase was applied in the permanent setting, with up to three programs uploaded; additional programs were added if necessary.

After implantation, for efficacy analysis, absolute and percentage changes were calculated for urinary incontinence episodes, number of voids, and urgency episodes. Patient-reported quality of life and satisfaction with therapy were assessed using the ICIQ-SF.

Statistical analyses were performed using SPSS Statistics software, version 26.0 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages, while continuous variables were presented as means and standard deviations. The normality of distribution of continuous variables was assessed using the Kolmogorov-Smirnov test.

RESULTS

Among the patients included in the study, 8 (50%) were female and 8 (50%) were male. The mean age was 42.4 ± 11.9 years and body mass index (BMI) was 25.5 ± 5.4 kg/m². The mean age at symptom onset was 28.3 ± 15.2 years, mean symptom duration was 12.6 ± 10.5 years, and mean age at implantation was 40.2 ± 11.1 years. Primary diagnosis and etiology of primary symptoms are summarized in (Figure-2).

The mean International Consultation on Incontinence Questionnaire–Short Form symptom score of all patients was 13.64 ± 7.61 before implantation and 7.50 ± 7.51 after implantation ($p = 0.003$). The mean decrease in ICIQ-SF symptom score was 6.12 ± 6.07 points. Table-1 summarizes the clinical features and outcomes of the patients.

There were no unanticipated adverse events. The most common device-related adverse event was reduced stimulation perception. Lead dysfunction was occured in 3 (18.7%) patients, whose therapeutic efficacy was reduced for an unknown

reason, which could be corrected by device reprogramming. Furthermore, only one patient required reoperation after surgical failure due to local hematoma. Surgical site infection occurred in 2 (12.5%) patients, one of which resulted in implant removal. Both infections occurred after fistulization of the stimulator to the skin in patients with diabetes mellitus who were also smokers. Discomfort or pain at the implantable pulse generator (IPG) site occurred in 2 (12.5%) patients. Based on these findings, the rate of complications requiring surgical intervention was 12.5%, and the rate of device-related adverse events was 18.7%.

SNM was performed in 14 (87.5%) patients for LUTD of bladder origin. Of the patients with bladder-related LUTD, 4 (28.6%) had received intradetrusor onabotulinumtoxinA injection, 2 (14.3%) had received α-blocker therapy, 5 (35.7%) had received antimuscarinic therapy, and 3 (21.4%) had received combined pharmacological therapy. Only 2 (12.5%) patients underwent SNM implantation for FI. The first-stage clinical response rate was 88.8%, and 2 (12.5%) patients achieved complete resolution of UUI.

We observed a statistically significant decrease in urinary frequency (voids/24 h), clean intermittent catheterization (CIC) requirement, post-void residual (PVR) volume, ICIQ-SF symptom score, and daily fecal incontinence episodes. When evaluated individually according to the indication, it was observed that SNM application significantly reduced daytime urination frequency in the overactive bladder group (p:0.034), ISQ-SF score and PVR (p:0.042) in the neurogenic LUTD group. Although there was only one case in the detrusor sphincter dyssynergy group, the elimination of the need for a catheter indicates that SNM may be effective in this group as well. In the fecal incontinence group, SNM was found to completely eliminate fecal incontinence episodes and provide a significant improvement in patient quality of life. Table-2 summarizes Clinical features of patients according to the primary diagnosis. No significant differences in clinical characteristics were identified between sexes when patients were categorized accordingly (Table-3).

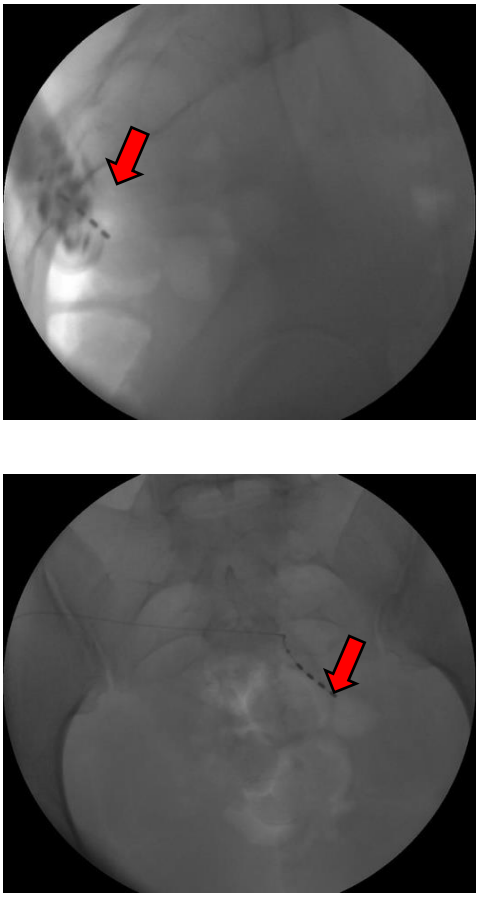

Figure-1. Fluoroscopy image of sacral neuromodulation application (A-Lateral view of SNM lead, B-Anterior-Posterior view of SNM lead, Red Arrow shows the lead location)

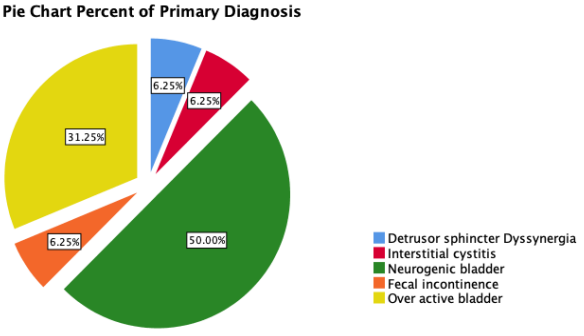

Figure-2. Distribution of primer diagnosis of the patients who underwent sacral neuromodulation

Table-1. Clinical features and outcomes of the patients

Parameter	Before SNM	After SNM	p Value
Absent bladder sensation, n (%)	5 (31.3%)	2 (12.5%)	0.083
Presence of pelvic pain, n (%)	4 (25%)	1 (6.3%)	0.083
Daytime urinary frequency, mean ± SD	10.0 ± 13.1	5.2 ± 5.8	0.009
Nocturia episodes/night, mean ± SD	2.5 ± 5.2	0.7 ± 1.4	0.068
Urgency episodes/day, mean ± SD	0.5 ± 2.0	0.1 ± 0.5	0.317
Urinary incontinence episodes/day, mean ± SD	2.5 ± 6.3	0.6 ± 1.4	0.197
Pad usage/day, mean ± SD	2.3 ± 6.2	0.6 ± 1.7	0.223
Clean intermittent catheterisation (CIC) frequency/day, mean ± SD	2.1 ± 2.3	0.8 ± 1.6	0.027
Post-void residual (PVR) volume, mL, mean ± SD	438.1 ± 334.2	216.0 ± 257.8	0.005
ICIQ-SF score, mean ± SD	13.6 ± 7.6	7.5 ± 7.5	0.003
Faecal incontinence episodes/day, mean ± SD	0.4 ± 1.44	0.1 ± 0.9	<0.001

Abbreviations: ICIQ-SF = International Consultation on Incontinence Questionnaire-Short Form; SNM = Sacral Neuromodulation; SD = Standard deviation; CIC = Clean intermittent catheterisation; PVR = Post-void residual.

Table-2. Clinical features of patients according to the primary diagnosis

Parameter	**Over Active Bladder n=5(31.25%)**			**Neurogenic lower urinary tract dysfunction n=8 (50.00%)**			**Detrusor sphincter dyssynergia n=1(6.25%)**			**Interstitial Cystitis n=1(6.25%)**			**Fecal incontinence n=1(6.25%)**		
	Before SNM	After SNM	p Value	Before SNM	After SNM	p Value	Before SNM	After SNM	p Value	Before SNM	After SNM	p Value	Before SNM	After SNM	p Value
Daytime urinary frequency, *episodes/day, mean ± SD*	11.20±8.46	5.20±3.56	0.034	5.38±4.03	3.38±1.92	0.168	54	25	N/A	3	2	N/A	4	4	N/A
Nocturia, *episodes/night, mean ± SD*	3.80±6.38	1.40±1.94	0.180	0.63±1.76	0.13±0.35	0.317	16	4	N/A	0	0	N/A	0	0	N/A
Urgency episodes/*day, mean ± SD*	1.60±3.57	0.40±0.89	0.317	0	0	1.000	0	0	N/A	0	0	N/A	0	0	N/A
Urinary incontinence episodes/*day, mean ± SD*	6.60±10.85	0.40±0.89	0.180	0.50±0.92	0	1.000	0	0	N/A	4	4	N/A	0	0	N/A
Pad count, *mean ± SD*	6.00±10.84	2.00±2.82	0.285	0.50±1.41	0.13±0.35	0.317	0	0	N/A	0	0	N/A	3	0	N/A
Intermittent catheterisation, episodes/*day, mean ± SD*	1.20±2.68	0.80±1.78	0.317	3.25±2.12	1.13±1.80	0.066	3	0	N/A	0	0	N/A	0	0	N/A
Post-void residual (PVR) volume, *mL, mean ± SD*	317.50±455.95	157.50±219.14	0.068	466.67±258.18	266.00±321.91	0.042	750	200	N/A	20	20	N/A	40	40	N/A
ICIQ-SF score, *mean ± SD*	15.60±8.84	8.40±8.56	0.063	16.00±4.71	8.75±7.99	0.028	10	6	N/A	2	2	N/A	0	0	N/A
Fecal incontinence episodes/*day, mean ± SD*	0	0	1.000	0	0	1.000	0	0	N/A	0	0	N/A	3	0	0.062

ICIQ-SF = International Consultation on Incontinence Questionnaire–Short Form; PVR = Post-void residual; SD = Standard deviation; SNM = Sacral neuromodulation.

Table-3. Differences in clinical features between patients according to sex

Parameter	Male n = 8 (50%)	Female n = 8 (50%)	p Value
Age, years, mean ± SD	43.75 ± 10.59	46.00 ± 16.49	0.713
Body mass index (BMI), kg/m², mean ± SD	26.41 ± 4.23	24.59 ± 6.65	0.401
Decrease in ICIQ-SF score, mean ± SD	6.38 ± 5.90	5.88 ± 6.64	0.749
Decrease in post-void residual (PVR) volume, mL, mean ± SD	219.29 ± 210.24	208.33 ± 305.05	0.424
Decrease in daytime urinary frequency, episodes/day, mean ± SD	7.25 ± 9.52	2.25 ± 5.47	0.113
Decrease in urinary incontinence episodes/day, mean ± SD	1.25 ± 2.81	2.63 ± 8.26	0.408
Decrease in urgency episodes/day, mean ± SD	0.75 ± 2.12	0	0.317
Decrease in nocturia episodes/night, mean ± SD	2.13 ± 4.22	1.38 ± 3.88	0.301

Abbreviations: BMI = Body mass index; ICIQ-SF = International Consultation on Incontinence Questionnaire-Short Form; PVR = Post-void residual; SD = Standard deviation

DISCUSSION

In this retrospective observational study, we aimed to interpret and analyze the results obtained from the study while placing them in the context of existing literature. We investigated the outcomes of SNM in patients with LUTD or bowel dysfunction. The results demonstrated improvements in various parameters, including urinary symptoms, quality of life (QoL), and incontinence episodes. However, complications were observed in a small proportion of patients.

When evaluated according to ICS-defined indications, OAB group showed significant reduction in increased daytime frequency, consistent with ICS guidelines recommending SNM as a third-line treatment for refractory OAB.Neurogenic LUTD group benefited particularly in terms of reduction in post-void residual and ISQ-SF scores, aligning with studies showing SNM effectiveness in selected neurogenic cases.

Detrusor sphincter dyssynergia (DSD) patient demonstrated marked improvement in voiding efficiency, which supports SNM use in carefully selected neurogenic dysfunction cases. Fecal incontinence patient experienced complete resolution of episodes, consistent with ICS and EAU guidelines that accept SNM as a treatment for refractory FI.

Our findings support that ICS guideline-based indications for SNM are applicable in our patient population. While OAB and neurogenic LUTD patients benefit most, FI patients may also experience substantial improvement. Conversely, outcomes in Interstitial cystitis/bladder pain syndrome remain uncertain.

The observed improvements in urinary symptoms and QoL after SNM implantation align with previous studies investigating the efficacy of SNM in treating LUTD (12,13). SNM is believed to modulate neural circuits in both central and peripheral neuronal pathways, resulting in therapeutic benefit. The exact mechanism by which SNM improves LUTD remains unclear, but two hypotheses have been proposed. The first suggests that SNM produces afferent activity that inhibits the abnormal neural activity underlying OAB, while the second proposes that SNM produces neuromodulation in supraspinal centers regulating lower urinary tract function (14).

We found that the most common primary diagnosis among patients implanted with SNM was neurogenic lower urinary tract dysfunction (50%) due to spinal cord injury (Figure-2). Previous studies support our findings. The study by Alghafees, including 28 patients who underwent SNM, showed that the most prevalent pathologies were neurogenic LUTD due to spinal cord injury (28.6%) and OAB (21.4%) (15). Another study reported similar results, with the most common pathology being idiopathic LUTD (54.2%) and neurological disease (45.8%) (16).

The current study reported a sex-balanced patient population. We did not observe a significant difference between sex and the success rate or clinical outcomes of SNM. However, studies from Kuwait and the Netherlands reported that they performed SNM predominantly in females (17,18). Another study from a Saudi tertiary care center reported similar results to ours, with no sex-related differences (15).

Age may be an important factor influencing SNM outcomes. In our study, age was not a significant

parameter affecting the results. The mean age was 42.4 ± 11.9 years, which is similar to other studies in the literature (19,20).

Our findings support the efficacy of SNM in managing LUTD, as indicated by the significant reduction in urinary symptoms assessed using the ICIQ-SF. The mean ICIQ-SF symptom score decreased by 6.12 points after SNM implantation, reflecting a substantial improvement in patient condition. These results are consistent with previous studies reporting successful outcomes in terms of symptom improvement and QoL (21,22). The overall success rate is reported in the range of 43–85% in the literature (23). The six-month results of the ROSETTA study reported a response rate of 84% during the first stage and a surgical intervention rate of 3% (24). While our study's first-stage response rate was similar to that of the ROSETTA study, our surgical intervention rates were higher.

Nevertheless, it is important to acknowledge adverse events associated with SNM. In our study, the complication rate requiring surgical intervention was 12.5%. The most common adverse events included reduced stimulation perception and discomfort or pain at the IPG site. These findings support the safety and benefits of SNM for patients with urinary and bowel dysfunctions. Reported complication rates range from 9–33% (23) and are consistent with existing literature, which has also highlighted potential adverse events such as pain, loss of therapeutic effect, infection, and bowel dysfunction (25,26).

Selection criteria for SNM vary among guidelines. The American Urological Association (AUA) recommends SNM as a third-line treatment option for severe refractory OAB or in patients who are not candidates for second-line therapies (27). The International Continence Society (ICS) suggests SNM for patients with OAB, with or without UUI, who have not responded to or are intolerant of conservative and pharmacological therapies (12). The European Association of Urology (EAU) guidelines recommend SNM for patients with refractory OAB/UUI despite antimuscarinic therapy (28). These variations reflect the ongoing debate and lack of consensus regarding optimal indications for SNM.

The present study contributes to the literature by reporting SNM outcomes in a Turkish population. However, certain limitations must be acknowledged. First, the retrospective nature of the study introduces inherent biases and limitations in data collection. Second, the sample size is relatively small, which may limit the generalizability of the results. Finally, the follow-up duration may not be sufficient to capture long-term outcomes and adverse events associated with SNM.

CONCLUSION

Our study demonstrates that sacral neuromodulation is an effective treatment option for patients with LUTD and bowel dysfunction. The improvements in LUTS and QoL observed in our patients support the therapeutic potential of SNM. In addition, SNM can be performed with an acceptable safety profile.

Conflicts of interest: Authors declared no conflict of interest.

References

1. Goldman HB, Lloyd JC, Noblett KL, et al. International Continence Society best practice statement for use of sacral neuromodulation. *Neurourology and urodynamics*. 2018;37(5):1823-1848.
2. Phillips A. Sacral neuromodulation system for treating refractory overactive bladder. *British Journal of Nursing*. 2020;29(18):S30-S37.
3. Gill BC, Pizarro-Berdichevsky J, Bhattacharyya PK, et al. Real-time changes in brain activity during sacral neuromodulation for overactive bladder. *The Journal of urology*. 2017;198(6):1379-1385.
4. Mass-Lindenbaum M, Calderón-Pollak D, Goldman H, Pizarro-Berdichevsky J. Sacral neuromodulation-when and for who. *International braz j urol*. 2021;47:647-656.
5. Averbeck MA, Gomes CM. Worldwide utilization patterns of sacral neuromodulation for neurogenic lower urinary tract dysfunction. *Current Bladder Dysfunction Reports*. 2016;11(4):356-364.
6. Hu M, Lai S, Zhang Y, Liu M, Wang J. Sacral neuromodulation for lower urinary tract dysfunction in spinal cord injury: a systematic review and meta-analysis. *Urologia Internationalis*. 2019;103(3):337-343.

7. Tutolo M, Ammirati E, Heesakkers J, et al. Efficacy and safety of sacral and percutaneous tibial neuromodulation in non-neurogenic lower urinary tract dysfunction and chronic pelvic pain: a systematic review of the literature. *European Urology*. 2018;73(3):406-418.
8. van Kerrebroeck PE, van Voskuilen AC, Heesakkers JP, et al. Results of sacral neuromodulation therapy for urinary voiding dysfunction: outcomes of a prospective, worldwide clinical study. *The Journal of urology*. 2007;178(5):2029-2034.
9. Averbeck MA, Moreno-Palacios J, Aparicio A. Is there a role for sacral neuromodulation in patients with neurogenic lower urinary tract dysfunction? *International braz j urol*. 2020;46:891-901.
10. Gormley E, Lightner D, Burgio K, et al. Diagnosis and treatment of non-neurogenic overactive bladder (OAB) in adults: an AUA/SUFU guideline (2019). 2020:
11. Nambiar AK, Arlandis S, Bø K, et al. European Association of Urology Guidelines on the Diagnosis and Management of Female Non-neurogenic Lower Urinary Tract Symptoms. Part 1: Diagnostics, Overactive Bladder, Stress Urinary Incontinence, and Mixed Urinary Incontinence. *European Urology*. 2022;
12. Siegel S, Noblett K, Mangel J, et al. Results of a prospective, randomized, multicenter study evaluating sacral neuromodulation with InterStim therapy compared to standard medical therapy at 6-months in subjects with mild symptoms of overactive bladder. *Neurourol Urodyn*. Mar 2015;34(3):224-30. doi:10.1002/nau.22544
13. Peters KM, Carrico DJ, Perez-Marrero RA, et al. Randomized trial of percutaneous tibial nerve stimulation versus Sham efficacy in the treatment of overactive bladder syndrome: results from the SUmiT trial. *J Urol*. Apr 2010;183(4):1438-43. doi:10.1016/j.juro.2009.12.036
14. Spinelli M, Sievert KD. Latest technologic and surgical developments in using InterStim Therapy for sacral neuromodulation: impact on treatment success and safety. *Eur Urol*. Dec 2008;54(6):1287-96. doi:10.1016/j.eururo.2008.01.076
15. Alghafees M, Ghazwani Y, Alqahtani M, Aldarrab R. Trends and Outcomes of Sacral Neuromodulation: A Saudi Tertiary Care Center Experience. *Journal of Urological Surgery*. 2022;9(1):25.
16. Al-Azzawi IS, Al-Tamimi MA. The first Iraqi experience in sacral neuromodulation for patients with lower urinary tract dysfunction. *Arab Journal of Urology*. 2018;16(4):391-396.
17. Shehab Z, Yaiesh S, Al-Terki A, Al-Shaiji T. [33] Sacral neuromodulation: Report of initial experience in Kuwait. *Arab Journal of Urology*. 2018;16(sup1):S16-S17.
18. van Wunnik BP, Govaert B, Leong R, Nieman FH, Baeten CG. Patient experience and satisfaction with sacral neuromodulation: results of a single-center sample survey. *Diseases of the colon & rectum*. 2011;54(1):95-100.
19. Gandhi S, Gajewski JB, Koziarz A, Almutairi S, Ali A, Cox A. Long-term outcomes of sacral neuromodulation for lower urinary tract dysfunction: A 23-year experience. *Neurourology and Urodynamics*. 2021;40(1):461-469.
20. Al-Zahrani AA, Elzayat EA, Gajewski JB. Long-term outcome and surgical interventions after sacral neuromodulation implant for lower urinary tract symptoms: 14-year experience at 1 center. *The Journal of urology*. 2011;185(3):981-986.
21. Kessler TM, Buchser E, Meyer S, et al. Sacral neuromodulation for refractory lower urinary tract dysfunction: results of a nationwide registry in Switzerland. *Eur Urol*. May 2007;51(5):1357-63. doi:10.1016/j.eururo.2006.11.011
22. Laviana A, Jellison F, Kim JH. Sacral neuromodulation for refractory overactive bladder, interstitial cystitis, and painful bladder syndrome. *Neurosurg Clin N Am*. Jan 2014;25(1):33-46. doi:10.1016/j.nec.2013.08.001
23. Ammirati E, Giammò A, Manassero A, Carone R. Neuromodulation in urology, state of the art. *Urologia Journal*. 2019;86(4):177-182.
24. Siddiqui NY, Wu JM, Amundsen CL. Efficacy and adverse events of sacral nerve stimulation for overactive bladder: a systematic review. *Neurourology and urodynamics*. 2010;29(S1):S18-S23.
25. Jonas U, Fowler CJ, Chancellor MB, et al. Efficacy of sacral nerve stimulation for urinary retention: results 18 months after implantation. *J Urol*. Jan 2001;165(1):15-9. doi:10.1097/00005392-200101000-00004

26. Siegel SW, Catanzaro F, Dijkema HE, et al. Long-term results of a multicenter study on sacral nerve stimulation for treatment of urinary urge incontinence, urgency-frequency, and retention. *Urology*. 2000;56(6):87-91.

27. Lightner DJ, Gomelsky A, Souter L, Vasavada SP. Diagnosis and Treatment of Overactive Bladder (Non-Neurogenic) in Adults: AUA/SUFU Guideline Amendment 2019. *J Urol*. Sep 2019;202(3):558-563. doi:10.1097/ju.0000000000000309

28. Thüroff JW, Abrams P, Andersson K-E, et al. EAU guidelines on urinary incontinence. *Actas Urológicas Españolas (English Edition)*. 2011;35(7):373-388.