Efficacy And Safety of Sacral Neuromodulation in the Treatment of Females with Refractory Idiopathic Non-Obstructive Urinary Retention

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Purpose: Non-obstructive urinary retention (NOUR) is the inability to empty the bladder with no physical obstruction to urine flow. It can occur as a result of neurological disorders or be idiopathic. In younger women, it may be caused by Fowler's syndrome (FS), a rare disorder in which the urethral sphincter fails to relax to allow urine to pass normally. This study covers both idiopathic NOUR and FS. Sacral neuromodulation (SNM) has been introduced as an effective option for patients with NOUR.

Materials and Methods: Forty-two patients (aged 17 to 61 years) suffering from refractory NOUR who had a successful first-stage SNM with the Interstim II device, and in whom the second stage was completed, were prospectively studied in the department of neurogenic bladder and neuromodulation in our hospital from February 2016 to August 2019 to evaluate the efficacy and safety of SNM.

Results: The study included forty-two women with NOUR: 20 (47%) with FS and 22 (53%) with idiopathic NOUR. Their mean age was 27.2 ± 12.4 years. Thirty-eight (90%) of them had a successful trial phase (responders) with more than 50% improvement in their voiding parameters. After continued follow-up, a clinical success rate of 79% (30 out of 38 cases) was achieved, with a median follow-up period of 28 ± 8 months. The voiding parameters of these 38 patients showed statistically significant improvement after SNM. Their post-void residual volume dropped significantly from 330 ± 77 mL to 97 ± 55 mL ($P < 0.001$), average voided volume increased from 60 ± 23 mL to 265 ± 99 mL ($P < 0.001$), and the number of clean intermittent catheterizations per day fell from 5.6 ± 1 to 1.3 ± 1.6 ($P < 0.001$). The total number of patients who required surgical revision was 10 (26.4%), for reasons including malfunction due to external trauma in four patients (10.5%), continuous pain in four (10.5%), and device infection in two (5%).

Conclusion: SNM is an effective and safe option for women with refractory idiopathic non-obstructive urinary retention and Fowler's syndrome.

Keywords: fowler's syndrome; sacral neuromodulation; non-obstructive urinary retention

INTRODUCTION

Non-obstructive urinary retention (NOUR) is the inability to completely empty the bladder with no physical obstruction to urine flow. It can occur as a result of neurological disorders, such as multiple sclerosis or spinal cord disease, or it can be idiopathic. In younger women, it may be caused by Fowler's syndrome (FS), which is a rare disorder in which the urethral sphincter fails to relax to allow urine to be passed normally.[1]

Chronic urinary retention is important because it can lead to significant morbidity, such as hydronephrosis, chronic renal insufficiency, and chronic urinary tract infections, as well as bothersome urinary symptoms such as incontinence, a slow urinary stream, and feelings of incomplete bladder emptying.[2]

Electromyography (EMG) of the external urethral sphincter divides women with NOUR into two categories. Patients who present with bursts and complex repetitive discharges on EMG are referred to as having FS,[3] and those who show no activity on EMG are said to have idiopathic NOUR.[4] Non-obstructive urinary retention represents one of the most challenging dilemmas in urological practice.[5]

Fowler's syndrome refers particularly to functional urinary retention in young women in the absence of overt neurologic disease. The typical history is that of a woman younger than 30 years who has found herself unable to void for a day or more with no urinary urgency but increasing lower abdominal discomfort when the bladder reaches full capacity. Some women may experience back pain or dysuria. A bladder capacity of over 1 L with no sensation of urgency is necessary for the diagnosis. There are no neurologic or laboratory features to support a diagnosis of any neurologic disease. The urodynamic findings are reduced bladder sensation, large bladder capacity, and absent or decreased detrusor contraction.[6] The exact etiology is unknown. MRI scans of the brain and the entire spinal cord have been reported to be normal; efforts to treat this condition by hormonal manipulation, pharmacologic therapy, or injections of onabotulinumtoxin-A have been unsuccessful. This condition is highly responsive to neuromodulation, with

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Table 1. Sociodemographic and clinical data

Variable	Mean	SD
Age (years)	27.2	12.4
Duration of retention (months)	25	16
Diagnosis	No.	Percentage
F.S	20	47%
INOUR	22	53%
Total	42	100%

SD= standard deviation, F.S= fowler syndrome, INOUR= idiopathic non-obstructive urinary retention

a success rate approaching 70% even in women who have had urinary retention for many months or years.[3,7,8]

Treatment of chronic NOUR in the form of urethral dilatation, intermittent catheterization, botulinum toxin injection of the urethral sphincter, and alpha-blockers has been tried for women with urinary retention. Spontaneous recovery has been observed in 42% of patients, in which precipitating factors were present, such as following pelvic surgery and postpartum.[9]

Sacral neuromodulation (SNM) is a minimally invasive therapy that involves the subcutaneous implantation of a programmable stimulator in the lower back. The device delivers low-amplitude electrical stimulation through a lead to the sacral nerve—typically accessed via the S3 foramen—with the aim of restoring the normal voiding cycle.[10] It may be indicated for NOUR, the symptoms of overactive bladder (urinary urge incontinence and urgency-frequency alone or in combination), and bowel dysfunction.[11] It was introduced as a revolutionary concept by Schmidt and Tanagho in 1979.[12-14]

S3 SNM can be done by either a one-stage or two-stage procedure. The one-stage procedure involves an initial test stage using a peripheral nerve evaluation (PNE) by implanting a temporary stimulating electrode through the S3 foramen. If voiding is shown to improve, the patients are offered a permanent stimulator; a different electrode will be inserted using an open sacral procedure and connected to a permanent implantable pulse generator (IPG).[15]

The new two-stage technique was introduced in 1997, with a tined electrode and using a minimally invasive approach;[16,17] it will be described in detail elsewhere in this article.

The exact mechanisms of how neuromodulation works are not completely understood; however, some have proposed that SNM is postulated to suppress the guarding reflex, leading to decreased urethral sphincter tone, thus facilitating voiding.[8,18]

S3 SNM received approval by the US Food and Drug Administration (FDA) for the treatment of urge incontinence in 1997 and for urgency/frequency and NOUR in 1999.[19]

MATERIALS AND METHODS

Forty-two female patients older than 16 years suffering from chronic NOUR, including idiopathic and Fowler's syndrome etiologies (indwelling urinary catheter or performing CIC), who were not responding to conservative therapy, were studied prospectively in our center from February 2016 to August 2019 regarding the efficacy and safety of SNM by two-stage Interstim II device implantation. Patient assessment included an elaborate medical history (age, duration of retention, medical, surgical, and drug history), physical examination, abdominal ultrasonography, and a three-day bladder diary that included the number of micturitions and voided urine volume (in case of incomplete retention). Catheterized urine volumes and post-void residual volumes were also recorded in patients using clean intermittent catheterization (CIC). Urodynamic studies were done with surface perineal electromyography (instead of a needle electrode to reduce invasiveness)[20], lum-

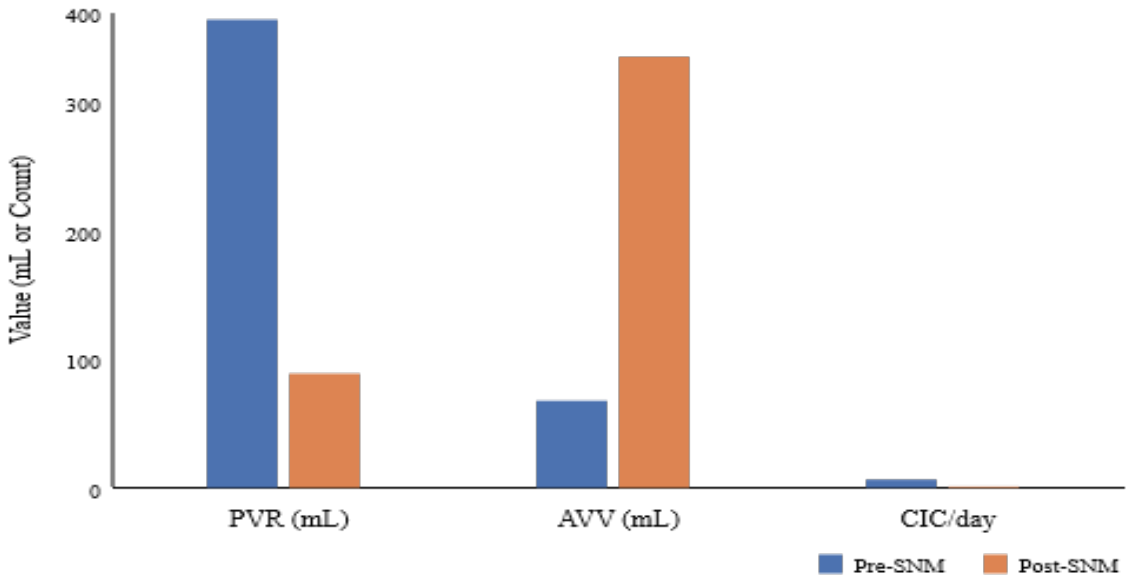

Figure 1. Comparison of voiding parameters before and after SNM for 30 successful patients.
PVR=post void residual volume, SNM=sacral neuromodulation, CIC=clean intermittent catheterization, AVV=average voided volume.

Table 2. Response rate of patients after the trial phase

Diagnosis	No. of patients	No. of responders	% of responders	No. of Non-responders	% of Non-responders
Overall patients	42	38	90%	4	10%
FS	20	20	100%	0	0%
IUR	22	18	81%	4	19%

FS= fowler syndrome, IUR=idiopathic urinary retention

bosacral MRI, and flexible cystoscopy.
The exclusion criteria included women with pelvic organ prolapse, anatomical bladder outlet obstruction, age below 16 years, a neurological etiology, and pregnancy. The sample size was calculated to estimate a minimum of a 50% success rate with a 95% confidence level and 80% power. Based on the formula for a single population proportion, the minimum required sample size was 42 participants.[21]

Surgical Technique: Staged Implantation

Stage one:

Preoperative intravenous antibiotics (third-generation cephalosporin) are given one hour before the procedure. Aseptic techniques for foreign body implants are implemented, and the surgical site is irrigated with amikacin (2 grams) diluted in normal saline (500 mL).
The patient is placed in the prone position, under controlled anesthesia. The location of the S3 foramen is marked on the skin by measuring 9 cm cephalad to the lower tip of the sacrum and 1 to 2 cm lateral to the midline on either side.
The insulated foramen needle is then inserted into the S3 foramen under fluoroscopic guidance. Then, stimulation is started, and the surgeon looks for the motor response, which is dorsiflexion of the great toe and contraction of the perineal area, which represents contraction of the levator muscles (bellows reflex). Once the surgeon is satisfied with the position, the sheath is removed so that the tined lead is anchored in place.
The external generator can be flexibly programmed for the duration of the intended trial while the patient records symptoms and bladder function in a voiding diary, including post-voiding residual urine (PVR), average voided volumes (AVV), and number of CIC/day. Initial programming was adjusted to maximize patient comfort and attempt to localize the sensory response to the vaginal area with a gentle pulsating feeling. If there is more than 50% improvement in their voiding function, we proceed with the stage-two procedure.

Stage two:

The patient is sedated and placed in the prone position. Using local anesthesia, the previous skin incision is opened, the temporary extension wire is removed, and then the extension of the IPG is connected to the lead and transposed to the contralateral site of the previous incision to make a small pocket under subcutaneous fat to accommodate the IPG.
Each patient was given a small device (patient's programmer), similar to a cell phone, with detailed instructions on how to use it (increase, decrease the level of stimulation, or turn it off).
Patients were followed up considering their symptomatic improvement, durability, and complications.
According to data collected from the last follow-up

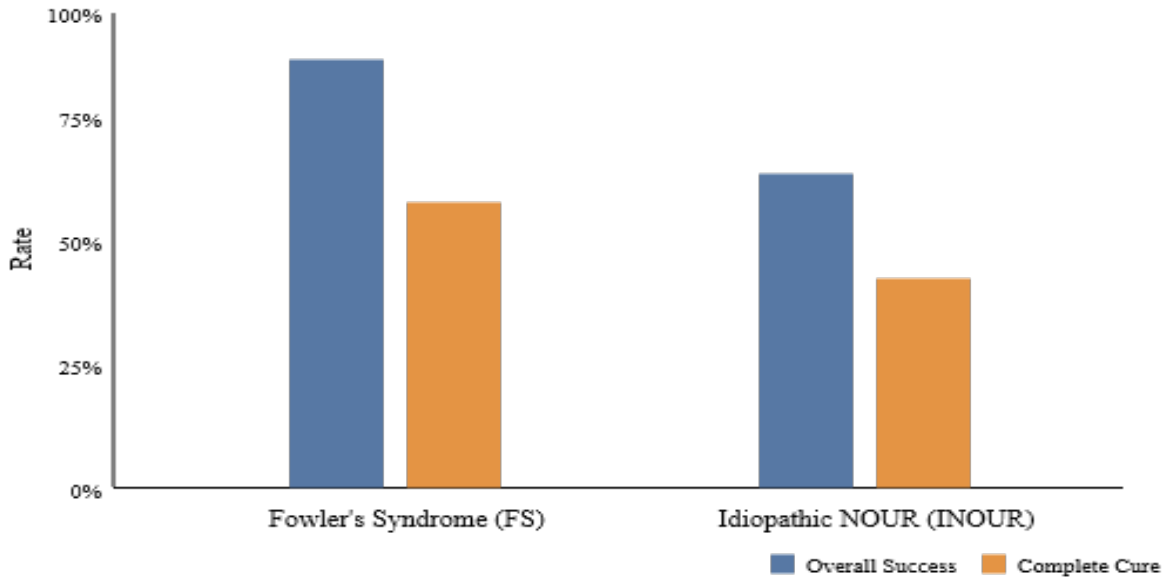

Figure 2. Success and cure rates by diagnosis.FS= fowler syndrome, INOUR=idiopathic non-obstructive urinary retention.

Table 3. PVR, AVV and No. of CIC/day before and after SNM for the 38 and 30 successful patients (responders).

Variable	Pre SNM	Post SNM	MD (95% CI)	*P*-value
38 responders				
PVR (mls)	Mean 330, SD 77	Mean 97, SD 55	233 (186-280)	< 0.001
AVV/day(mls)	Mean 60, SD 23	Mean 265, SD 99	205 (158-253.5)	< 0.001
No. of CIC/day	Mean 5.6, SD 1	Mean 1.3, SD 1.6	4.3 (3.31-5.21)	< 0.001
30 successful patients				
PVR (mls)	Mean 332, SD 83	Mean 80, SD 49	252 (189-297)	< 0.001
AVV/day(mls)	Mean 61, SD 24.5	Mean 302, SD 75	241 (156-272)	< 0.001
No. of CIC/day	Mean 5.8, SD 0.9	Mean 0.8, SD 1.3	5 (2.52-5.61)	< 0.001

SD=standard deviation, PVR=post void residual volume, SNM=sacral neuromodulation, CIC=clean intermittent catheterization, AVV=average voided volume, MD=mean difference.

visit, the success of treatment was defined as the percentage of patients who had a successful outcome with more than 50% improvement in their voiding parameters (PVR, AVV, and number of CIC/day). A cure was defined as voiding with complete elimination of catheterization, while recurrent retention needing intermittent or permanent catheterization was considered a failure.[22]

For statistical purposes, we considered patients with an indwelling urinary catheter (10 patients) as if they performed 6 CICs/day because the optimal interval of CICs for patients with complete retention is 3-4 hours during the day and 1-2 times/night, totaling about 6 times a day.

The initial responding patients were followed up at 3, 6, and 12 months, and then annually for up to 3 years, with a mean follow-up duration of 28 ± 8 months to assess efficacy and safety. Patients were also able to contact the clinical team at any time between scheduled visits in the event of unexpected issues. Bladder diary measurements were performed during the initial test phase to evaluate treatment response. This assessment was repeated during follow-up only if clinically indicated (recurrence of symptoms, suspicion of urinary retention, or device malfunction).

Statistical Package for the Social Sciences (SPSS) version 24 and Microsoft Office Excel 2013 were used for data entry and analysis. Mean and standard deviation were used to represent the numerical data, while frequency and percentage were used to represent the categorical data. Appropriate statistical tests were applied, including the Chi-square test and paired-sample t-test, with significance defined at $p < 0.05$. For comparisons involving small sample sizes, Fisher's exact test was used. Data normality was assessed using the Shapiro–Wilk test, which confirmed a normal distribution.

Ethics approval and consent to participate: Approval from the ethics committee was obtained from the

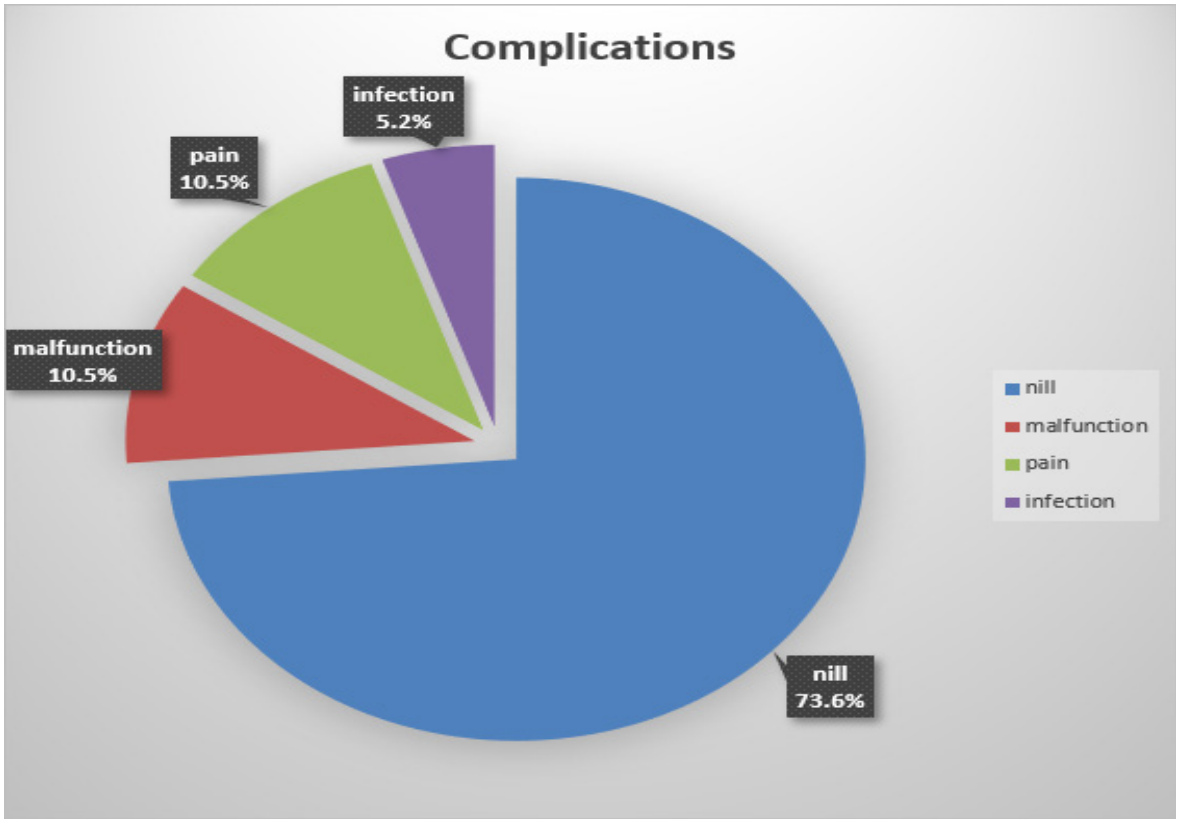

Figure 3. Complications requiring surgical revision (n=10).

Table 4. No. and percentage of patient with overall success and cure rate according their specific diagnosis.

Diagnosis	No. of patients	No. of Overall success	% Of overall success	No. of cure	% Of complete success
Overall	38	30	79	20	53
FS	20	18	90	12	60
Idiopathic NOUR	18	12	66	8	44

FS= fowler syndrome, NOUR =non obstructive urinary retention.

Health Ethics Committee in the College of Medicine, University of Baghdad.

RESULTS

Forty-two women with a history of NOUR, each of whom had tried one or more treatment modalities in the form of alpha-blockers, urethral dilatation, and botulinum toxin injection into the urethral sphincter and pelvic floor without benefit, underwent staged Interstim II device implantation and were followed from February 2016 to August 2019. Twenty of them were suffering from Fowler syndrome (47%), and the others (53%) with idiopathic NOUR. Their mean age was 27.2 ± 12.4 years (ranging from 17 to 61). The mean duration of their retention was 25 ± 16 months (ranging from 6-60), as shown in (**Table 1**).

All forty-two chosen women who were fulfilling the criteria for indication of neuromodulation underwent stage one tined lead insertion in the S3 foramen. Thirty-eight women responded well during the first week of the trial phase with more than 50% improvement in their voiding parameters (PVR, AVV, and number of CIC/day). Four women who were suffering from idiopathic NOUR did not respond well throughout four weeks of the trial phase, so their devices were explanted and they were excluded from the study. However, these thirty-eight women (responders) proceeded with stage 2 implantation of the permanent IPG.

So, the overall response rate was 90% (38/42). The responders with FS were 100% (20/20), while for those with idiopathic NOUR the response rate was 81% (18/22), as shown in (**Table 2**).

(**Table 3**) shows the overall differences between pre- and post-SNM variables (PVR, AVV, and number of CIC/day) in the form of mean ± SD for responding women.

The success rate of responding patients was 79% (30/38). Their mean preoperative PVR was 332 ± 83 mL, which had fallen to 80 ± 49 mL after stimulation ($P < 0.001$), with a significant mean difference of 252. The mean voided volumes per day was 61 ± 24.5 mL and became 302 ± 75 ($P < 0.001$), and the mean difference (241) was significant too.

The average number of CICs/day for these 30 patients was 5.8 ± 0.9 pre-SNM, which was considerably reduced to 0.8 ± 1.3 post-SNM ($P < 0.001$) with a mean difference of (5), as detailed in (**Table 3**) and shown in (**Figure 1**).

The response to stimulation varied among these 38 patients, ranging from complete evacuation without the need for CIC (cure), which happened to 20 women (53%), while ten of them continued to show an incomplete but significant response with more than 50% improvement (6.2 ± 0.4 CICs/day became 2.4 ± 1 after stimulation, $P < 0.001$), and significant improvement in their PVRs and average voided volumes.

Eight patients had recurrent retention needing catheterization, so they were considered as failures. Six of these eight patients had idiopathic NOUR and two with FS. Two of them requested to explant their device after 9 months of stimulation, while the others did not as they got some benefit from it.

According to their specific diagnosis, the success and cure rates were in favor of women with FS; their success and cure rates were 90% and 60%, respectively. However, the outcome of women with idiopathic NOUR was much lower than those with FS; 66% of them were considered successful while 44% were completely cured, as shown in (**Table 4**) and (**Figure 2**).

During follow-up, the total number of patients who required surgical revision of their devices was 10 (26.4%), for reasons including malfunction due to external trauma in four (10.5%), continuous pain and discomfort at the lead or IPG sites that did not respond to reprogramming in four (10.5%), and device infection in two (5%), as shown in (**Figure 3**). These were not considered as failures but rather as complications because their devices were replaced and they showed the same responses as before these complications.

Most of our patients complained of an undesirable sensation or pain during the first post-operative month. They were managed successfully by reprogramming the device, and we considered these events as a side effect rather than a complication.

Four women became pregnant during the follow-up period and had their devices deactivated throughout pregnancy. They were managed with clean intermittent catheterization (CIC) during this time and resumed device use postpartum. All four remained responders after reactivation.

Therefore, only the conditions that required surgical intervention were considered as complications.

DISCUSSION

Non-obstructive urinary retention (NOUR) is a complex urological condition that presents significant management challenges, particularly due to the frequent reliance on intermittent or permanent catheterization. Since Tanagho and Schmidt first introduced sacral nerve stimulation (SNS) for refractory lower urinary tract dysfunction in 1982[24], substantial advances have been made in managing conditions such as NOUR through neuromodulatory techniques.

In our study, the long-term response rate to the trial phase of sacral neuromodulation was 79%, which, although promising, was slightly lower than the 88.8% success rate reported by Shahbaz Mehmood et al. in a cohort of 27 NOUR patients who demonstrated a greater than 50% reduction in catheterization and symptom improvement after initial SNS implantation.[5] Similarly, Al-Zahrani et al. reported a higher success rate of 87.5% in 16 idiopathic NOUR patients, with a median follow-up of 50.7 months.[25] Conversely, De Ridder et al. identified a differential outcome based on etiology, with women diagnosed with Fowler's syndrome achieving superior long-term outcomes (72%) compared to

those with idiopathic NOUR (46%) at five years.[13]
In our series, 38 patients responded to the trial phase, and 30 (approximately 79%) maintained more than 50% improvement in voiding parameters over an average duration of 28 ± 8 months. The variation in reported success rates across studies may be attributed to differences in patient selection criteria, follow-up duration, etiologic subtypes, and definitions of clinical success. A landmark meta-analysis by Gross et al. in 2010 remains one of the most authoritative evaluations of SNM efficacy in NOUR, incorporating 14 studies—including one randomized controlled trial and 13 observational studies. Their pooled analysis demonstrated a significant mean reduction in post-void residual (PVR) by 236 mL and an increase in voided volume by 299 mL (both $P < 0.00001$) following SNM implantation.[26] When compared with our findings—a mean PVR reduction of 233 mL and an increase in voided volume of 205 mL (both $P < 0.001$)—our results closely align in terms of PVR, though the voided volume gains were somewhat lower. This consistency lends further support to the reproducibility and robustness of SNM outcomes across diverse clinical settings.
Concerning the overall cure rate, it was 53% (20/38). Concerning their specific diagnosis, 60% of FS and 44% of idiopathic NOUR eliminated their need for urinary catheterization. Peeters et al. studied 94 patients with idiopathic NOUR (32 patients with Fowler's; 61 non-Fowler's), after a mean follow-up of 46.88 months. Their overall cure rate was 58%, with 62.5% for Fowler's syndrome and 53% for idiopathic retention.[27] Although their result was slightly higher than ours, it was comparable in terms of favoring FS. So, we deduced that FS is not only a predictor of SNM response and overall success but it is also predictive of a complete cure. The initial effectiveness of sacral neuromodulation (SNM) may decline over time due to neural habituation, lead migration, disease progression, or suboptimal device reprogramming. Regular follow-up and timely adjustments are essential to maintain long-term efficacy.[28,29]
Regarding the safety profile, during follow-up, with a mean duration of 28 ± 8 months, the total number of patients with significant complications that required surgical revision of their devices was 10 (26.4%). The main reasons were device malfunction due to external trauma in 4 (10.5%), continuous pain and discomfort in 4 (10.5%), and device infection in two (5%). Siegel et al. revealed that the overall surgical revision rate was 33% (73 of 219 patients), including pain at the neurostimulator site (15.3%), new pain (9.0%), suspected lead migration (8.4%), infection (6.1%), and transient electric shock (5.5%).[30]
This study stands out by including a broad age range (17–61 years) and only female patients, all of whom were refractory to previous treatments. Regular follow-ups were conducted at 3, 6, and 12 months, then annually, with a follow-up duration of up to three years. This design allowed for a thorough evaluation of the efficacy and safety of sacral neuromodulation over time. However, this study has several limitations. The small sample size may limit the generalizability of the results. As a single-center study, the findings may be influenced by specific institutional practices. Additionally, the lack of a control group limits the ability to compare outcomes with alternative treatments.

CONCLUSIONS

Sacral neuromodulation is an FDA-approved, effective, and safe minimally invasive therapy for women with refractory idiopathic non-obstructive urinary retention and Fowler syndrome; it results in statistically significant improvements in voiding parameters and a notable cure rate for what is otherwise a challenging health problem to treat.

SUMMARY

Sacral neuromodulation is a safe and effective implanted device for women with non-obstructive chronic urinary retention. It helps patients regain the ability to urinate independently, significantly improving their quality of life.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

REFERENCES

1. Bruce C. National institute for health care excellence interventional procedure consultation document, June 2015. Sacral nerve stimulation for idiopathic chronic non-obstructive urinary retention [internet]. Available from 1 (nice.org.uk). [Accessed 2 October 2019]
2. Stoffel JT, Peterson AC, Sandhu JS, Suskin AM, Wei JT, Lightner DJ. AUA white paper on nonneurogenic chronic urinary retention: consensus definition, treatment algorithm, and outcome end points. J Urol. 2017;198:153-60.
3. Fowler CJ, Christmas TJ, Chapple CR, Parkhouse HF, Kirby RS, Jacobs HS. Abnormal electromyographic activity of the urethral sphincter, voiding dysfunction, and polycystic ovaries: a new syndrome? BMJ. 1988;297:1436-8.
4. Shaker HS, Hassouna M. Sacral root neuromodulation in idiopathic nonobstructive chronic urinary retention. J Urol. 1998;159:1476-8.
5. Mehmood S, Altaweel WM. Long-term outcome of sacral neuromodulation in patients with idiopathic nonobstructive urinary retention: Single-center experience. Urol Ann. 2017;9:244.
6. Szymański JK, Słabuszewska-Jóźwiak A, Jakiel G. Fowler's Syndrome-The Cause of Urinary Retention in Young Women, Often Forgotten, but Significant and Challenging to Treat. Int J Environ Res Public Health. 2021;18:3310.
7. Fowler CJ. Neurological disorders of micturition and their treatment. Brain. 1999;122:1213-31.
8. Wein AJ, Dmochowski RR. Neuromuscular Dysfunction of the Lower Urinary Tract. In: Campbell-Walsh Urology. 11th ed. 2019:304.
9. Swinn MJ, Wiseman OJ, Lowe E, Fowler CJ. The cause and natural history of isolated urinary retention in young women. J Urol. 2002;167:151-6.
10. Ismail MB, Abdulhussein WQ. Efficacy and Safety of Sacral Neuromodulation in

Treatment of Refractory Overactive Bladder. Indian J Forensic Med Toxicol. 2020;15:1315-21.
11. Ismail MB, Abdulhussein WQ. The Safety and Efficacy of Sacral Neuromodulation on Refractory Urgency Urinary and Fecal Incontinence in Iraqi Patients. Medico Legal Update. 2021;21:575-9.
12. Dasgupta R, Wiseman OJ, Kitchen N, Fowler CJ. Long-term results of sacral neuromodulation for women with urinary retention. BJU Int. 2004;94:335-7.
13. De Ridder D, Ost D, Bruyninckx F. The presence of Fowler's syndrome predicts successful long-term outcome of sacral nerve stimulation in women with urinary retention. Eur Urol. 2007;51:229-34.
14. Schmidt RA, Tanagho EA. Feasibility of controlled micturition through electric stimulation. Urol Int. 1979;34:199-230.
15. Banakhar M, Hassouna M. Percutaneous nerve evaluation test versus staged test trials for sacral neuromodulation: sensitivity, specificity, and predictive values of each technique. Int Neurourol J. 2016;20:250.
16. Janknegt RA, Weil EH, Eerdmans PH. Improving neuromodulation technique for refractory voiding dysfunctions: two-stage implant. Urology. 1997;49:358-62.
17. Scheepens WA, Van Koeveringe GA, de Bie RA, Weil EH, van Kerrebroeck PE. Long-term efficacy and safety results of the two-stage implantation technique in sacral neuromodulation. BJU Int. 2002;90:840-5.
18. Van Kerrebroeck PE, Marcelissen TA. Sacral neuromodulation for lower urinary tract dysfunction. World J Urol. 2012;30:445-50.
19. Thompson JH, Sutherland SE, Siegel SW. Sacral neuromodulation: therapy evolution. Indian J Urol. 2010;26:379.
20. Clothier JC, Wright AJ. Dysfunctional voiding: the importance of non-invasive urodynamics in diagnosis and treatment. Pediatr Nephrol. 2018;33:381-94.
21. Trump T, Goldman HB. Sacral neuromodulation for urinary incontinence. Continence. 2024;12:101697.
22. Coolen RL, Groen J, Stillebroer AB, Scheepe JR, Witte LP, Blok BF. Two-Staged Sacral Neuromodulation for the Treatment of Nonobstructive Urinary Retention: A Multicenter Study Assessing Predictors of Success. Neuromodulation. 2023;26:1823-30.
23. Van Kerrebroeck PE, Marcelissen TA. Sacral neuromodulation for lower urinary tract dysfunction. World J Urol. 2012;30:445-50.
24. Tanagho EA, Schmidt RA. Electrical stimulation in the clinical management of the neurogenic bladder. J Urol. 1988;140:1331-9.
25. 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. J Urol. 2011;185:981-6.
26. Gross C, Habli M, Lindsell C, South M. Sacral neuromodulation for nonobstructive urinary retention: a meta-analysis. Female Pelvic Med Reconstr Surg. 2010;16:249-53.
27. Peeters K, Sahai A, De Ridder D, Van Der Aa F. Long-term follow-up of sacral neuromodulation for lower urinary tract dysfunction. BJU Int. 2014;113:789-94.
28. van Kerrebroeck PE, van Voskuilen AC, Heesakkers JP, Lycklama á Nijholt AA, Siegel S, Jonas U, et al. Results of sacral neuromodulation therapy for urinary voiding dysfunction: outcomes of a prospective, worldwide clinical study. J Urol. 2007;178:2029-34.
29. Sukhu T, Kennelly MJ, Kurpad R. Sacral neuromodulation in overactive bladder: a review and current perspectives. Res Rep Urol. 2016;8:193-9.
30. Siegel SW, Catanzaro F, Dijkema HE, Elhilali MM, Fowler CJ, Gajewski JB, 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;56:87-91.