Research Article

Real-world efficacy and tolerability of solifenacin for the treatment of neurogenic overactive bladder in patients with multiple sclerosis

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Abstract

Background: Evidence on the use of antimuscarinic agents, such as solifenacin, for the treatment of neurogenic overactive bladder (nOAB) in patients with multiple sclerosis (MS) mainly derives from small, selected populations or industry-sponsored trials. Real-world data on its effectiveness and tolerability in unselected MS cohorts remain limited. **Objective**: The aim of this study is to evaluate the efficacy and safety of solifenacin in a real-world population of MS patients managed in an outpatient setting. **Methods**: We conducted a retrospective analysis of consecutive MS patients treated with solifenacin at any point in their urological treatment course. Demographic, clinical, and urodynamic data were collected, including lower urinary tract symptoms (LUTS), uroflowmetry parameters, and treatment-related adverse drug reactions. **Results**: Seventy-four patients were included, of whom 71.6% were female, with a mean age of 49 ± 10.7 years. Solifenacin was prescribed as first-line therapy in 82.4% of cases. During treatment, resolution of nOAB symptoms was achieved in 63.5% of patients, while urge urinary incontinence decreased to 35.1% during treatment. Uroflowmetry parameters and post-void residual volumes remained stable, indicating a negligible impact on voiding efficiency. Fourteen mild adverse drug reactions were reported, which were mainly constipation and transient urinary retention. **Conclusion**: This study confirms that solifenacin is an effective and well-tolerated treatment for nOAB in MS patients, with a favorable safety profile and minimal impact on bladder emptying. Unlike previous studies based on highly selected populations, our results provide pragmatic evidence from everyday clinical practice, supporting solifenacin as a reliable first-line option in neurogenic LUTS management among MS patients.

Keyword: Multiple sclerosis, Neurogenic overactive bladder, Solifenacin, Antimuscarinic agents, Real-world data, Lower urinary tract symptoms

1. Introduction

Multiple sclerosis (MS) is the most prevalent chronic inflammatory and neurodegenerative disease of the central nervous system.[1,2] Globally, approximately 2.8 million individuals are affected by MS, with the highest prevalence rates reported in high-income North America (164.6 per 100,000), Western Europe (127.0 per 100,000), and Australia (91.1 per 100,000).[3] The disease predominantly affects young adults, with a mean age of onset between 20 and 40 years.[4] Although its exact etiology remains unclear, the disease has a complex multifactorial pathogenesis involving autoimmunity, environmental, and/or genetic factors.[1,4] Genetic susceptibility is evidenced by familial clustering, with approximately 15% of patients reporting an affected relative and a 2–4% risk in first-degree relatives compared

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Submitted: 29 October 2025; Revision received: 19 January 2026; Accepted: 26 January 2026; Published: 06 March 2026

How to cite this article: Orecchia L, Rosato E, Vogrig P, *et al*. Real-world efficacy and tolerability of solifenacin for the treatment of neurogenic overactive bladder in patients with multiple sclerosis. *Bladder*. 2025:e21200084. DOI: 10.14440/bladder.0353

to 0.1% in the general population.[5] Additionally, MS is more prevalent in females, with a female-to-male ratio of approximately 2–3:1, particularly in the relapsing–remitting phenotype.[6] This sex difference is attributed to both genetic and hormonal factors, with the ratio increasing after puberty and remaining elevated in adult-onset MS.[6]

Neurogenic lower urinary tract symptoms (nLUTS) represent one of the most prevalent and debilitating manifestations of MS, affecting 80–95% of patients during the disease course.[7] The prevalence of LUTS increases with disease duration and disability, with symptoms typically emerging around 6–8 years after MS diagnosis, and nearly all patients report urinary symptoms 10 years or more after disease onset.[8,9] The impact of nLUTS in MS extends far beyond simple physical discomfort, profoundly affecting patient autonomy, self-perception, and social identity.[7] These symptoms significantly impair quality of life (QoL) across multiple domains, including physical, mental, and social functioning, and are associated with considerable morbidity, increased depression and anxiety, and even increased mortality.[9] Patients frequently restrict professional and recreational participation due to fear of incontinence episodes and concern about access to appropriate facilities, leading to avoidance behaviors and social isolation.[9] This cycle is compounded by the physical limitations imposed by MS and bladder dysfunction, which can result in a sedentary lifestyle and further exacerbate MS-related fatigue and muscle atrophy.[10] Addressing bladder symptoms in MS is not solely about managing urinary function; it is integral to preserving patients' ability to engage socially, maintain physical activity, and optimize cognitive and occupational performance.[10]

Overactive bladder (OAB) symptoms, such as urgency urinary incontinence (UUI), are among the most frequently reported complaints, while voiding dysfunction and urinary retention tend to occur in patients with longer disease duration and higher disability.[11] Urinary incontinence alone affects approximately 35% of MS patients and shows strong positive associations with disability level, female gender, and reduced QoL scores.[9] Despite the high prevalence and clinical impact of urinary disorders in MS, these symptoms are often underreported and undertreated.[11,12] For these reasons, effective management of nLUTS is crucial not only to alleviate symptoms but also to prevent urological complications, such as urinary tract infections, bladder stones, and chronic renal impairment.[1,13] Thus, comprehensive management of neurogenic bladder in MS has broad implications for overall QoL and functional status. Consequently, a multidisciplinary approach, involving neurologists, urologists, gynecologists, rehabilitation specialists, and trained nurses, is essential for optimal care.[12,14]

As indicated by the European Association of Urology Guidelines, the first-line treatment of neurogenic OAB (nOAB) or neurogenic detrusor overactivity involves the use of antimuscarinic drugs (AMs), supported by Level 1A evidence.[12] Other alternative therapeutic approaches include botulinum toxin A injections, tibial nerve stimulation, and sacral neuromodulation, with varying levels of evidence in MS populations.[12]

Six AMs are currently available—oxybutynin, tolterodine, trospium, solifenacin, darifenacin, and fesoterodine—with relative differences in their efficacy and tolerability profiles.[15] They act on the muscarinic receptors localized on the bladder wall, inhibiting the detrusor contractions triggered by the parasympathetic nervous system's activation. However, due to their incomplete receptor selectivity, AMs are associated with systemic anticholinergic side effects, including xerostomia (dry mouth), flushing, urinary retention, and constipation, which can complicate treatment.[13] Emerging evidence also suggests potential concerns regarding anticholinergic use and cognitive decline or dementia development, particularly in elderly patients or those with pre-existing cognitive impairment.[12] However, solifenacin is characterized by a favorable pharmacokinetic profile with a limited ability to cross the blood–brain barrier compared to older generation molecules, such as oxybutynin.[12,16]

The existing literature on the use of AMs in MS is often based on retrospective and small case series, or industry-sponsored trials and studies with mixed groups of patients (i.e., patients with spinal cord injuries, Parkinson's disease).[17-21] Several studies have investigated AM administration in MS patients' series, concluding that AMs were generally effective, with dose-dependent adverse effects.[13] Xerostomia was the common cause of treatment discontinuation, and its efficacy, tolerability, and LUTS evolution should be investigated periodically.[13,16]

This study aims to provide real-world evidence on the efficacy, tolerability, and safety of solifenacin in MS patients with nOAB, thereby addressing the current lack of MS-specific data on antimuscarinic therapy and contributing to the optimization of treatment strategies for this population. Solifenacin was selected for this investigation based on its competitive antagonism of muscarinic receptors, with preferential affinity for the M3 and M2 subtypes. While M3 receptors are primarily responsible for mediating detrusor contraction, M2 receptors—despite being more abundant—exert a modulatory and facilitatory role, which may become particularly relevant in the setting of neurogenic bladder dysfunction.[12,16] Moreover, the choice of solifenacin over tertiary amines, such as oxybutynin, was driven by the need to limit overall anticholinergic burden, a critical consideration in MS patients who are vulnerable to cognitive and central nervous system adverse effects.[12,16]

2. Methods

2.1. Data collection

Between January 2023 and March 2025, we retrospectively reviewed clinical data on all MS patients referred to the outpatient urology service at Policlinico Tor Vergata. This was a single-center, observational, retrospective study. We included consecutive patients who received solifenacin at any point in their urological treatment course.

Comprehensive data were collected on patients' demographic characteristics (age and sex), clinical history—including year of MS diagnosis, disease duration, MS phenotype, and ongoing or previous disease-modifying therapies—and follow-up duration (months). Neurological disability was assessed using the Expanded Disability Status Scale.[22] Data on LUTS were systematically recorded, including the presence of storage and voiding symptoms, UUI and its severity (quantified by the number of pads used per day), use of clean intermittent catheterization, the annual frequency of urinary tract infections (UTIs), as documented by urinalysis and urine culture, and prior exposure to other AMs or mirabegron. Information regarding solifenacin treatment, including dosage and treatment duration, was also collected. Treatment-related adverse drug reactions (ADRs) were evaluated, and their causality was assessed using the Naranjo Scale.[23] The relationship between a drug and an adverse event was categorized as definite (score ≥ 9), probable (5–8), possible (1–4), or doubtful (≤0). The severity of ADRs and the need for treatment discontinuation or dose adjustment were also recorded. Patients were excluded if they lacked baseline uroflowmetry (before starting solifenacin) or lacked at least one follow-up assessment after treatment initiation. Patients with incomplete or missing data were also excluded. Ultrasound post-void residual (PVR) was evaluated in all patients before and after treatment. Uroflowmetry parameters considered included peak flow rate (Qmax, mL/s), voided volume (mL), and PVR (mL) before and after solifenacin administration. In some cases, an invasive urodynamic study (iUDS; cystometry followed by a pressure/flow study) was performed using a 6 Fr water-filled catheter and an 8 Fr rectal balloon to measure bladder pressure and abdominal pressure, respectively. Parameters from cystometry and the pressure/flow study were reported in accordance with the International Continence Society's Good Urodynamic Practices and Terms.[24]

2.2. Ethics approval

This study was conducted in accordance with Good Clinical Practice according to the Declaration of Helsinki and Good Clinical Practice. Ethics approval was obtained from the Lazio Regional Ethics Committee (protocol no.: 120.24CET2ptv). All patients provided written informed consent to participate.

2.3. Statistical analysis

Descriptive statistics were used for all recorded characteristics. To analyze categorical and dichotomous variables, we performed a chi-square test. The analysis of the normal distribution of each parameter was performed using the Kolmogorov–Smirnov test. For comparisons between independent groups, a Student's *t*-test was used for variables with a normal distribution, while a Wilcoxon–Mann–Whitney test was applied to compare variables with a non-normal distribution. A p-value < 0.05 was considered statistically significant. Jamovi version 2.7.14 was used for all analyses.

3. Results

3.1. Patients' characteristics and clinical presentation

During the study period, a total of 178 MS patients were screened at our outpatient urology service. Among them, 149 (83.7%) presented symptoms consistent with nOAB. Out of these symptomatic patients, 115 (77.1%) received solifenacin as part of their management. For the final analysis, 19 patients were excluded due to incomplete baseline or follow-up data, and 22 patients were lost to follow-up, resulting in a final study cohort of 74 patients (Figure 1). The mean age of the study population was 49 years (standard deviation ± 10.7 years), and 71.6% were female. The mean disease duration was 12 years (standard deviation ± 9.7 years). Most patients had relapsing–remitting MS (53/74, 71.6%), while a smaller proportion were classified as primary progressive disease (5/74, 6.8%) (Table 1). Storage LUTS were present in 60.8% (45/74) of patients. Among these, UUI was reported in 75.7% of cases (34/45), with a median pad usage of 0 pads/day (interquartile range [IQR]: 0–2). Fourteen patients (18.9%) underwent a urodynamic invasive study: six for storage LUTS and eight for mixed LUTS. All 14 patients exhibited detrusor overactivity during filling cystometry, with a median detrusor pressure of 20 cmH_2O (IQR: 18–41). During the flow/pressure study, median detrusor pressure at Qmax was 35.8 cmH_2O (IQR: 23–46). Additionally, 22.9% (17/74; 16 females) experienced recurrent UTIs (defined as >3 episodes/year). Among these, five patients (29.4%) were receiving fingolimod for MS management, five (29.4%) were receiving natalizumab, three (21.4%) were receiving dimethyl fumarate, one (7.1%) was receiving ocrelizumab, and three (21.4%) were not currently on any disease-modifying therapy.

Solifenacin was introduced as a first-line therapy in 82.4% of patients, whereas in the remaining cases, solifenacin was prescribed after switching from another AM or mirabegron. A comparative analysis of clinical outcomes after introducing solifenacin at a mean follow-up of 12 months is presented

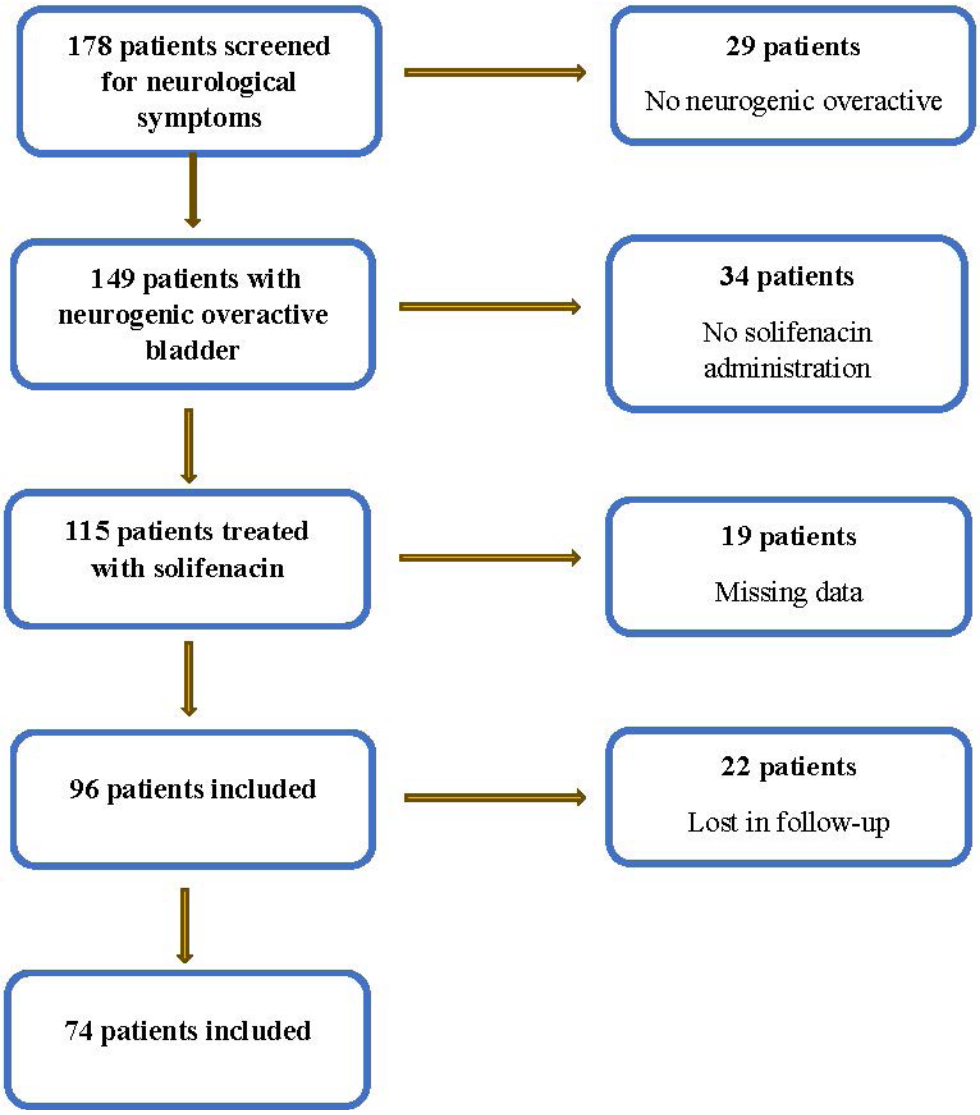

Figure 1. Flow chart of patient inclusion and recruitment

in Table 2. During treatment, nOAB symptoms resolved in 63.5% of patients, while UUI was reported in 35.1% of cases (compared to 75.7% at baseline). The impact of solifenacin on uroflowmetry parameters was overall negligible. Among the 32 patients (43.2%) who repeated the test at follow-up, the median voided volume (234.0 mL vs. 202.5 mL) and Qmax (11.0 mL/s vs. 13.5 mL/s) remained comparable. The PVR, assessed in all patients, showed no significant difference at baseline (10.0 mL [IQR: 0–36]) and during follow-up (12.5 mL [IQR: 0–30]). Among the 14 patients who underwent iUDS, no detrusor overactivity was observed during follow-up cystomanometry. Median detrusor pressure at Qmax decreased significantly from 35.8 cmH_2O to 14.2 cmH_2O ($p < 0.05$), while maximum cystometric capacity increased from 335.0 mL to 427.7 mL, although this change did not reach statistical significance.

Among patients with recurrent UTIs, 76.5% (13/17) reported no further episodes after solifenacin was initiated. The four patients with persistent UTIs were receiving fingolimod (three patients) and natalizumab (one patient) as disease-modifying therapy.

3.2. Adverse drug reactions and drug adjustments

Overall, 14 ADRs were reported in 11 patients, corresponding to 14.8% of the study population (Table 2). The most frequently observed ADR was constipation (6.7%), and dry mouth was reported in 1.4% of cases. According to the Naranjo causality assessment, 10 ADRs (71.4%) were classified as probable (5–8 score) and four (28.6%) as possible (1–4 score). No ADRs were classified as definite, and none met criteria for severe adverse reactions. All reported ADRs were mild in intensity and reversible. Solifenacin treatment

Table 1. Characteristics of included patients

Characteristics	First assessment
Age (years), mean ± standard deviation	49 ± 10.7
Gender	
Male	21 (28.4%)
Female	53 (71.6%)
MS duration (years), mean ± standard deviation	12 ±9.7
Type of MS	
Relapsing–remitting	53 (71.6%)
Primary progressive	5 (6.8%)
Secondary progressive	3 (4.0%)
Not available	13 (17.6%)
Expanded Disability Status Scale, mean ± standard deviation	
Total score	4.0 (2.5–6)
Bowel and bladder function score	1.8 (1–2)
MS therapy	
Yes	58 (78.4%)
No	16 (21.6%)
Type of multiple sclerosis drug received	
Teriflunomide	5 (6.8%)
Dimethyl fumarate	12 (16.2%)
Fingolimod	9 (12.2%)
Natalizumab	9 (12.2%)
Ocrelizumab	14 (18.9%)
Siponimod	1 (1.4%)
Copaxone	2 (2.7%)
Cladribine	6 (8.1%)
Type of lower urinary tract symptoms (LUTS)	
Storage LUTS	45 (60.8%)
Voiding LUTS	0 (0.0%)
Mixed LUTS	29 (39.2%)

Note: Data presented as n (%), unless stated otherwise.

was continued by 81.0% of patients throughout the follow-up period. Dose escalation to 10 mg/day was required in 13.5% of patients to achieve adequate symptom control. Treatment discontinuation occurred in 6.8% of cases, mainly due to worsening or persistence of LUTS rather than intolerance. These patients subsequently shifted to second-line treatment for nOAB, including intradetrusor botulinum toxin injections. One patient developed an allergic reaction characterized by a diffuse cutaneous rash, which resolved completely after discontinuation of solifenacin. This patient was subsequently switched to mirabegron, with no further adverse events reported. A beta-3 adrenergic agonist was also prescribed in four out of five patients who developed constipation, resulting in symptom improvement and treatment continuation. Two female patients developed an episode of urinary retention and started clean intermittent catheterization with no long-term sequelae observed.

4. Discussion

This retrospective study provides real-world evidence on the role of solifenacin in treating nOAB among MS patients, demonstrating good symptom control and an acceptable safety profile.

Antimuscarinic drugs have been shown to improve LUTS and urodynamic parameters compared to placebo.[17] In particular, 5 mg of solifenacin has demonstrated superior efficacy to tolterodine in reducing micturition frequency, urgency, and leakage episodes, with QoL improvement in 58% versus 46% of patients.[17] Van Rey and Heesakkers

Table 2. Pre- and post-treatment outcome comparison at 12 months

Outcome	First assessment	During treatment	*p*-value
Symptoms			
Neurogenic overactive bladder (%)	74 (100%)	27 (36.5%)	<0.0001
Urgency urinary incontinence (%)	56 (75.7%)	26 (35.1%)	<0.0001
Uroflowmetry[a], median (interquartile range)			
Voided volume (mL)	234.0 (131–319)	202.5 (124–314)	Not significant
Peak flow rate (mL/s)	11.0 (6–22)	13.5 (7–24)	Not significant
Post-void residual volume (mL)	10.0 (0–36)	12.5 (0–30)	Not significant
Adverse drug reactions[b]			
Constipation	-	5 (6.8%)	-
Worsening of lower urinary tract symptoms	-	5 (6.8%)	-
Acute urinary retention	-	2 (2.7%)	-
Dry mouth	-	1 (1.4%)	-
Allergic reaction	-	1 (1.4%)	-
Therapeutic outcomes			
Continuation, 5 mg per day	-	50 (67.6%)	-
Continuation, titrated to 10 mg per day	-	10 (13.5%)	-
Discontinuation, side effects	-	5 (6.7%)	-
Discontinuation, changed to another anticholinergic	-	4 (5.4%)	-
Discontinuation, changed to mirabegron	-	5 (6.7%)	-

Notes: Data presented as *n* (%), unless stated otherwise. [a]Uroflowmetry repeated in 32 (43.2%) patients during treatment, [b]Adverse drug reactions were assessed using the Naranjo Scale; all reported cases scored between 1 and 8 (possible to probable causality).

reported a 73% improvement in storage LUTS in their case series.[18] In our study, solifenacin improved nOAB in 63.5% of patients and led to a 40.6% reduction in the prevalence of UUI episodes (from 75.7% at baseline to 35.1% at follow-up). A dose of 5 mg of solifenacin was effective for 81.0% of the patients, although 13.5% required an increased dosage of 10 mg daily for adequate symptom control. In the literature, the safety and tolerability of solifenacin were demonstrated in dose-escalation studies on healthy volunteers and geriatric patients, and on subjects with hepatic or renal impairment. However, a higher incidence of drug-related adverse effects was observed at 20 and 30 mg doses of solifenacin.[25]

The management of UUI remains a major clinical challenge in patients with MS, given its association with higher disability levels and reduced QoL.[7,10,14] In our study, treatment with solifenacin was associated with a reduction in the prevalence of UUI, which decreased from 75.7% at baseline to 35.1% during follow-up. This finding suggests a potential clinical benefit in terms of daily symptom management. Although median pad usage remained low (0 pads/day), the decrease in the proportion of patients reporting incontinence episodes may still be clinically meaningful. Furthermore, by potentially reducing the anxiety related to urgency and incontinence, solifenacin may positively influence patients' perceived well-being, in line with observations previously reported in neurological populations.[7,9,11] However, these interpretations should be viewed with caution, as QoL outcomes were not formally assessed, and the retrospective design limits the ability to fully capture patient-reported benefits.

Published data show that AM treatment reduces maximum detrusor pressure by 30–40% from baseline, accompanied by corresponding increases in maximum cystometric capacity.[19,20] The landmark SONIC trial demonstrated significant improvements in urodynamic parameters with 10 mg of solifenacin in patients with neurogenic detrusor overactivity due to MS or spinal cord injury, showing a 58% increase in maximum cystometric capacity (from 77.8 mL to 134.2 mL) and a reduction of maximum detrusor pressure to <40 cmH_2O in 29% of patients receiving active treatment.[20] In our cohort, detrusor overactivity was no longer observed during follow-up iUDS; a mild, non-significant increase in maximum cystometric capacity was noted, and a significant reduction in median detrusor pressure at Qmax was observed in this small subgroup (from 35.8 cmH_2O to 14.2 cmH_2O, $p < 0.05$). This effect is clinically relevant, as it indicates that solifenacin does not merely postpone the sensation of urgency but rather enhances the bladder's functional capacity, thereby promoting a more predictable and controllable voiding pattern.[16] Maintaining low detrusor pressure during the bladder filling phase in neurological patients is considered important for the prevention of upper urinary tract damage. Recent literature suggests that storage detrusor pressures ≥15 cmH_2O may represent a potential risk for upper urinary tract deterioration in patients with neurogenic bladder, whereas the traditionally accepted safe value is <40 cmH_2O.[26,27] However, given the small size of this subgroup ($n = 14$), these urodynamic findings should be considered preliminary and interpreted cautiously. For the same reasons, stratification of detrusor pressure at Qmax by gender was not performed due to the small sample size, and these parameters were primarily used to observe trends in detrusor pressure during treatment. Measurement of PVR volume should be performed preferably before antimuscarinic treatment is started, and monitored if patients develop incomplete bladder emptying or report recurrent UTIs.[7] In our study, the impact on PVR was overall negligible, with a median PVR of 10.0 mL at baseline and 12.5 mL at follow-up, suggesting minimal risk of urinary retention with solifenacin therapy in our series.

For the majority of antimuscarinic formulations, dry mouth was the most reported ADR.[28] A systematic review by Madhuvrata *et al*.[17] reported that fewer patients experienced dry mouth when administered with 5 mg of solifenacin compared to other antimuscarinics, with no difference in withdrawal rates, and this adverse effect is less frequent with extended-release formulations.[17] Other ADRs noted in placebo-controlled trials were blurred vision (oxybutynin, propiverine, and solifenacin); constipation (darifenacin, solifenacin, and trospium); dyspepsia (darifenacin and oxybutynin); erythema and pruritus (oxybutynin); and urinary retention (oxybutynin).[28] In our study, 11/74 (14.8%) ADRs were observed during treatment. Constipation was observed in 6.7% of cases, acute urinary retention in 2.7%, and dry mouth in only 1.4%. The low rate of dry mouth (1.4%) in our cohort is particularly noteworthy and substantially lower than rates reported in many clinical trials, which may reflect the real-world use of lower starting doses and individualized dose optimization.[17]

Urinary tract infections are common in MS due to factors such as high bladder pressures, urinary stasis, and catheter use.[29] The relationship between AMs and UTI risk remains controversial.[29,30] A systematic review and meta-analysis of 35,939 patients in 33 trials found that AMs statistically significantly increased the incidence of UTIs at 1–3 months after treatment (relative risk: 1.23; 95% confidence interval: 1.04–1.45; $p = 0.013$) compared with the placebo, and also significantly increased the risks of urinary retention, dysuria, and residual urine volume (relative risk: 2.88; 95% confidence interval: 1.79–4.63; $p < 0.001$). In our cohort of 17 patients with recurrent UTIs at baseline, solifenacin reduced UTI episodes in 76.5% of patients. This finding suggests that effective management of neurogenic detrusor overactivity with solifenacin may reduce UTI frequency by

improving bladder emptying dynamics and reducing high-pressure storage, though the exact mechanism requires further investigation. However, MS therapies, including glucocorticoids and some disease-modifying treatments, such as natalizumab and fingolimod, can further increase UTI risk.[31,32] Notably, in our cohort, the four patients with persistent UTIs were receiving fingolimod (three patients) and natalizumab (one patient).

The long-term safety of antimuscarinic therapy in patients with MS has become a central concern in contemporary neurourology. Recent longitudinal studies have raised concerns regarding cumulative anticholinergic burden and its association with accelerated brain atrophy and dementia. In our cohort, the mean age of 49 years represents a critical window in which patients are often still professionally active but may already be experiencing early MS-related cognitive decline.[16] The low incidence of self-reported cognitive complaints observed in our study—although not assessed through formal neuropsychological testing—is consistent with the pharmacokinetic profile of solifenacin.[12,16,25] Unlike oxybutynin, which is highly lipophilic and readily crosses the blood–brain barrier, solifenacin has a larger molecular structure and is actively transported out of the central nervous system, providing a relative "neuroprotective" margin that is particularly relevant for the MS population.

The switch of one patient to mirabegron following an allergic reaction to solifenacin highlights the relevance of β3-adrenoceptor agonists as a complementary therapeutic option.[16] While solifenacin modulates the parasympathetic-mediated contractile phase of bladder activity, β3-agonists act on the sympathetic pathway to enhance bladder filling. In clinical practice, as reflected in our cohort—where four patients required dose adjustments or adjunctive measures for constipation—a more individualized strategy, potentially combining lower doses of solifenacin with mirabegron, may further optimize the balance between efficacy and tolerability.[33]

However, this study has several limitations. First, it is a small retrospective case series, which inherently limits generalizability. The exclusion of patients due to missing data or loss to follow-up (35.6% of the solifenacin-treated group) is a recognized challenge in retrospective studies involving chronic neurological populations like MS. However, a preliminary comparison showed no significant demographic or clinical differences (e.g., age, Expanded Disability Status Scale, or MS phenotype) between included and excluded patients. Nevertheless, considering the scarce data coming from real-life on AM use in MS populations, these findings provide valuable insights. Second, uroflowmetry data (voided volume, Qmax, and PVR) were collected from a heterogeneous population that included patients with mixed LUTS (39.2%), potentially introducing bias.

Another limitation is the absence of a validated symptom score, such as the Overactive Bladder Symptom Score, to objectively quantify the severity of symptoms and their improvement.[34] As this was a retrospective real-world study, clinical efficacy was assessed based on patient-reported symptom resolution and objective urodynamic or uroflowmetry parameters recorded during follow-up visits.

Future larger prospective studies are needed to provide more consistent results. With a higher number of patients, it would be possible to conduct subgroup analyses to distinguish data coming from uroflowmetry or iUDS by sex, LUTS subtype (storage, voiding, and mixed LUTS), and MS phenotype. Additionally, long-term follow-up studies are warranted to assess the durability of solifenacin's efficacy, the development of tolerance, and potential long-term safety.

5. Conclusion

In conclusion, this preliminary retrospective analysis provides essential real-world insights into the management of nOAB in MS patients treated with solifenacin. Our observations suggest that solifenacin offers a highly balanced therapeutic approach, demonstrating a robust trend in symptom reduction—specifically regarding the debilitating occurrence of UUI—while maintaining a reassuring safety profile.[16,20] Notably, the preservation of voiding efficiency and the stability of PVR volumes in our cohort suggest that solifenacin can be used safely without significantly increasing the risk of acute urinary retention if patients are monitored within a structured urological follow-up.

One of the most clinically significant findings of this study is the low incidence of common antimuscarinic side effects, such as xerostomia. In chronic conditions like MS, where treatment adherence is often compromised by the cumulative burden of multiple medications, the high treatment persistence (81.0%) observed in our cohort is encouraging. It suggests that solifenacin's pharmacokinetic profile—characterized by relative M3 selectivity and limited central nervous system penetration—translates into a tolerable long-term option for a population that is particularly sensitive to cognitive and physical side effects.

Furthermore, the observed reduction in the frequency of UTIs in a subset of patients is a provocative finding that warrants further investigations.[29] By lowering high-pressure detrusor contractions and improving storage dynamics, solifenacin may improve mucosal perfusion and local immunological defenses, thereby reducing the host's susceptibility to recurrent infections. This potential protective effect could have significant implications for reducing the overall morbidity and healthcare costs associated with MS-

related urological complications.

However, the limitations of this study—including its retrospective nature, the lack of a standardized symptom score like the Overactive Bladder Symptom Score, and the inherent selection bias of a tertiary academic center—must be acknowledged. The loss to follow-up, while typical for chronic neurological cohorts, highlights the need for better patient engagement and digital health monitoring in neuro-urology.

Future research should prioritize long-term cognitive monitoring to definitively assess the "anticholinergic burden" over years of treatment, stratify analysis by MS phenotype (relapsing–remitting vs. progressive) to determine if dosing strategies should differ based on the underlying neurodegenerative trajectory, and evaluate mechanism of combination therapy, specifically at the synergistic effects of solifenacin and beta3-adrenoceptor agonists to maximize efficacy while minimizing dose-dependent side effects. Ultimately, these findings support solifenacin as a viable and effective first-line option for managing nLUTS. By integrating such pharmacological strategies into a proactive, multidisciplinary care model involving neurologists and urologists, we can significantly enhance the QoL and long-term renal health of patients living with multiple sclerosis.

Acknowledgments

None.

Funding

None.

Conflict of interest

All authors declare no conflicts of interest.

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Ethics approval and consent to participate

Ethics approval was obtained from the Lazio Regional Ethics Committee (protocol no.: 120.24CET2ptv). All patients provided written informed consent to collect and publish their data.

Consent for publication

All patients provided written informed consent for data publication.

Data availability statement

Data are available in a repository that can be requested from the corresponding author.

Additional disclosure

Part of the findings has been presented at the 46th Italian Society of Urodynamics (SIUD) National Congress, held from June 23–25, at Verona, Italy, under the presentation entitled "Preliminary assessment of the efficacy and tolerability of solifenacin for the treatment of neurogenic overactive bladder in patients affected by multiple sclerosis."

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