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Original Article

Urinary symptoms and cystometry findings in patients with multiple system atrophy: A tertiary care experience

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Abstract

Objectives: This study aims to characterize urinary symptoms and evaluate urodynamic findings using filling and voiding cystometry in participants with multiple system atrophy (MSA), and to guide the management of bladder dysfunction based on cystometric findings through pharmacological, behavioral, and supportive interventions.

Patients and methods: Between November 2022 and June 2023, a total of 27 patients who were diagnosed with MSA and experienced urinary symptoms were screened. Among them, those who were referred to our neurorehabilitation unit for rehabilitation consultation and bladder management were included. Sociodemographic data of the patients, illness duration, type and duration of urinary complaints such as voiding difficulty, nocturia, and urinary urge incontinence were documented. All medical comorbidities and medications, including those prescribed for MSA, were also noted. All patients underwent urodynamic evaluation, including filling and voiding cystometry.

Results: Of a total of 27 patients, 23 were male and four were female with a mean age of 57.6 ± 7 (range, 48 to 77) years. The mean duration of illness was 29.7 ± 20 (range, 4 to 84) months, while the mean duration of urinary symptoms was 19 ± 16 (range, 3 to 66) months. The most common urinary symptoms were urgency and increased frequency (n = 18, 66.7%), feeling of incomplete evacuation and urge urinary incontinence (n = 16, 59.3%), nocturia (n = 13, 48%), retention of urine (n = 10, 37%), straining to void (n = 8, 29.6%), stress incontinence (n = 3, 11.1%), and incontinence without awareness (n = 2, 7.4%). According to cystometry, 77.8% participants had neurogenic detrusor overactivity (n = 21), with more than half had associated detrusor sphincter dyssynergia (n = 15, 55.6%). Six participants had acontractile/hypocontractile detrusor. The bladder management was based on cystometry findings and consisted of pharmacotherapy, behavioral, and supportive therapy.

Conclusion: Urinary symptoms are common and diverse in patients with MSA. Early cystometric evaluation and appropriate management guided by the findings may help reduce disease-related morbidity and improve quality of life.

Keywords: Filling and voiding cystometry, multiple system atrophy, urinary symptoms.

A small percentage of participants presenting with parkinsonism may not have features typical of idiopathic Parkinson's disease (PD).[1] In patients with parkinsonian manifestations, rapid clinical deterioration despite dopaminergic therapy, the need for regular wheelchair use within five years

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of symptom onset, cerebellar manifestations such as limb and gait ataxia, early-onset autonomic dysfunction, urinary and erectile dysfunction, and sudomotor dysfunction are suggestive of a multisystem neurodegenerative process, particularly multiple system atrophy (MSA).[2-5]

The incidence of MSA is reported to be 0.6 to 3 cases per 100,000 individuals per year and the crude prevalence is reported between 1.9 and 4.9 per 100,000 population.[5] Most of the patients succumb to illness within five to 10 years after the first symptom appears, but rare cases may survive up to 15 years. Multiple system atrophy is further classified according to the predominant clinical presentation as parkinsonian (MSA-P), cerebellar (MSA-C), or mixed.[6] Among the many clinical features of MSA, one is the onset of autonomic dysfunction such as orthostatic hypotension, bladder and bowel dysfunction and erectile dysfunction. The most common urinary symptoms include unexplained voiding difficulty and urinary urge incontinence.[5] Urinary symptoms can either precede, develop concomitantly or may follow the motor symptom onset and usually carry a negative prognosis when the onset is early.[7] Diagnosis and management of associated neurogenic bladder dysfunction is essential to keep these participants dry and socially active for as long as possible during the course of illness. To date, no study from India has systematically evaluated cystometric findings in patients with MSA. Furthermore, MSA-associated neurogenic bladder dysfunction and its management strategies remain inadequately characterized in the existing literature.

In the present study, we aimed to characterize urinary symptoms and evaluate urodynamic findings using filling and voiding cystometry in participants with MSA, and to guide the management of bladder dysfunction based on cystometric findings through pharmacological, behavioral, and supportive interventions.

PATIENTS AND METHODS

Study design and study population

This single-center, prospective, cross sectional study was conducted at National Institute of Mental Health and Neurosciences, Department of Neurological Rehabilitation, between November 2022 and June 2023. Patients who were diagnosed with MSA according to the Movement Disorders Society (MDS) MSA diagnostic criteria[8] and experienced urinary symptoms were screened. Among them, those who were referred to our unit for rehabilitation consultation and bladder management were included. A total of 42 patients with MSA were examined and 32 of them had urinary symptoms. Finally, a total of 27 patients who gave consent for cystometry were recruited. The remaining five patients who were unwilling to undergo cystometry were advised supportive measures. Those with severe comorbidities or who refused to give consent were excluded from the study. This study employed convenience sampling and included participants of all ages and sexes with MSA who presented with urinary symptoms during the study period. A written informed consent was obtained from each patient. The study protocol was approved by the National Institute of Mental Health and Neuro Sciences-Institute Ethics Committee (Date: November 15, 2022, No: NIMH/DO/IEC[BS&NS DIV]). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Data collection and the procedural details

The procedure was performed following an initial clinical assessment, meticulous bladder diary recording over 72 h, and ultrasonography (USG) of the kidneys, ureters, and bladder (KUB). Ultrasonography was used to assess prostate status in male participants, post-void residual (PVR) urine volume, and evidence of upper urinary tract changes, including hydroureter and/or hydronephrosis suggestive of vesicoureteral reflux. Routine urine analysis and urine culture and sensitivity tests were carried out per protocol before the cystometry test. Asymptomatic urinary tract infections were not treated with antibiotics. Sociodemographic data of the patients, illness duration, type and duration of urinary complaints such as voiding difficulty, nocturia, and urinary urge incontinence were documented. All medical comorbidities and medications, including those prescribed for MSA, were also noted.

Cystometry

Filling and voiding cystometry was performed by one of the authors, who was not blinded to the

participants' clinical symptoms, and assisted by a urodynamic lab technician using the multichannel pressure recording technology with Life-Tech Urolab Primus system (Life-Tech International, Inc., Houston, TX, USA). The patients were taken for procedure with bowel preparation with proctoclysis enema in the morning. The bladder sensations were defined according to the International Continence Society (ICS) guidelines and terminology, and the procedure was comprehensibly explained to all patients prior to the study.[9]

Filling cystometry was performed by infusing normal saline through a double lumen 6-Fr catheter in urethra at room temperature and a medium fill rate of 20 mL/min with participants in lithotomy position on the urodynamic table. The external pressure transducers were levelled at the upper edge of the symphysis pubis relative to the atmospheric pressure. This catheter also recorded vesical pressure during filling and voiding phase (P_{ves}). The filling rate was subsequently adjusted according events such as urge, leaks (if any) or patient's discomfort and the end point of filling phase was set at 500 mL or multiple leaks interfering with filling of bladder. A 10-Fr balloon catheter was inserted per rectum to measure the abdominal pressure (Pabd). During voiding phase participants were made to sit to void. Sphincter activity was recorded using surface electrodes in the perineal region. Detrusor pressure (P_{det}) was calculated by the urodynamic machine by subtracting Pabd from P_{ves}. The complete data were captured and analyzed, and bladder management was tailored to the findings. Management strategies included pharmacotherapy (antimuscarinic agents or β3-adrenergic receptor agonists for neurogenic detrusor overactivity (NDO) and α-adrenergic receptor blockers for a non-relaxing sphincter or detrusor-sphincter dyssynergia), as well as supportive and behavioral interventions. Significant PVR urine volume was defined as residual urine volume of > 100 mL after self-voiding.[10-12]

Definitions

Urinary symptoms were defined according to the terminology of the ICS. Nocturia was defined as the number of times an individual wakes from the main sleep period to void, with each episode of urination followed by sleep or the intention to return to sleep. Increased daytime urinary frequency was defined as the individual's (or caregiver's) perception that voiding occurs more frequently during waking hours than previously considered normal. Urge urinary incontinence was defined as involuntary urine leakage associated with or immediately preceded by urgency. Urinary retention was defined as the inability of the urinary bladder to empty, irrespective of whether the underlying cause was neurological or non-neurological.[9]

Cystometric findings were also defined according to ICS terminology. Neurogenic detrusor overactivity was defined as the occurrence of involuntary detrusor muscle contractions during the bladder-filling phase, detected during cystometry. An acontractile detrusor was defined as the absence of detrusor contraction during urodynamic testing, resulting in prolonged or unsuccessful bladder emptying. Detrusor-sphincter dyssynergia was defined as a lack of coordination between detrusor muscle contraction and external urethral sphincter relaxation during voiding, characterized by involuntary sphincter contraction concurrent with a detrusor contraction.[9]

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 22.0 software (IBM Corp., Armonk, NY, USA). Continuous data were presented in mean ± standard deviation (SD) or median (min-max), while categorical data were presented in number and frequency.

RESULTS

Of a total of 27 patients with MSA (MSA-C=21, MSA-P=6), 23 were male and four were female with a mean age of 57.6 ± 7 (range, 48 to 77) years. Among the recruited participants, four had urinary symptoms before the onset of motor symptoms, seven had along with motor symptoms and 16 had motor symptoms preceding the urinary symptoms (range, 6 to 66 months). The mean duration of illness was 29.7 ± 20 (range, 4 to 84) months, while the mean duration of urinary symptoms was 19 ± 16 (range, 3 to 66) months (Table 1).

Table 1. Patients' Urinary symptoms related data

	n	%	Mean ± SD	Range
Symptom onset				
Urinary before motor symptoms	4	14.8		7-58
Urinary along with motor symptoms	7	26		
Motor before Urinary symptoms (months)	16	59.2		6-66
Unified multiple system atrophy rating scale- UMSARS			29.8 ± 9.5	11-53
Urinary symptom duration (months)			19 ± 16	3-66
Other symptoms				
Constipation	12	44.4		
Incontinence	2	7.4		
Erectile dysfunction	3	13		
Orthostatic hypotension	12	44.4		
Perianal examination: impairment in				
Voluntary anal contraction	7	26		
Anal tone	4	14.8		
Anal wink	2	7.4		
Clitoro/bulto cavernous reflex & peri-anal sensation	1	3.7		
Deep anal pressure	0	0		

SD: Standard deviation.

Table 2. Cystometry finding in patients with multiple system atrophy

	n	%	Mean ± SD	Mean
First sensation				
Normal	8	29.7		
Hyposensitive	4	14.8		
Hypersensitive	3	11.1		
No first sensation	12	44.4		
Poor bladder compliance	13	48.15		
Detrusor activity				
Hypoactive	3	11.1		
Acontractile	3	11.1		
Overactive	21	77.8		
Detrusor-sphincter-dyssynergia	15	55.6		
Post void residual volume	26	96.3		
Volume (mL)			300.6 ± 216.1	
Significant PVR (> 100 mL)	20	74		396.2*
Detrusor pressure (P_{det}) (cm H_2O)				
Filling phase			60.6 ± 28.6	
Voiding phase			54.5 ± 29.1	

SD: Standard deviation; PVR, post void residual volume; * Mean post void residual volume.

The common urinary symptoms reported in the study were urgency, increased frequency (n = 18, 66.7%), feeling of incomplete evacuation and urge urinary incontinence (n = 16, 59.3%), nocturia (n = 13, 48%), retention of urine (n = 10, 37%), straining to void (n = 8, 29.6%), stress incontinence (n = 3, 11.1%) and incontinence without awareness (n = 2, 7.4%). Other symptoms

reported were erectile dysfunction in three of the 23 male participants, reduced bowel frequency in 12 and fecal incontinence in two.

The USG KUB revealed significant PVR urine volume in 14 participants (52%), prostatomegaly in two male participants, and none of the 27 participants had evidence of back pressure changes (vesicoureteral reflux).

Normal bladder sensation was reported by eight participants (29.7%). Three had hypersensitive (11.1%), four had hyposensitive bladder (14.8%) and 12 participants failed to report the first sensation at all (44.4%). Strong desire to void was reported at a bladder volume of < 300 mL by four (14.8%), between 300 and 500 mL by 10 (37%) and at > 500 mL by one. No complications were noted in any patients after the cystometry.

Decreased bladder compliance ($\Delta V/\Delta P_{det}$) was recorded in 13 participants (48.15%). Neurogenic detrusor overactivity was recorded in 21 participants (77.8%) and detrusor sphincter dyssynergia (DSD) was observed in 15 (55.6%). Out of 21 participants who were observed to have NDO, nine had phasic, three had terminal, six had sustained, and three had compound type during the filling phase. Six participants had acontractile/hypocontractile detrusor (22.2%). Significant PVR urine was observed in 20 participants (74%, mean volume = 396.2 ± 163.3 mL). Based on the cystometry findings participants were managed with pharmacotherapy (antimuscarinics, parasympathomimetic medication, alpha blockers, beta 3 agonists), timed voiding, indwelling catheter/supra-pubic catheterization, fluid restriction and maintenance of a bladder diary. Out of the 21 participants with overactive detrusor, 18 were started on anti-muscarinic (tolterodine-15, solifenacin-3) and three on beta 3 agonist (mirabegron). Participants with DSD were additionally started with alpha blockers (tamsulosin or silodosin), including two with prostatomegaly. Two participants with acontractile/hypocontractile detrusor were started with parasympathomimetic (bethanechol) and the remaining four with poor sensations were advised clean intermittent self-catheterization (CISC).

DISCUSSION

In the present study, we characterized urinary symptoms and evaluated urodynamic findings using filling and voiding cystometry in participants with MSA. Our study results showed varied urinary complaints which appeared at different times during the course of illness. Even the cystometry suggested different findings with no set pattern in terms of detrusor and sphincter behavior and the suggested management differed accordingly.

Multiple system atrophy is a rapidly progressive neurodegenerative disease with poor response to treatment. Autonomic dysfunctions such as orthostatic hypotension, bladder and bowel dysfunction, and sudomotor dysfunctions are common.[13] Clinical implications of early cystometry in MSA patients with urinary symptoms are prevention of damage to upper urinary tract and kidney, and improved quality of life. In the present study, we attempted to find out the urodynamic profile of 27 participants with MSA with urinary symptoms. The usual age at the time of diagnosis of MSA is reported to be between 55 and 60 years.[14] In our study, the mean age of the participants was 57.6 ± 7 years. Literature suggests slightly more occurrence in males, with male to female ratio of 1.3:1,[15] but in our recruitment there were significantly more males (~6:1). The marked male predominance in this cohort may reflect the small sample size or the reported sex-related differences in the clinical presentation of MSA, with autonomic symptoms, including urinary dysfunction, more frequently reported in males and motor symptoms predominating in females. Furthermore, recruitment was based on the presence of neurogenic bladder dysfunction, which may have contributed to the observed sex distribution.[15]

A range of urinary symptoms was observed in our cohort, consistent with the findings of an earlier study by Choi et al.[11] The urinary complaints suggested a mixed pattern of bladder dysfunction involving both the filling and voiding phases. Some voiding symptoms, such as straining to void and a sensation of incomplete bladder emptying, may be attributable to prostatomegaly, which was observed in two participants. However,

detrusor-sphincter dyssynergia may represent another important contributing factor. Variations in disease duration and severity at symptom onset may also account for the heterogeneity in cystometric findings.

In our study, a significant PVR urine volume (> 100 mL) was observed in almost 74% participants, consistent with findings from a previous study.[16] Indeed, elevated PVR urine volume is a core clinical feature in clinically established MSA according to MDS diagnostic criteria. Potential underlying mechanisms include an acontractile or hypocontractile detrusor, DSD, and prostatomegaly.[17]

Furthermore, voluntary anal contraction (VAC) was impaired in more than 25% participants, and four participants had reduced anal sphincter tone. In their study, Eschlböck et al.[16] reported substantially higher prevalences of impaired VAC and reduced sphincter tone (49.1% and 34%, respectively). These abnormalities may manifest as fecal urgency and incontinence, as well as urinary leakage associated with urgency or occurring without the individual's awareness.

Nearly 80% participants in our study had NDP, while DSD was observed in 55.6%. Similar findings have been reported in previous studies.[16] Yamamoto et al.[18] reported a higher prevalence of acontractile/hypocontractile detrusor in MSA-P compared to MSA-C. In our cohort, MSA-C was the predominant subtype accounting for 21 of 27 participants (77.8%). This distribution may help explain our findings, with acontractile or hypocontractile detrusor function observed in only six participants (22.2%). The implications of DSD are more hazardous to the participants with effects such as vesicoureteral reflux, potentially damaging the upper urinary tracts and kidney. As the sensations in urethra are intact in these participants, clean intermittent self catheterization is not advisable and pharmacotherapy in the form of alpha blockers to be prescribed to improve urinary volume. In addition, DSD is responsible for symptoms such as straining to void and incomplete evacuation.

In the current study, urinary symptoms preceded the onset of motor symptoms in four participants (14.8%), occurred concurrently with motor symptom onset in seven (26.0%), and developed after motor symptom onset in 16 (59.2%), with a latency of six to 66 months. Similar results were reported by Sakakibara et al.,[19] with 18.2% of their cohort having urinary dysfunction preceding motor symptoms. Isolated urinary symptom preceding the motor symptoms may lead to misdiagnosis, as it is not common with most of the neurodegenerative disorders. Zhang et al.[20] also reported 3.5% mortality due to urinary tract dysfunction in their MSA cohort with aspiration pneumonia and cardiac issues as the most common factors. Delayed diagnosis of MSA is not uncommon, particularly when urinary symptoms precede the motor dysfunction and could be due to beginning of the pathology at the spinal cord level than higher up.[21] Given the median survival of less than 10 years after symptom onset, early recognition and appropriate management of bladder dysfunction are important for optimizing patients' quality of life and potentially reducing complications that may affect survival.[22]

Although cystometry is valuable for evaluating urinary dysfunction in patients with MSA, its routine use may be limited in resource-constrained settings such as ours. Key barriers include the limited availability of urodynamic facilities outside tertiary care centers and the invasive nature of the procedure, which may cause patient discomfort and reduce its acceptability. This study has several limitations, including a small sample size, a heterogeneous cohort of participants with MSA, and the absence of a control group. Furthermore, the lack of detailed statistical analyses limited the assessment of potential associations between clinical variables, such as disease duration and PVR urine volume, partly because some relevant data were unavailable. The absence of longitudinal follow-up also precluded evaluation of the effectiveness of the recommended management strategies in improving urinary symptoms over time. Future studies should include larger, more homogeneous cohorts and adopt longitudinal designs to better characterize the progression of urinary dysfunction and assess the long-term effectiveness of bladder management strategies in patients with MSA.

In conclusion, urinary symptoms are common and diverse in participants with MSA. Cystometry

may have important clinical utility and should be considered early in the disease course when urinary symptoms are first reported to guide appropriate bladder management strategies. Early identification and targeted management of bladder dysfunction may help reduce morbidity and improve quality of life. Future longitudinal studies are warranted to determine whether cystometry-guided management can reduce complications and improve long-term outcomes, including survival.

Declaration of Conflicting Interests

The authors declare that there are no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Author Contributions

G.S.: Literature review, data collection & processing, writing article; A.G.: Idea/supervision, design, method, data analysis, manuscript editing , critical review; H.R.: Data collection & processing, literature review; N.B.P.: Supervision, design, critical review, idea; V.H.: Idea, resource person, design, materials.

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

AI Disclosure

The authors declare that artificial intelligence (AI) tools were not used, or were used solely for language editing, and had no role in data analysis, interpretation, or the formulation of conclusions. All scientific content, data interpretation, and conclusions are the sole responsibility of the authors. The authors further confirm that AI tools were not used to generate, fabricate, or 'hallucinate' references, and that all references have been carefully verified for accuracy.

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