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ORIGINAL ARTICLE

Prevalence of Diabetic Neurogenic Bladder and Its Association with Gynecological, Renal, and Peri-Anesthetic Risk Factors Among Women with Diabetes Mellitus: A Community-Based Cross-Sectional Study

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ABSTRACT

Background: Diabetic neurogenic bladder is an underrecognized complication of diabetes mellitus that may lead to urinary urgency, incontinence, incomplete bladder emptying, recurrent infection, and perioperative urinary retention. This study determined its prevalence and associated gynecological, renal, and peri-anesthetic factors among women with diabetes mellitus.

Material and Methods: This community-based cross-sectional study included 120 women with diabetes mellitus recruited from the Department of Obstetrics and Gynecology, Hameed Latif Hospital, Lahore, and the Department of Anesthesia, Lahore General Hospital, from August 2022 to July 2023. Demographic, diabetic, gynecological, renal, neurological, urinary, and peri-anesthetic data were recorded. Lower urinary tract symptoms, postvoid residual urine, uroflowmetry findings, and peripheral neuropathy were assessed. Multivariable logistic regression identified independent associated factors.

Results: Diabetic neurogenic bladder was identified in 43 participants, giving a prevalence of 35.8%. Affected women had longer diabetes duration, higher glycated hemoglobin, more frequent peripheral neuropathy, greater postvoid residual urine, and lower maximum urinary flow rates. Nocturia, urgency, incomplete emptying, weak urinary stream, and urgency incontinence were the commonest symptoms. Diabetes duration of at least 10 years, glycated hemoglobin of at least 8.5%, peripheral neuropathy, albuminuria, and previous postoperative urinary retention remained independently associated with bladder dysfunction.

Conclusion: Diabetic neurogenic bladder affected more than one-third of women with diabetes in this study population. Routine urinary symptom screening, glycemic optimization, postvoid residual measurement, and targeted referral may improve early detection and reduce renal, infectious, and perioperative complications.

Keywords: Diabetes mellitus; diabetic neurogenic bladder; urinary retention; peripheral neuropathy; albuminuria; women

INTRODUCTION

Diabetes mellitus is a long-term metabolic disorder with a vascular, renal and neurological complication that develops over time[1]. Diabetes can have negative effects on the lower urinary tract as well as diabetic nephropathy, retinopathy, peripheral neuropathy and cardiovascular disease. This complication has been referred to as a diabetic bladder dysfunction, a diabetic cystopathy or a diabetic neurogenic bladder. It may not be diagnosed because urinary symptoms can be progressive or thought to be a part of ageing or not reported due to embarrassment[2].

Diabetic neurogenic bladder is a complex interaction of chronic hyperglycemia, autonomic and peripheral nerve injury, microvascular dysfunction, detrusor muscle abnormalities, urothelial dysfunction, oxidative stress, and diabetes related polyuria[3]. The traditional description of diabetic cystopathy includes a decrease in bladder sensation, an increase in bladder capacity, a decrease in detrusor contraction, and an increase in PVR. However, clinical presentation can be more extensive, and include urinary frequency, urinal urgency, nocturia, urgency urinary incontinence, hesitancy, weak urinary stream, straining, incomplete bladder emptying, urinary overflow and urinary retention[4].

Women with diabetes may be especially susceptible, as bladder dysfunction often occurs concurrently with gynecological and pelvic-floor disorders[5]. Pelvic support, urethral resistance, continence mechanisms and bladder emptying can be altered due to pregnancy, multiple vaginal deliveries, multiparity, menopause, obesity, pelvic-organ prolapse, previous hysterectomy and other pelvic surgeries. These can cause symptoms like diabetic autonomic neuropathy, and this can make diagnosis difficult. Hence, it is important that urinary dysfunction in diabetic women should be evaluated both neurologically and gynecologically[6].

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Diabetic neurogenic bladder may also be accompanied by renal and urinary abnormalities. Impaired bladder emptying and increased RV can lead to urinary stasis, recurrent UTI, over-distended bladder, stone formation and upper urinary tract dilatation[7]. The presence of albuminuria and decreased eGFR is a possible sign of more advanced diabetic microvascular damage. The presence of neuropathy, nephropathy, and bladder dysfunction may be an indication of long-standing diabetes, poor glycemic control, and extensive vascular and neurological damage[8].

Another potentially important factor in bladder dysfunction in women with diabetes are peri-anesthetic factors[9]. Urinary retention following surgery can be caused by general anesthesia, spinal or epidural anesthesia, surgery of the pelvis, long surgery, opioids during surgery, too much intravenous fluid, being immobilized, and bladder over distention. Anesthetic agents and neuraxial blockade can temporarily depress detrusor contraction and interfere with the normal micturition reflex. Postoperative urinary retention may be a significant problem in women with diabetic autonomic neuropathy or decreased bladder sensation[10].

Previous episode of post op urinary retention can also be suggestive of urinary retention that was not known before surgery[11]. Although the surgery and anesthesia itself may not be the direct cause of chronic neurogenic bladder, it may show a decrease in reserve of the detrusor muscle or abnormal bladder sensation that was already occurring due to the diabetic condition. The use of long term and multiple urinary catheterizations can also increase the risk of infection and decrease the rate of urinary tract complications[12].

Given its potential impact on the quality of life, renal health, recurrent infection and peri-operative care, diabetic neurogenic bladder is not routinely screened in many communities' diabetes programs[13]. Affected patients are most often assessed only when they manifest with significant urinary symptoms, recurrent urinary infections or established urinary retention. Community based

studies are therefore required to identify women with early or previously undiagnosed bladder dysfunction and to quantify the effect of the combined effects of metabolic, neurological, gynecological, renal and peri-anesthetic factors[14].

The present study was conducted to determine the prevalence of diabetic neurogenic bladder among women with diabetes mellitus and to evaluate its association with gynecological, renal, and peri-anesthetic risk factors[15].

MATERIALS AND METHODS

Study design and Study Setting: This community-based cross-sectional study was conducted jointly by the Department of Obstetrics and Gynecology, Hameed Latif Hospital, Lahore, Pakistan, and the Department of Anesthesia, Lahore General Hospital/Ameer-ud-Din Medical College, Lahore, Pakistan. The study was conducted from August 2022 to July 2023. Women with diabetes mellitus were identified in the community using diabetes-screening activities, as well as in the outpatient clinics and affiliated primary healthcare services.

Study Population: A sample of 120 women who had a confirmed diagnosis of diabetes mellitus were included in the study. Women of 30–70 years age who had been diagnosed with diabetes mellitus type 1 or type 2 and were willing to give written informed consent were included. Participants had to be clinically stable with a reliable medical, gynecological, urinary, renal, surgical and anesthetic history.

Pregnant women, those with an active urinary tract infection at the time of assessment, women with an indwelling urinary catheter and women with a known congenital urinary tract abnormality were excluded. Patients with a history of urinary tract malignancy, urethral stricture, advanced pelvic-organ prolapse leading to mechanical obstruction, previous spinal cord injury, multiple sclerosis, bladder dysfunction due to stroke, cauda equina syndrome and a known neurological cause of neurogenic bladder were also excluded. Women with acute kidney injury or incomplete clinical records were not included.

Sample size and sampling technique: The sample size for the study was 120 people. A sample size was determined based on a prevalence of diabetic bladder dysfunction of 50%, 95% confidence level and an acceptable margin of error. A non-probability consecutive sampling technique was used. All of the eligible women who came for the study period were approached to participate in the study until the desired sample size was reached.

Data Collection Procedure: Data were collected through a structured questionnaire which was developed based on the objectives of the study. Direct interviews, medical records, laboratory reports and ultrasonic assessment were used to obtain information. Demographic characteristics, duration and type of diabetes, treatment regimen, glycemic control, associated comorbidities, symptoms of diabetic neuropathy, gynecological history, renal status, urinary symptoms, previous surgeries, anesthetic exposure, postoperative urinary retention, and duration of urinary catheterization was included in the questionnaire.

Information on age, educational status, living status, height, weight and body mass index was collected. The duration of diabetes was determined from the date when the diagnosis was confirmed. Glycemic control was evaluated by the most recent glycated hemoglobin (HbA1c) reading that was available within the past three months. Poor glycemic control was considered a glycated hemoglobin ≥8.5%.

Evaluation of Lower Urinary Tract Symptoms: LUTS were evaluated by asking the participants about urinary frequency, urgency, nocturia, urgency urinary incontinence, stress urinary incontinence, hesitancy, weak urinary stream, intermittent flow, straining, incomplete bladder emptying, overflow incontinence, and past urinary retention. The International Prostate Symptom Score has been modified to be used for women to measure symptoms of urgency. A score of 0-7 was regarded as mild, 8-19 as moderate and 20-35 as severe.

The participants were also asked about how long the symptoms lasted, how the symptoms affected their daily life, use of protective pads, recurrent urinary tract infections, and urological consultations they have had prior to the study. Those women who developed symptoms compatible with the presence of an active UTI had a urinalysis and urine culture and their bladder assessment was deferred until the UTI cleared.

Neurological Assessment: A focused neurological examination was performed in all to detect diabetic peripheral neuropathy. Symptoms of numbness, tingling and burning were assessed, as well as absence of protective sensation, ankle reflexes and vibration perception with a 128 Hz tuning fork. Where possible, the examination component of the Michigan Neuropathy Screening Instrument was used. Peripheral neuropathy was defined by an examination score of 2.5 or more, or by decreased vibration sensibility and delayed ankle reflexes in a participant who had had diabetes for a long time.

Bladder Function Assessment: Bladder emptying was assessed by transabdominal ultrasonography of the postvoid residual urine. The participants were asked to arrive with a full bladder and were instructed to get up and void normally in private. Within 10 minutes of voiding, postvoid residual urine was measured. Residual urine volumes of less than 50 mL were considered normal, 50-99 mL borderline, and volumes of 100 mL or more as clinically elevated.

If available and the participant voided at least 150 mL, a uroflowmetry was conducted. The maximum urinary flow rate, voided volume, voiding time and urinary flow pattern were measured. When the amount of urine voided was considered adequate, urinary flow rates <15 mL/s were deemed suggestive of bladder emptying impairment.

Diabetic Neurogenic Bladder Assessment: Moderate or severe LUTS and/or urinary retention plus objective evidence of impaired bladder emptying were considered indicative of probable diabetic neurogenic bladder. Objective impairment was considered to be a PVR ≥ 100 mL or a maximum urinary flow ≤ 15 mL/s. In addition, all participants had to have clinical signs of diabetic peripheral or diabetic autonomic neuropathy, and no other major mechanical, neurological, infectious, or malignant cause of bladder dysfunction.

"Probable diabetic neurogenic bladder" was used since multichannel urodynamic testing was not undertaken in all the participants. Women who had inconclusive results or very problematic bladder dysfunction were referred to a specialist in either urology or urogynecology.

Assessment of Gynecological Risk Factors: Each participant had a detailed gynecologic and obstetric history. Age at menarche, parity, number of vaginal and cesarean deliveries, menopausal status, duration since menopause, previous hysterectomy, previous pelvic or gynecological surgery, presence of genitourinary syndrome of menopause, and urinary incontinence were recorded as variables.

Multiparity was those women with four or more previous deliveries. Pelvic-organ prolapse was evaluated by the gynecologist and classified based on the clinical severity. Advanced prolapse that stretched out beyond the hymen and created likely mechanical urinary obstruction was excluded and mild and moderate prolapse included for analysis.

Assessment of Renal and Urinary Risk Factors: For renal assessment, serum creatinine, estimated glomerular filtration rate, urinalysis, urine albumin-to-creatinine ratio, and renal ultrasonography (as clinically indicated) were used. A urine albumin-to-creatinine ratio ≥30 mg/g was used as the definition of albuminuria. An estimated glomerular filtration rate (eGFR) of less than 60mL/min/1.73m² was considered reduced renal function.

Recurrent urinary tract infection, which is a history of recurrent UTIs. Recurrent infection was considered as two or more medically documented infections in 6 months or three or more infections in 12 months. History of previous pyelonephritis, renal stones, hydronephrosis and upper urinary tract dilatation were also recorded where backed by medical history and/or imaging.

Pre-operative evaluation of risk factors: A thorough surgical and anesthetic history of each participant was taken. Previous general anesthesia, spinal anesthesia, epidural anesthesia, type of surgery, duration of surgery, previous pelvic/abdominal surgery, perioperative urinary catheterization, prolonged urinary catheterization and postoperative intensive-care admission were recorded.

Participants were asked in particular about their past history of not being able to get rid of urine after surgery or anesthesia. Urine retention was considered postoperative if it was documented that there was no urine passage or if urinary catheterization was performed. Prolonged urinary catheterization was taken to be urinary catheterization of more than 24 hours following surgery. It was also noted whether or not there were any recurring episodes of post-op urinary retention and any complications that arose from them.

Outcome Measures: The main outcome was the proportion of women with DM with probable diabetic neurogenic bladder. Secondary outcomes involved the relationship between diabetic neurogenic bladder and the following: gynecological factors, renal impairment markers, recurrent urinary tract infection, duration of diabetes, glycemic control, peripheral neuropathy, prior anesthesia, postoperative urinary retention, and length of urinary catheterization.

Ethical Considerations: Prior to starting the study, ethical approval was secured from the concerned institutional review committees of Hameed Latif Hospital and Lahore general Hospital/Ameer-ud-Din medical college. The approval numbers should be inserted in the final manuscript. All participants signed an informed consent form prior to participation. The participants were told the aims of the study, how the examination would be conducted, the benefits that could accrue from participating and that they could withdraw from the study at any time without any repercussions on their medical treatment. To assure confidentiality, identification codes were used rather than recording participant names on the study forms.

Statistical Analysis: The data was entered & analyzed by the help of IBM SPSS Statistics version 26. Normally distributed continuous variables were presented as mean (standard deviation) while skewed continuous variables were presented as median (interquartile range). Categorical variables were reported as number and percentages.

Prevalence of diabetic neurogenic bladder (DNB) was determined as the number of participants who met the operational definition of DNB divided by the total number of participants and was reported as a 95% confidence interval. Both groups, with and without probable diabetic neurogenic bladder, were compared with respect to continuous variables by independent-samples t test or Mann–Whitney U test. The chi-square test or Fisher exact test was used for categorical variables.

First, univariable logistic regression was used to determine the possible factors associated with diabetic neurogenic bladder. All variables with a P value < 0.10 at univariable logistic regression analysis and clinically relevant variables were added to a multivariable logistic regression model. Adjusted odds ratios (ORs) with 95% confidence interval (CI) are presented. Statistically significant was set at a p value of <0.05.

RESULTS

The total number of women with diabetes mellitus were 120. A probable diabetic neurogenic bladder was diagnosed in 43 of the participants (35.8%) and in 77 participants there was no evidence of bladder dysfunction.

Diabetic neurogenic bladder women were significantly older and had a longer duration of diabetes than women without diabetic neurogenic bladder. Their glycated hemoglobin levels and the occurrence of peripheral neuropathy were also higher. Diabetes duration of at least 10 years, glycated hemoglobin of at least 8.5%, insulin treatment, and peripheral neuropathy were significantly associated with diabetic neurogenic bladder, as shown in Table 1.

Women with DB had more LUTS. Significant differences were detected between the affected group and the non-affected in nocturia, urgency, incomplete bladder emptying, weak urinary stream, urgency urinary incontinence and straining. Additionally, women with diabetic neurogenic bladder had a higher median PVR and lower maximum urinary flow rate as shown in Table 2.

Multiparity, postmenopause, prior pelvic surgery, PEP, albuminuria, decreased eGFR, past history of UTI, prior postoperative urinary retention, and long term postoperative catheterization were all significantly more common among those with diabetic neurogenic bladder.

Diabetes duration ≥ 10 years, poor glycemic control, peripheral neuropathy, albuminuria and past history of urinary retention following surgery were independent risk factors for diabetic neurogenic bladder in multivariable logistic regression. The strongest association was with peripheral neuropathy as seen in Table 3.

Diabetic neurogenic bladder was present in more than one-third of this study population, and was strongly associated with long duration of diabetes, poor glycemic control, peripheral neuropathy, renal involvement, and history of urinary retention following surgery.

Table 1: Clinical characteristics of the study participants

Variable	Diabetic neurogenic bladder, n=43	No diabetic neurogenic bladder, n=77	p value
Age, years	53.7±9.1	48.6±8.7	0.004
Diabetes duration, years	11.8±5.9	7.4±4.6	<0.001
Diabetes duration ≥10 years	29 (67.4%)	26 (33.8%)	<0.001
Glycated hemoglobin, %	9.1±1.6	7.9±1.4	<0.001
Glycated hemoglobin ≥8.5%	29 (67.4%)	25 (32.5%)	<0.001
Insulin treatment	28 (65.1%)	33 (42.9%)	0.019
Hypertension	29 (67.4%)	39 (50.6%)	0.075
Peripheral neuropathy	31 (72.1%)	20 (26.0%)	<0.001

Table 2: Urinary symptoms and bladder-function findings

Variable	Diabetic neurogenic bladder, n=43	No diabetic neurogenic bladder, n=77	p value
Nocturia	34 (79.1%)	31 (40.3%)	<0.001
Urinary urgency	31 (72.1%)	25 (32.5%)	<0.001
Incomplete bladder emptying	28 (65.1%)	12 (15.6%)	<0.001
Weak urinary stream	25 (58.1%)	10 (13.0%)	<0.001
Urgency urinary incontinence	24 (55.8%)	19 (24.7%)	0.001
Straining during urination	17 (39.5%)	7 (9.1%)	<0.001
Postvoid residual urine, mL	142 (110–210)	42 (20–68)	<0.001
Maximum urinary flow rate, mL/s	12.8±4.1	21.9±5.6	<0.001

Table 3: Independent factors associated with diabetic neurogenic bladder

Variable	Adjusted odds ratio	95% confidence interval	p value
Diabetes duration ≥10 years	2.84	1.17–6.89	0.021
Glycated hemoglobin ≥8.5%	2.61	1.07–6.38	0.035
Peripheral neuropathy	3.92	1.58–9.76	0.003
Albuminuria	2.73	1.11–6.73	0.029
Previous postoperative urinary retention	3.68	1.12–12.10	0.032

DISCUSSION

The present study found that diabetic neurogenic bladder affected 35.8% of women with diabetes mellitus[1]. This discovery suggests that incontinence is a prevalent, but possibly underestimated, issue for women with diabetes. The affected participants had more urinary symptoms, larger postvoid residual urine volume, and lower urinary flow rates than women who did not have bladder dysfunction. Diabetes duration, glycemic control, peripheral neuropathy, urinary protein (albuminuria), and urinary retention

after surgery remained independent risk factors for diabetic neurogenic bladder[2,3].

The women with diabetic neurogenic bladder had a longer duration of diabetes, and were older. Autonomic and peripheral nerve fibres that mediate micturition can be injured in a progressive manner over time when hyperglycaemic[4]. Long term neurological injury can lead to a loss of bladder awareness and impaired detrusor contractility resulting in a raised residual urine volume. Weak urinary stream, straining, and urinary retention were all more common among affected participants, which may be due to these changes in bladder properties[5].

Poor glycemic control was also independently associated with diabetic neurogenic bladder. Microvascular damage, oxidative stress, nerve conduction defects, urothelial dysfunction and changes in bladder wall structure may be associated with chronic hyperglycemia[6]. The polyuria of diabetes can lead to urinary frequency, urgency and nocturia in the early stages and to a decrease in bladder sensation and a loss of bladder emptying in the late stages due to the development of autonomic neuropathy. This evolution is the reason that storage as well as voiding symptoms were also noted in the study population[7].

Peripheral neuropathy was independently associated with diabetic neurogenic bladder the most. This discovery will help to advance the understanding of the contribution of neurological damage to diabetic bladder dysfunction[8]. Peripheral neuropathy is not a direct measure of an autonomic bladder but if present may signify more advanced and diffuse diabetic neuropathy. Thus, women with peripheral neuropathy, such as decreased vibration sensation or loss of ankle reflexes, may need specific evaluation for lower urinary tract dysfunction[9,10].

The most common symptoms in women with incontinence were nocturia, urinary urgency, incomplete emptying, weak urinary stream and urgency urinary incontinence[11]. This mixed picture illustrates that diabetic bladder dysfunction is not restricted to urinary retention or an underactive bladder. Sometimes overactive bladder symptoms may be the first symptoms of disease, while others may have progressive decrease in detrusor contractility. Thus, there is a need to screen for both storage symptoms and voiding symptoms[12].

There were a number of gynecological factors which were more prevalent in women with diabetic neurogenic bladder. Pelvic-floor support, urethral resistance and bladder emptying may be influenced by multiparity, menopause, previous pelvic surgery and mild to moderate pelvic-organ prolapse[13]. These factors were all retained as statistically significant, however, in the adjusted model, the association of these factors seemed to overlap with age, obesity, duration of diabetes and neurological complications. Where there is longstanding diabetes, although gynecological abnormalities may contribute to the urinary symptoms they should not be assumed to be the cause of the bladder dysfunction[14].

Diabetic neurogenic bladder was still significantly related to albuminuria. This association may indicate that there is a common disease burden of diabetic microvascular damage[15]. Women with albuminuria might have more systemic disease affecting the kidneys, peripheral nerves, the autonomic pathways, and the lower urinary tract. Affected women also had more cases of reduced estimated glomerular filtration rate which, however, was not an independent factor in the final model[16].

Diabetic neurogenic bladder was significantly associated with recurrent UTI in women. A high PVR can lead to urinary stasis and bacterial growth, which may lead to recurrent UTIs. On the contrary, urinary infection can cause a temporary aggravation of urinary urgency, frequency, and incontinence. The cross-sectional nature of this study precluded determining the direction of this relationship[17,18].

Diabetic neurogenic bladder was independently associated with previous postoperative urinary retention. Normal micturition may be temporarily disrupted following anesthesia and surgery or due to the use of opioids, immobility, or bladder overdistention. But postoperative retention may also be a clue to an undiagnosed bladder sensory or detrusor contractility defect. So, a history of postoperative urinary retention can be an important clinical clue to an underlying diabetic bladder dysfunction[19,20].

Diabetic neurogenic bladder was not significantly associated with general anesthesia or neuraxial anesthesia only[1,11]. This indicates that it is not so much the exposure to anesthetic as to whether or not postoperative retention or extended catheterization takes place. Pre-operative urinary assessment and post-operative bladder-volume monitoring may be beneficial for women who have longstanding diabetes, poor glycemic control, peripheral neuropathy, and/or a history of urinary retention[2,14].

The results are significant in terms of diabetes care within the community[5]. In a typical diabetes follow-up, cardiovascular, renal, retinal and peripheral neurological complications are the main concerns, while urinary symptoms may be overlooked. Urinary urgency, nocturia, weak urinary stream, incomplete emptying and previous urine retention may be simple questions that could help identify women needing further assessment. Measurement of postvoid residual urine is noninvasive and may be particularly useful among high-risk patients[6-10].

There were a number of limitations in this study. Because of its cross-sectional design, it was not possible to establish causal or temporal relationships[12]. The findings may not be generalizable due to the relatively small sample size and consecutive sampling technique. Peri-anesthetic information was of some participant recall and could have been subject to recall bias. Not all participants had formal multichannel urodynamic testing; so the diagnosis was restricted to 'probable diabetic neurogenic bladder'. Furthermore, the modified urinary symptom score may not be able to differentiate diabetic neurological dysfunction from pelvic-floor and gynecological dysfunction[14-18].

Overcoming these difficulties, a study of diabetic bladder dysfunction was carried out combining urinary symptoms, neurological examination, postvoid residual urine, urinary flow findings, and excluding major alternative causes. It also assessed, as a whole, gynecological, renal, and peri-anesthetic factors, giving a more comprehensive clinical evaluation of the bladder dysfunction in diabetic women[19,20].

CONCLUSION

Diabetic neurogenic bladder was detected in over one-third of diabetic women. Independent factors associated with its presence included long diabetes duration, poor glycemic control, peripheral neuropathy, albuminuria and previous postoperative urinary retention. Commonly affected women presented with nocturia, urgency, weak urinary stream, urinary incontinence and incomplete bladder emptying.

Routine screening for LUTS should be a part of diabetes follow-up especially for women with longstanding diabetes, poor glycemic control, neurological problems, renal failure, a history of postoperative retention or recurrent UTI. Postvoid residual urine should be measured and an appropriate urological or urogynecological evaluation performed in high-risk patients. Early identification and better glycemic control may lead to decreased urinary complications, recurrent infection, renal deterioration, and peri-operative bladder related morbidity.

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Authors' Contributions: SA and QUAQ contributed to the study conception, participant recruitment, gynecological assessment, and manuscript preparation. EUH contributed to the urological assessment and interpretation of bladder-function findings. H and MAA contributed to the collection and interpretation of peri-anesthetic data. HB contributed to the renal assessment, statistical interpretation, supervision, and critical revision of the manuscript. All authors reviewed and approved the final manuscript.

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Conflict of Interest: The authors declare no financial, professional, or personal relationships that could have influenced the conduct or reporting of this study.

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