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Original Research

Urodynamic Outcomes in Women with Pelvic Organ Prolapse Assessed using Pelvic Organ Prolapse Quantification: A Prospective Study

Magdoleen Barry[1], Abdulrahman Bogis[1,*], Maysoon Alhaizan[1], Dana Aldabeeb[1], Baydaa Alsannan[2], Ghadeer Al-shaikh[1]

[1]Department of Obstetrics & Gynecology, College of Medicine, King Saud University, 11461 Riyadh, Saudi Arabia
[2]Department of Obstetrics & Gynecology, College of Medicine, Kuwait University, 74252 Kuwait, Kuwait
*Correspondence: aabogis@gmail.com (Abdulrahman Bogis)
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Abstract

Background: Urodynamic studies (UDS) are diagnostic tools used to evaluate urinary function and guide the management of conditions such as detrusor overactivity (DO) and urodynamic stress incontinence (USI), both of which significantly affect the quality of life of patients. Despite their clinical importance, comprehensive data on the relationship between these outcomes and pelvic organ support are lacking. Pelvic organ prolapse (POP), commonly assessed using the standardized pelvic organ prolapse quantification (POP-Q) system, is frequently associated with lower urinary tract symptoms (LUTS). This study aimed to determine the correlation between POP-Q classification and UDS findings and to investigate the association of different types of POP with DO and USI. **Methods**: This prospective observational cohort study encompassed women presenting to or referred to the Urogynecology Clinic at King Saud University Medical City, Riyadh, Saudi Arabia. Consecutively enrolled women underwent comprehensive clinical evaluations, including medical history, pelvic examination using the POP-Q system, and standardized urodynamic testing. Chi-square and analysis of variance (ANOVA) tests were used to examine the correlation between anatomical findings and urodynamic parameters, including bladder capacity, post-void residual (PVR), maximum flow rate (Q-max), flow time, time to maximum flow, first desire to void, and strong desire to void. Statistical significance was defined as $p < 0.05$. Multiple linear regression (MLR) was used to determine the independent predictors of each UDS diagnosis. **Results**: Out of the 153 women included, 127 had POP, among whom 74% experienced USI. The most frequent types of POP were anterior (92.1%) and posterior (91.3 %) vaginal wall prolapses, whereas apical prolapse was less frequent (39.4%). Among those with apical prolapse, a significant correlation was observed with time to maximum flow ($p = 0.050$), even in the earlier stages. A significant association was observed between anterior prolapse and PVR ($p = 0.026$). Posterior prolapse was significantly correlated with Q-max ($p = 0.014$) and flow time ($p = 0.046$). These findings indicate that some elements obstruct the urine outflow. No significant correlations were observed between the USI or DO and the different stages of apical ($p = 0.51$; $p = 0.60$), anterior ($p = 0.40$; $p = 0.80$), or posterior prolapse ($p = 0.55$; $p = 0.59$). The presence of a history of stress incontinence was associated with a four times greater likelihood of the presence of USI in UDS. **Conclusions**: This study showed that different stages and types of POP were linked with certain urodynamic findings, suggesting the presence of partial urine outflow obstruction might occur. These findings indicate complex clinical interactions that require personalized management. Recognizing these associations enables clinicians to tailor individualized interventions, such as pessary use, pelvic floor physical therapy, or surgical correction, based on the affected compartment involved and the urodynamic profile, thereby improving symptom control and patient outcomes.

Keywords: pelvic organ prolapse; urodynamic study; stress urinary incontinence; detrusor overactivity

1. Introduction

Urodynamic tests are diagnostic tests used to assess the bladder function. Their advantage lies in reaching an objective diagnosis after the initial assessment, which enables treatment improvement and ultimately leads to better outcomes [1]. Urodynamic tests are not necessary before the empirical, conservative, or noninvasive treatment of stress urinary incontinence (SUI) [2]. However, urodynamic investigations are indicated before initiating invasive therapy for SUI [3,4] and are occasionally required before prolapse surgery to determine whether a patient has occult stress incontinence [1].

Detrusor overactivity (DO) and urodynamic stress incontinence (USI) are two distinct urodynamic diagnoses that significantly affect women's quality of life. DO is characterized by involuntary detrusor contractions during the filling phase, often resulting in urinary urgency, frequency, and urge incontinence. In contrast, USI is defined as the involuntary leakage of urine during increased abdominal pressure (e.g., coughing or sneezing) in the absence of detrusor contractions. These conditions can lead to substantial psychological distress, social limitations, and reduced physical function in the affected women.

Pelvic floor disorders (PFD), including lower urinary tract symptoms (LUTS) and pelvic organ prolapse (POP),

significantly affect the quality of life, physical function, and psychological well-being of women worldwide [5,6]. Despite their high prevalence, these conditions often remain underreported because of cultural sensitivity and limited awareness, particularly in conservative societies. Globally, the prevalence of PFD varies widely, with studies reporting rates ranging from approximately 25% to 45% depending on age, parity, and socioeconomic status [7–9]. Worldwide, the number of women with POP, a significant component of PFD, is 13.43 million, with an age-standardized incidence rate of 316 per 100,000 in 2019. These figures underscore the disease burden, especially among aging women and in societies where population aging is a significant concern and where this burden is likely to be amplified further [10].

In Saudi Arabia, the rapidly evolving healthcare landscape is increasingly focusing on addressing women's health issues, including urogynecological conditions [11]. However, comprehensive reports characterizing the clinical profiles of Saudi women seeking care for PFD are scarce [11,12]. Understanding the clinical presentations and demographics of women attending specialized urogynecology clinics is crucial for improving health services, tailoring culturally appropriate interventions, and enhancing preventive measures.

POP frequently occurs alongside urinary symptoms, including urinary frequency, urgency, incontinence, and difficulty in voiding [13,14]. These symptoms can significantly impair the patients' daily activities, social interactions, emotional well-being, and overall quality of life. However, the detailed clinical characteristics of Saudi women remain unclear. Addressing this knowledge gap through comprehensive characterization of POP and associated LUTS is essential for developing targeted management strategies, improving diagnostic accuracy, and enhancing therapeutic effectiveness [15].

Physicians often establish an empirical diagnosis based on examination of the patient's LUTS, physical findings, urinalysis results, and other tests, such as urodynamic studies (UDS), to guide early care [16,17]. Currently, consistent reports on the prevalence of LUTS associated with POP are lacking, and limited evidence is available regarding the incidence of this association. Obstructive voiding is frequently associated with POP [18]. In addition, one study showed that mild cases of POP typically do not present with urinary symptoms [19].

This study aimed to determine the potential correlation between the (pelvic organ prolapse quantification (POP-Q)) findings and urodynamic study UDS findings. The secondary objective was to investigate the association between anterior, posterior vaginal wall prolapse and/or apical prolapse with DO and USI.

Understanding these associations has significant clinical implications in patient care. It can help clinicians predict which patients with POP are more likely to experience urodynamic abnormalities, potentially influencing their decisions to perform preoperative studies. Additionally, these findings may guide surgical planning by identifying patients who may benefit from combined procedures that address both prolapse and urodynamic dysfunction. Furthermore, this knowledge can improve patient counseling by setting realistic expectations about postoperative outcomes, particularly regarding the variable and unpredictable nature of LUTS resolution after prolapse repair, where symptoms may completely resolve, partially improve, persist unchanged, or, in some cases, develop new symptoms. Finally, in resource-limited settings, these associations may help prioritize patients who require a more comprehensive urodynamic evaluation.

This study is particularly significant, as it represents one of the first comprehensive analyses of the association between POP and urodynamics in the Saudi population. The conservative cultural context may influence symptom-reporting patterns, healthcare-seeking behaviors, and treatment preferences compared to Western populations. Additionally, genetic, dietary, and lifestyle factors specific to this region may affect the prevalence and presentation of floor disorders, making this study crucial for the development of culturally appropriate management strategies for Middle Eastern women.

2. Materials and Methods

We conducted a prospective cohort study involving women who sought care or were referred to the urogynaecology clinic of King Saud University Medical City (KSUMC), which serves a diverse population in Riyadh, Saudi Arabia. The study spanned one year, from April 2023 to March 2024.

We included women who presented with POP symptoms or LUTS and underwent POP-Q and urodynamic evaluation. The exclusion criteria included inadequate physical examination, absence of urodynamic assessment, and concomitant neurological disorders.

To ensure representativeness, we consecutively enrolled all patients who visited the clinic during the study period. Given the comprehensive inclusion of all eligible participants within the specified time frame, we did not employ sampling methods.

Clinical assessment involved obtaining detailed medical histories, performing physical examinations using the POP-Q system [20], maintaining frequency-volume charts, and conducting urine analysis. Based on the initial physical examination, the participants were categorized according to the type of POP (apical, anterior, or posterior vaginal wall prolapse) and degree of prolapse, ranging from stages 1 to 4 (if present). Trained urogynecologists conducted all history-taking and clinical examinations.

The POP-Q system evaluates six anatomical points: point Aa (anterior vaginal wall, 3 cm from the hymen), point Ba (most distal position of the anterior vaginal wall), point C (cervical or vaginal cuff), point Ap (posterior vagi-

nal wall, 3 cm from the hymen), point Bp (most distal position of the posterior vaginal wall), and point D (the posterior fornix). Prolapse staging was determined by the most advanced point: stage 0 (no prolapse), stage I (leading edge >1 cm above the hymen), stage II (leading edge ≤ 1 cm above or below the hymen), stage III (leading edge >1 cm below the hymen but <2 cm less than the total vaginal length), and stage IV (complete eversion).

To minimize assessment bias, UDS, including uroflowmetry and filling cystometry, were performed by trained technicians blinded to the specific POP-Q findings. However, complete blinding was not feasible because the clinical examination findings were available in the patients' medical records. The process followed a standardized protocol based on the Good Urodynamic Practice Guidelines of the International Continence Society (ICS) [21].

Urodynamic diagnoses were defined according to the ICS standards. USI is defined as involuntary urine leakage during increased abdominal pressure in the absence of detrusor contraction. DO is a urodynamic condition characterized by involuntary detrusor contractions during the filling phase, which may be spontaneous or provoked. Mixed urinary incontinence (MUI) is defined as a combination of stress and urgency urinary incontinence symptoms confirmed by the presence of both USI and DO on urodynamic testing.

Data were collected from electronic health records (EHRs), which are routinely maintained for healthcare service provision. The collected data included patient demographics and clinical history including age, weight, height, parity, number of vaginal and cesarean deliveries, menopausal status, body mass index (BMI), diabetes mellitus, chief complaint, diagnosis, POP-Q stage, and prior surgical intervention (anterior repair, vaginal repair, anti-incontinence surgery, and hysterectomy). For urodynamic assessments, the recorded data included bladder capacity (mL), PVR (mL), maximum flow rate (Q-max; mL/s), flow time (s), time to maximum flow (s), initial urge to void (mL), strong urge to void (mL), presence of USI, and DO.

To ensure data quality and integrity, trained research assistants independently verified the accuracy and completeness of the data extracted from electronic health records. Regular audits were conducted throughout the study period and discrepancies were resolved through consensus meetings with senior investigators. In addition, standardized EHR data collection protocols ensured that the extracted data were subject to minimal errors and high levels of consistency.

We describe the clinical characteristics, urological symptoms, and UDS findings related to the presence or absence of POP. Additionally, we provide a detailed description of the UDS findings according to the type (apical, anterior, and posterior vaginal wall prolapse) and severity of POP. For patients with multi-compartment prolapse, each compartment was staged independently based on its most advanced point (Ba for the anterior, C for the apical, and Bp for the posterior). The overall prolapse stage was determined based on the most advanced compartment. Statistical analyses were performed for both individual compartment stages and the predominant (most advanced) compartment.

Data were analyzed using IBM SPSS Statistics for Windows (version 24.0; IBM Corp., Armonk, NY, USA). Quantitative variables are summarized as means and standard deviations (SD) or medians and ranges, as appropriate. Qualitative variables were expressed as frequencies and percentages. Qualitative variables were compared using chi-square tests. For quantitative variables, comparisons between two independent groups were made using Student's t-test if the data were normally distributed, and the Mann-Whitney U test if not. When comparing more than two groups, one-way analysis of variance (ANOVA) was used for normally distributed data and the Kruskal-Wallis test was used for non-normally distributed data. Statistical significance was set at $p < 0.05$. Additionally, multiple logistic regression (MLR) was used to determine the independent predictors of each UDS diagnosis while controlling for potential confounders and determining independent associations. This analytical approach was chosen because it allows for the simultaneous evaluation of multiple predictor variables, accounts for the effects of covariates, and provides estimates of the relative contribution of each factor to outcomes.

Approval was obtained from the Institutional Review Board (IRB) before initiating data collection. This study was approved by the Institutional Review Board of King Saud University (approval number E-24-8650). All patient data were securely stored, anonymized, and handled according to the institutional guidelines and ethical standards to ensure confidentiality. Data access was strictly limited to authorized research team members, and identifiable information was removed prior to analysis to safeguard patient privacy.

3. Results

In total, 153 women were included in the analysis. Of these, 127 (83%) were diagnosed with POP and 26 (17%) without POP. The demographic information of the participants is presented in Table 1. The average age of female participants with POP was 54.53 $\pm$ 12.65 years, while the average age of female participants without POP was 53.89 $\pm$ 15.64 years. The mean $\pm$ SD for parity among women with and without POP was 5.72 $\pm$ 2.49 and 4.35 $\pm$ 2.99, respectively, for vaginal delivery, and 0.38 $\pm$ 0.88 and 0.52 $\pm$ 1.12 for CS. Compared to women without POP, those with POP had a significantly higher median parity and number of vaginal deliveries, and the mean BMI for women with POP was 32.20 $\pm$ 6.15 kg/m^2. In contrast, it was 32.24 $\pm$ 6.39 kg/m^2 for women without POP. Table 1 shows the

Table 1. Demographic data between POP and Non-POP cases.

	n	Mean	SD	Minimum	Maximum	*p*-value
Age (years)						
POP	127	54.53	12.65	27.00	96.00	0.821
No POP	26	53.89	15.64	24.00	80.00	
Parity						
POP	127	5.72	2.49	0.00	13.00	0.014
No POP	26	4.35	2.99	0.00	10.00	
VD						
POP	127	5.35	2.61	0.00	13.00	0.010
No POP	26	3.81	3.38	0.00	10.00	
CS						
POP	127	0.38	0.88	0.00	4.00	0.475
No POP	26	0.52	1.12	0.00	5.00	
Weight (kg)						
POP	127	77.19	14.48	42.30	128.00	0.301
No POP	26	80.88	24.98	53.20	156.00	
Height (cm)						
POP	127	154.99	6.23	137.40	172.00	0.105
No POP	26	151.91	16.59	77.20	169.00	
BMI (kg/m^2)						
POP	127	32.20	6.15	18.80	58.18	0.877
No POP	26	32.24	6.39	22.19	51.38	

n, number; SD, standard deviation; VD, vaginal delivery; CS, cesarean section; BMI, body mass index; POP, pelvic organ prolapse.

Table 2. POP-Q staging.

	Stage I		Stage II		Stage III		Stage IV	
	n	%	n	%	n	%	n	%
Apical (n = 50)	27	54.0%	15	30.0%	8	16.0%	0	0.0%
Anterior vaginal prolapse (n = 117)	52	44.4%	54	46.2%	9	7.7%	2	1.7%
Posterior vaginal prolapse (n = 116)	34	29.3%	69	59.5%	13	11.2%	0	0.0%

POP-Q, pelvic organ prolapse quantification.

notable associations between POP and parity ($p = 0.014$), the number of vaginal deliveries ($p = 0.010$), and BMI ($p = 0.877$).

Based on the women's urogynaecological history, SUI was reported in 94 individuals (74%), whereas urgency was recorded in 92 individuals (72.4%). The most frequently reported symptoms were frequent urge urinary incontinence (68.5%) and urge urinary incontinence (UUI) (61.4%). Two significant correlations were noted between POP and symptoms: the feeling of vaginal bulge ($p < 0.001$) and hesitancy ($p = 0.03$).

Regarding POP statistics, the most prevalent types were anterior vaginal prolapse, accounting for 92.1%, and posterior vaginal prolapse, accounting for 91.3%. In contrast, apical prolapse was present in only 39.4% of the POP cases, while multiple components were observed in 86.6% of the cases. USI was prevalent in 71 patients (55.9%), and DO was present in 56 patients (44.1%). A small number of patients had undergone prior repair or surgery, which included five cases (3.9%) of hysterectomies, eight cases (6.3%) of previous vaginal repair, and four cases (3.1%) of previous anti-incontinence surgery.

Table 2 presents the distribution of POP types categorized according to the POP-Q staging system. Most women with apical prolapse were in the first stage, accounting for over half of the total (54.0%). Among patients with anterior vaginal prolapse, 54 (46.2%) were in the second stage. Similarly, more than half of the women had prolapse, and 69 (59.5%) were in the second stage.

Table 3 shows the association between urodynamic findings and staging of different types of prolapse. A link was detected between apical prolapse and time to maximum flow ($p = 0.050$). The correlation between urodynamics and anterior vaginal prolapse was also significantly associated with post-void residual (PVR) ($p = 0.026$). Two significant relationships were noted with posterior vaginal prolapse: Q-max ($p = 0.014$) and flow time ($p = 0.046$).

Table 3. Urodynamic findings according to staging of different prolapse types.

	Stage I		Stage II		Stage III		*p*-value
	Mean ± SD	Median (range)	Mean ± SD	Median (range)	Mean ± SD	Median (range)	
Apical Prolapse (n = 50)							
PVR (mL)	20 ± 26	7 (0–98)	28 ± 35	12 (0–99)	17 ± 18	19 (0–50)	0.814
Q-max (mL/s)	19 ± 9	17 (7–40)	18 ± 8	17 (3–36)	20 ± 13	15 (6–48)	0.890
Flow time (s)	55 ± 27	46 (15–129)	47 ± 16	46 (23–87)	54 ± 26	61 (13–86)	0.730
Time to maximum flow (s)	31 ± 49	19 (3–261)	12 ± 11	7 (3–38)	15 ± 13	9 (4–37)	0.050
Bladder capacity (mL)	458 ± 91	462 (158–558)	463 ± 55	477 (356–537)	453 ± 123	503 (157–538)	0.870
Anterior Prolapse (n = 117)							
PVR (mL)	11 ± 17	5 (0–82)	20 ± 22	16 (0–98)	23 ± 34	7 (0–99)	0.026
Q-max (mL/s)	23 ± 10	10 (8–19)	19 ± 9	17 (3–48)	16 ± 9	14 (6–29)	0.090
Flow time (s)	47 ± 22	32 (10–35)	53 ± 21	51 (15–129)	55 ± 23	56 (13–86)	0.320
Time to max flow (s)	13 ± 8	10 (0–34)	22 ± 42	10 (1–261)	20 ± 16	13 (4–45)	0.310
Bladder capacity (mL)	464 ± 84	469 (129–610)	466 ± 84	484 (158–580)	439 ± 118	500 (157–518)	0.850
Posterior Prolapse (n = 116)							
PVR (mL)	15 ± 20	9 (0–82)	18 ± 23	11 (0–96)	15 ± 29	0 (0–99)	0.330
Q-max (mL/s)	21 ± 10	20 (8–48)	22 ± 10	20 (3–48)	14 ± 4	15 (6–18)	0.014
Flow time (s)	45 ± 20	43 (8–89)	51 ± 22	49 (18–129)	62 ± 23	62 (13–87)	0.046
Time to max flow (s)	10 ± 6	10 (1–24)	17 ± 23	11 (2–261)	36 ± 69	11 (4–261)	0.091
Bladder capacity (mL)	455 ± 82	464 (158–605)	466 ± 80	480 (171–605)	457 ± 100	500 (157–553)	0.650

PVR, post-void residual; Q-max, maximum urinary flow rate; SD, standard deviation.
Statistical significance was set at $p < 0.05$.

Table 4. Relation of POP with DO, USI & MUI.

	USI		DO		MUI	
	No	Yes	No	Yes	No	Yes
Apical prolapse (n = 50)						
Stage I	15 (57.7%)	12 (50.0%)	20 (57.1%)	7 (46.7%)	16 (48.5%)	11 (64.7%)
Stage II	6 (23.1%)	9 (37.5%)	9 (25.7%)	6 (40.0%)	11 (33.3%)	4 (23.5%)
Stage III	5 (19.2%)	3 (12.5%)	6 (17.1%)	2 (13.3%)	6 (18.2%)	2 (11.8%)
p-value	0.51		0.60		0.55	
Anterior vaginal prolapse (n = 117)						
Stage I	19 (38.8%)	33 (48.5%)	27 (41.5%)	25 (48.1%)	29 (43.3%)	23 (46.0%)
Stage II	23 (46.9%)	31 (45.6%)	31 (47.7%)	23 (44.2%)	30 (44.8%)	24 (48.0%)
Stage III	6 (12.2%)	3 (4.4%)	6 (9.2%)	3 (5.8%)	6 (9.0%)	3 (6.0%)
Stage IV	1 (2.0%)	1 (1.5%)	1 (1.5%)	1 (1.9%)	2 (3.0%)	0
p-value	0.40		0.80		0.59	
Posterior vaginal prolapse (n = 116)						
Stage I	14 (28.6%)	20 (29.9%)	23 (35.9%)	11 (21.2%)	19 (28.4%)	15 (30.6%)
Stage II	28 (57.1%)	41 (61.2%)	34 (53.1%)	35 (67.3%)	40 (59.7%)	29 (59.2%)
Stage III	7 (14.3%)	6 (9.0%)	7 (10.9%)	6 (11.5%)	8 (11.9%)	5 (10.2%)
p-value	0.55		0.59		0.94	

Chi-square test was used for analysis table data was presented as n (%). DO, detrusor overactivity; USI, urodynamic stress incontinence; MUI, mixed urinary incontinence.

No significant association was found between USI and POP stage for any type of POP. Furthermore, no significant association was detected between DO and MUI, and POP (Table 4).

Multiple logistic regression analysis revealed that a history of SUI was a predictor of USI on urodynamic testing (odds ratio (OR): 4.182, 95% confidence interval (CI): 1.594–10.974; $p = 0.004$), while apical compartment prolapse was a protective factor for DO (OR: 0.400, 95% CI: 0.175–0.918; $p = 0.031$) (Table 5).

When the characteristics predicting MUI were studied, low parity and lack of stress incontinence were found to be predictors of normal conditions (OR: 0.79, 95% CI: 0.643–0.988; $p = 0.039$) and (OR: 0.33, 95% CI: 0.123–887; $p = 0.028$, respectively).

Table 5. Multiple logistic regression analysis for factors affecting urodynamics.

	USI			DO		
	p-value	OR	95% CI of OR	*p*-value	OR	95% CI of OR
Age	0.272	0.971	0.921–1.023	0.230	1.032	0.980–1.086
Parity	0.703	1.037	0.861–1.248	0.797	1.024	0.854–1.227
Menopause	0.250	2.132	0.587–7.747	0.128	0.384	0.112–1.318
Previous surgery	0.207	5.674	0.383–84.096	0.465	0.427	0.044–4.186
Vaginal repair	0.397	0.482	0.089–2.614	0.229	2.832	0.520–15.420
Apical prolapse	0.118	0.510	0.220–1.185	0.031	0.400	0.175–0.918
Anterior prolapse	0.626	2.156	0.098–47.522		NS	
Posterior prolapse	0.460	2.688	0.195–37.074		NS	
Stress incontinence	0.004	4.182	1.594–10.974	0.197	0.542	0.214–1.374
Compound compartment prolapse	0.785	1.503	0.080–28.140		NS	
BMI (kg/m^2)	0.358	0.970	0.909–1.035	0.931	1.003	0.941–1.069
Constant	0.800	0.608		0.999	<0.001	

OR, odds ratio; CI, confidence interval; NS, not significant.

4. Discussion

Among our patients, anterior and posterior vaginal prolapse were the most prevalent types of POP. Apical prolapse was less common and its severity was predominantly mild. Hendrix *et al*. [22] reported that, among 27,342 postmenopausal women, a higher BMI was significantly associated with an increased risk of uterine prolapse. In addition, higher parity was strongly associated with an elevated risk [22]. In contrast, our study observed that women with POP had a lower median BMI than those without prolapse, suggesting that factors other than BMI may play a more significant role in our population. However, consistent with the findings of Hendrix *et al*. [22], we found that a higher parity was significantly associated with POP.

Correlations between urodynamic measures and POP-Q staging revealed a strong connection between stage I apical prolapse and time to maximum flow; patients in the first stage had a considerably higher mean time to maximum flow. Stages III and IV anterior vaginal prolapse were associated with PVR, with these individuals having a significantly higher mean PVR. Regarding posterior vaginal prolapse, patients with stage II prolapse had a significantly greater Q-max, whereas those with stage III prolapse had a significantly longer mean flow time. Earlier apical prolapse had a greater impact on UDS than later stages of anterior and posterior prolapse. Such effects could be observed in some elements of the restriction of urine outflow, as evidenced by a high PVR and long mean time to maximum flow. This finding is crucial for surgical intervention because it indicates that prolapse significantly affects bladder emptying. Surgical repair can relieve this obstruction and improve the bladder function.

Earlier stages of apical prolapse showing greater urodynamic effects than advanced stages can be explained by several physiological mechanisms. During early apical prolapse, the descent of the cervix or vaginal apex may create a ‘kinking’ effect on the bladder neck and proximal urethra, leading to functional obstruction without complete mechanical compression. This partial obstruction may be more problematic for normal voiding mechanics than for complete prolapse, in which case, compensatory mechanisms may develop. Additionally, early apical descent may alter the normal anatomical relationships between the bladder, urethra, and supporting structures, thereby disrupting the coordinated mechanism of micturition. As prolapse progresses, the bladder may adapt to the altered anatomy or the obstruction may become so severe that overflow mechanisms predominate over compensatory mechanisms.

Our findings align with those of Munno *et al*. [23], who demonstrated that bladder outlet obstruction due to POP could generate bladder alterations, resulting in overactive bladder symptoms. However, our results differ from those of Cameron [19], who found no association between POP stage and the severity of LUTS. The observed increase in PVR with advanced anterior prolapse supports the findings of previous studies, suggesting that mechanical obstruction becomes more prominent at higher prolapse stages.

In contrast to our results, a previous study demonstrated that anterior vaginal prolapse was not correlated with the maximum flow rate or PVR. However, it is strongly associated to urinary incontinence during physical exercise [24]. There was a noticeable increase in the PVR volume among individuals with more advanced stages of anterior prolapse [24]. Our data support these results, as individuals with anterior vaginal prolapse stages III and IV had significantly greater PVR volumes than those with lower prolapse stages. Our findings align with those of a recent study, which also found no significant correlation between POP stages and the first urge to void [25].

USI and DO were the two most common urodynamic findings in this study, representing 55.9% and 44.1% of the women, respectively. However, no correlation was found between USI, DO, or MUI, and the various types and stages of POP.

Multiple logistic regression analysis revealed that SUI increased the likelihood of USI almost four-fold, whereas apical prolapse decreased the probability of DO. In addition, the absence of stress incontinence and limited number of childbirths protected against MUI.

Consistent with our results, Schimpf *et al*. [24] did not observe a significant association between anterior wall prolapse and DO, urgency, or urge incontinence. The difficulty in establishing a correlation between increasing rates of incontinence and advancement of the anterior vaginal prolapse stage was acknowledged [22] which aligns with our findings as we observed no connection between the stages of anterior prolapse and USI.

A previous study on UDS yielded similar findings, showing a lower prevalence of DO (18.7%) than of USI (33.8%) [25]. However, our study observed a higher proportion of DO, as mentioned earlier. Moreover, Serati *et al*. [26] found a significant adverse association between stress incontinence and DO. We observed no correlation between SUI and DO. Our findings are consistent with the prediction that the absence of MUI indicates a lack of stress incontinence in women with obesity.

We found a strong correlation between a history of SUI and USI, with the likelihood of being almost four times higher, which might indicate that a history of SUI can usually be dependent upon for clinical decision-making without the need to perform UDS in patients with no other LUTS or POP symptoms. Based on this finding, surgeons may confidently proceed with a procedure that addresses both prolapse and incontinence without the need for confirmatory UDS in cases where a patient's history strongly indicates stress incontinence. The treatment focus should be on the most critical patient concern and a significant component should be improving women's quality of life.

Our findings have several clinical implications. First, patients with early stage apical prolapse may benefit from early intervention to prevent the progression of urodynamic dysfunctions. Second, the association between advanced anterior/posterior prolapse and obstructive parameters suggests that surgical repair may improve the bladder emptying function. Third, the strong correlation between a clinical history of stress incontinence and urodynamic findings supports the use of clinical assessment in decision-making, potentially reducing the need for routine preoperative urodynamics in selected patients.

The strengths of this study include conducting research at a highly specialized urogynecology clinic in Saudi Arabia and providing a unique clinical context. Comprehensive assessments including detailed UDS following standard protocols ensured robust data collection. Additionally, high-quality standardized data collection processes supported by built-in quality assurance mechanisms further increased the reliability of the results.

However, this study had certain limitations. First, its cross-sectional design prevented the establishment of a causal relationship between POP and the urodynamic findings. We could not determine whether prolapse leads to urodynamic changes or whether the two conditions share a common underlying pathophysiology. Second, we did not use validated symptom questionnaires such as the Pelvic Floor Distress Inventory (PFDI-20) or the International Consultation on Incontinence Questionnaire (ICIQ), which would have provided a standardized symptom assessment and facilitated comparison with international studies. Third, our study had a relatively small sample size (n = 153), which may limit the generalizability of our findings and the statistical power to detect small but clinically meaningful associations in large studies. This limitation is compounded by the imbalance in our study groups, with only 26 patients (17%) in the non-POP control group compared to 127 patients (83%) in the POP group, which limits the statistical power for comparative analyses between the groups. This is particularly relevant for subgroup analyses based on prolapse stage, in which some categories had a limited number of participants. Fourth, important background characteristics such as family history, socioeconomic status, genetic factors, and sexual history were not collected, which may have helped better explain the findings. Finally, the clinical outcomes following the interventions were not assessed, and no long-term follow-up was conducted.

We recommend the following for the clinical management of women presenting with urogynecological symptoms in specialized clinics: (1) simultaneous assessment and management of SUI in women presenting with POP, particularly anterior vaginal wall prolapse, given its high prevalence; (2) recognition of severe anterior and posterior prolapse as potential indicators of bladder outlet obstruction, which may warrant surgical intervention to improve bladder emptying; and (3) routine screening for USI in patients with POP, given its strong association. Given the high prevalence of POP and the need for surgical treatment [27], future studies should include longitudinal follow-ups to assess the temporal relationship between prolapse progression and urodynamic changes. Specific hypotheses for future research include the following: (1) whether surgical correction of early apical prolapse prevents the development of urodynamic dysfunction, (2) whether urodynamic parameters can predict surgical outcomes, and (3) whether the observed associations vary across different ethnic populations. Interventional studies examining the effects of prolapse repair on specific urodynamic parameters could provide valuable insights into the clinical significance of these associations.

5. Conclusions

This study showed that anterior and posterior vaginal prolapse were the most frequent types of POP. The correlations between UDS and POP varied according to the type and stage: Earlier stages of apical prolapse were associated

with signs of obstruction of urine outflow, whereas it was observed with more advanced stages of anterior and posterior vaginal prolapse. However, USI, DO, and MUI were not associated with the POP type or stage; a history of pure urinary stress incontinence could predict USI. In contrast, the apical compartment was a protective factor against DO, and both low parity and lack of stress incontinence were predictors of normal conditions. Therefore, POP can affect specific parameters of urodynamics and bladder function depending on the type and stage of POP. Moreover, such changes in urodynamics may facilitate better management of POP.

Availability of Data and Materials

The dataset collected and analyzed during the current study is not publicly available due to privacy and ethical restrictions, as it contains confidential patient information. However, data are available from the corresponding author, Dr. Abdulrahman Bogis, on reasonable request and subject to approval by the Institutional Review Board at King Saud University, Riyadh, Saudi Arabia.

Author Contributions

MB and GA designed the research study. MB, AB, DA, and MA collected the data. AB, MA and BA analyzed the data. All authors have contributed to the drafting and critical revision of the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was approved by the Institutional Review Board at King Saud University, Riyadh, Saudi Arabia (Approval Number: E-24-8650). The purpose and aim of the study were explained to all recruited participants, and a signed informed consent form was obtained from all patients before the study was started. Participation was voluntary and complete anonymity was ensured. All the study procedures were performed in accordance with the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

Declaration of AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work, the authors utilized ChatGPT-5.0 to verify spelling and grammar. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.31083/CEOG41533.

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