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Association of International Prostate Symptom Score Storage vs. Voiding Symptoms with Uroflowmetry Parameters

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Abstract: Lower urinary tract symptoms (LUTS) are a common clinical presentation, typically assessed subjectively using the International Prostate Symptom Score (IPSS), while objective evaluation is performed by uroflowmetric studies. Although numerous studies have explored the association between LUTS severity and uroflowmetric parameters globally, a significant research gap remains in correlating individual LUTS components with objective uroflowmetric findings. This study aims to investigate the relationship between specific LUTS domains, as assessed by the IPSS, and corresponding uroflowmetric parameters. This study examines how IPSS storage and voiding scores relate to uroflowmetry measures {maximum flow rate (Qmax), average flow rate (Qavg), voided volume}and compares their associations. Research was conducted as cross-sectional descriptive study including 208 patients aged 18–94 years presenting with LUTS for the first time. Assessment of LUTS were performed using the IPSS questionnaire, categorizing patients as having mild, moderate, or severe symptoms. Objective evaluation was carried out through uroflowmetry, Q_{max}, Q_{ave}, and total voided volume (TV), followed by post-void residual volume (PVRV) assessment via ultrasonography. The relationships between subjective symptom severity and objective uroflowmetric parameters were then analyzed. The mean age of the study population was 61.52 ± 13.67 years, with the majority of participants (79.3%) being over 50 years of age. Statistical analysis demonstrated significant differences in all four uroflowmetric parameters between the mild vs. severe and moderate vs. severe LUTS groups. Furthermore, the presence of specific symptoms : incomplete evacuation, poor stream, intermittency, straining, and increased daytime frequency was associated with significant decrease in Q_{max}, Q_{ave}, and significant increase in PVRV in participants with symptoms compared to participants without these symptoms. This study demonstrates a clear association between the IPSS assessed LUTS severity and objective assessment of uroflowmetric parameters. As symptom severity increased, Qmax, Qave, and TV declined, while PVRV rose significantly. Among individual symptoms, incomplete evacuation and increased daytime frequency showed the strongest correlations with poor uroflowmetric outcomes, indicating impaired bladder emptying. These findings highlight the value of uroflowmetry as an objective complement to the IPSS, particularly for assessing voiding symptoms and prioritizing patients for further evaluation in resource-limited settings.

Keywords: *LUTS, IPSS, Uroflowmetry, Storage Symptoms, Voiding Symptoms.*

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I. INTRODUCTION

LUTS encompass a wide spectrum of urinary disturbances that are broadly classified into storage and voiding symptoms. Storage symptoms include urgency, frequency, nocturia, and dysuria, which are often attributed to an overactive bladder, whereas voiding symptoms such as incomplete bladder emptying, poor stream, intermittency, and straining are commonly due to obstruction of the urinary pathway. The prevalence of specific symptoms differs by sex; storage symptoms are more frequent in women, often associated with gynecological factors contributing to bladder overactivity, while men more commonly experience voiding symptoms secondary to benign or malignant prostatic obstruction[1] . The International Prostate Symptom Score (IPSS) is a widely used, validated questionnaire for

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the subjective assessment of LUTS severity. It evaluates seven parameters which are incomplete bladder emptying, weak stream, intermittency, straining, daytime frequency, urgency, and nocturia.

In contrast to the subjective assessment provided by the IPSS, uroflowmetry offers an objective evaluation of urinary flow. It is a non-invasive diagnostic test that measures parameters such as the Q_{max}, Q_{ave}, and TV. Post-micturition residual volume (PVRV) is often assessed via ultrasonography to complement uroflowmetry findings. These parameters reflect the combined influence of detrusor contractility and bladder outlet resistance.[2]

Despite extensive research on LUTS and uroflowmetry, there remains a significant research gap in correlating subjective symptom severity with objective uroflowmetric findings. While studies have compared LUTS patterns across different demographic and epidemiological groups, few have examined the individualized relationship between specific LUTS and uroflowmetric parameters, particularly within the South Asian population. The present study aims to analyze the association between individual LUTS and uroflowmetric findings to provide a more precise understanding of voiding dysfunction and its diagnostic implications.

II. METHOD

This study was conducted as a cross-sectional descriptive analysis using data obtained from the Urology Laboratory of the Faculty of Medicine, University of Peradeniya. A total of 208 patients, aged 18 to 94 years, who presented with LUTS for the first time, were included. Patients with a history of urinary tract or pelvic surgery, those with a voided urine volume less than 100 mL, and those currently receiving medical treatment for benign prostatic hyperplasia (BPH) were excluded from the study.

LUTS were assessed subjectively using IPSS, a validated, interviewer administered questionnaire. The IPSS includes seven parameters: incomplete bladder emptying, weak stream, intermittency, straining, daytime frequency, urgency, and nocturia. Each parameter was rated on a six-point Likert scale ranging from 0 to 5 (0 = never; 1 = less than one in five times; 2 = less than half the time; 3 = about half the time; 4 = more than half the time; and 5 = almost always). The total IPSS score was calculated by summing the individual symptom scores, and patients were categorized according to symptom severity: mild (0–7), moderate (8–19), and severe (20–35).

Following completion of the IPSS questionnaire, all participants underwent uroflowmetry to obtain objective measurements of urinary flow parameters, including Q_{max}, Q_{ave}, and TV. Subsequently, PVRV was measured using pelvic ultrasonography.

The uroflowmetric parameters (Q_{max}, Q_{ave}, TV, and PVRV) were compared between participants across the severity levels and each IPSS symptom to evaluate the relationship between subjective symptom severity and objective voiding performance. Data were analyzed using IBM SPSS Statistics software (version 2021).

III. RESULTS

A total of 208 patients were included in this study, with a mean age of 61.52 ± 13.67 years. The majority of participants (79.3%) were over the age of 50 years. Descriptive studies of the whole population was performed despite the severity level of IPSS.

Table 1 : Means and Standard Deviations of Uroflowmetric Parameters of the Study Population

	Mean (ml)	**Std. deviation (ml)**
Q_{max}	14.05	8.32
Q_{ave}	6.66	3.87
TV	389.17	234.08
PVRV	58.05	60.45

Based on the IPSS, most patients presented with moderate symptom severity, followed by those with severe and mild categories.

Table 2 : Frequencies of IPSS categories

	Frequency	**%**
Mild	29	14
Moderate	103	50
Severe	76	36

Analysis of uroflowmetric parameters (Q_{max}, Q_{ave}, TV, PVRV) across the mild, moderate, and severe IPSS groups demonstrated a progressive decline in Q_{max}, Q_{ave} and TV, accompanied by a gradual increase in PVRV as symptom severity increased.

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Table 3 : Means of Uroflowmetric Parameters Between Severity Categories of IPSS

Severity	Q_{max}	Q_{ave}	TV	PVRV
Mild	17.10 ± 5.78	9.24 ± 3.04	486.82 ± 224.42	39.32 ± 54.46
Moderate	15.60 ± 9.79	7.28 ± 4.26	425.19 ± 234.92	45.54 ± 49.33
Severe	10.80 ± 5.53	4.84 ± 2.60	303.07 ± 210.70	82.16 ± 68.77

Table 4: Significant values after comparison of means between severity groups

Severity	Q_{max}	Q_{ave}	TV	PVRV
Mild vs Moderate	0.554	0.020	0.395	0.845
Mild vs Severe	0.000	0.000	0.001	0.004
Moderate vs Severe	0.000	0.000	0.001	0.000

Statistical comparison revealed significant differences in all four parameters (Q_{max}, Q_{ave}, TV, PVRV) between the mild vs. severe and moderate vs. severe groups. Between the mild vs. moderate groups, only Q_{ave} showed a significant difference. A Spearman's rank-order correlation was conducted to assess the relationship between total IPSS score and each uroflowmetric parameter (Q_{max}, Q_{ave}, TV, PVRV).

Table 5 : Correlation between IPSS total score vs Q_{max}, Q_{ave}, TV, and PVRV.

	Correlation coefficient	Sig.
IPSS vs Q_{max}	- 0.365	0.001
IPSS vs Q_{ave}	- 0.453	0.001
IPSS vs TV	- 0.335	0.001
IPSS vs PVRV	0.401	0.001

Frequencies of each symptom of IPSS were further analyzed using descriptive studies.

Table 6 : Frequencies of each IPSS symptom

Symptom	Percentage (%)
Incomplete evacuation	72.1
Poor stream	90.4
Intermittency	77.4
Straining	55.8
Urgency	92.8
Frequency	87.0
Nocturia	87.5

Furthermore, the means of Q_{max}, Q_{ave}, TV, PVRV between patients with and without each individual IPSS symptom were compared using the Mann–Whitney U test, as the data followed a non-parametric distribution pattern.

Table 7: Comparison of means (Q_{max}, Q_{ave}, TV, PVRV) between patients with and without each LUT symptom

Symptom		%	Q_{max}	Q_{ave}	PVRV	TV
Incomplete evacuation	No	27.9	16.04 ± 9.21	7.76 ± 4.15	22.23 ± 37.69	419.37 + 243.78
	Yes	72.1	13.29 ± 7.85	6.25 ± 3.69	71.91 ± 61.98	377.48 + 229.99
	Sig		0.011	0.004	0.001	0.259
Poor stream	No	9.6	19.08 ± 10.55	10.05 ± 5.39	55.80 ± 71.00	421.12 + 256.68
	Yes	90.4	13.52 ± 7.90	6.31 ± 3.50	58.30 ± 59.44	385.77 + 232.03
	Sig		0.009	0.001	0.331	0.446
Intermittency	No	22.6	18.54 ± 11.45	9.40 ± 5.16	40.16 ± 47.89	461.25 + 229.82
	Yes	77.4	12.75 ± 6.66	5.87 ± 2.98	63.29 ± 62.83	368.12 + 231.81
	Sig		0.001	0.001	0.012	0.007
Straining	No	44.2	15.32 ± 8.28	7.55 ± 4.00	53.02 ± 57.16	426.78 + 218.29
	Yes	55.8	13.06 ± 8.25	5.96 ± 3.63	62.05 ± 62.90	359.33 + 242.69
	Sig		0.023	0.001	0.169	0.010
Urgency	No	7.2	14.91 ± 8.22	7.59 ± 4.50	37.82 ± 44.08	430.00 + 215.94
	Yes	92.8	13.99 ± 8.35	6.60 ± 3.82	59.63 ± 61.35	385.99 + 235.66
	Sig		0.658	0.501	0.139	0.335
Frequency	No	13.0	17.54 ± 8.22	8.84 ± 3.50	35.77 ± 40.38	462.96 + 284.88
	Yes	87.0	13.54 ± 8.24	6.34 ± 3.83	61.38 ± 62.31	378.16 + 224.40

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	Sig		0.006	0.001	0.022	0.137
Nocturia	No	12.5	15.61 ± 5.87	7.80 ± 3.73	52.86 ± 61.85	450.11 + 219.32
	Yes	87.5	13.84 ± 8.61	6.51 ± 3.87	58.80 ± 60.39	380.46 + 235.40
	Sig		0.042	0.063	0.612	0.093

A linear regression analysis was performed to further explore the association between LUTS and the uroflowmetric parameters (Q_{max}, Q_{ave}, TV, PVRV).

Table 8 : Correlation of Q_{max}, Q_{ave}, TV, PVRV with each symptom of IPSS

Symptom	**Q_{max}**		**Q_{ave}**		**TV**		**PVRV**	
	UC	***Sig.***	***UC***	***Sig.***	***UC***	***Sig.***	***UC***	***Sig.***
Incomplete evacuation	- 0.626	0.092	- 0.311	0.001	1.726	0.001	21.326	0.001
Poor stream	- 0.668	0.096	- 0.276	0.060	-4.227	0.873	-6.118	0.014
Intermittency	-1.100	0.005	- 0.675	0.122	-11.114	0.715	3.758	0.114
Straining	0.123	0.735	- 0.015	0.001	-7.513	0.320	-2.243	0.319
Urgency	0.734	0.064	0.241	0.925	-7.687	0.479	2.076	0.393
Frequency	- 0.002	0.996	0.002	0.170	-11.548	0.502	0.797	0.793
Nocturia	- 0.971	0.018	- 0.448	0.993	-33.684	0.420	0.804	0.748

UC : Unstandardized Coefficients

IV. DISCUSSION

The IPSS questionnaire is a widely used tool for the subjective assessment of LUTS, where the total score reflects the overall severity of symptoms in an individual. In the present cohort, the majority (49.5%) of patients presented with moderate severity of LUTS. This may be explained by the fact that patients with mild disease often do not seek medical attention, as their daily activities are less affected, leading to underrepresentation in clinical data.

Normal micturition involves both passive and active mechanisms. Bladder outlet relaxation (passive) and detrusor muscle contraction (active) resulting in a bell-shaped uroflowmetric curve in healthy individuals. Deviations from this pattern indicate pathology: a flat or plateau-like curve may suggest decreased detrusor contractility or increased urethral resistance due to obstruction, while an asymmetric or multi-peaked curve can reflect fluctuating detrusor power, abdominal straining, or intermittent sphincter activity where these patterns were observed in the patients of our study [2]. According to a study done with healthy males, demonstrated mean values of Q_{max} : 25.28 ± 8.70 ml/s, Q_{ave} : 14.77 ± 4.79 ml/s, and TV : 405.48 ± 163.86 ml [3]. In contrast, our study population demonstrated mean values of Q_{max}: 14.05 ± 8.32 ml/s, Q_{ave}: 6.66 ± 3.87 ml/s, TV: 389.17 ± 234.08 ml, PVRV: 58.05 ± 60.45 ml which are compatible with previous research [4]. These values suggestive of obstructive conditions such as benign prostatic hyperplasia or detrusor muscle underactivity result in decreased flow rates and increased residual volumes.

Further analysis of uroflowmetric parameters (Q_{max}, Q_{ave}, TV, PVRV) across the mild, moderate, and severe IPSS groups demonstrated a gradual decline in Q_{max}, Q_{ave}, and TV, alongside a progressive increase in PVRV. Correlation analysis confirmed these findings, showing significant negative correlations between total IPSS and Q_{max} (-0.365), Q_{ave} (-0.453), and TV (-0.335), while PVRV showed a significant positive correlation (+0.401). These results highlight that uroflowmetry can provide an objective assessment of LUTS severity. Pairwise comparisons further revealed significant differences in all four uroflowmetric parameters between mild vs. severe and moderate vs. severe groups, while only Q_{ave} differed significantly between mild and moderate groups. These findings are consistent with existing literature [5].

Although the total IPSS score offers a collective measure of LUTS severity, individual symptoms vary widely among patients, warranting symptom-specific analysis. In this study of 208 patients, urgency was the most common symptom (92.8%), followed by poor stream (90.4%). The least frequent symptoms were straining (55.8%) and intermittency (77.4%). These frequencies align with previous studies conducted in Sri Lanka [6]. Further research, particularly with ultrasonographic assessment of bladder outlet obstruction, is needed to understand why storage symptoms predominate over voiding symptoms in this population.

When comparing uroflowmetric parameters in patients with and without specific symptoms, significant reductions in Q_{max} and Q_{ave} were observed in those with incomplete evacuation, poor stream, intermittency, straining, and increased daytime frequency. Conversely, PVRV was significantly higher in patients with incomplete evacuation, intermittency, and increased daytime frequency. These results suggest that uroflowmetry provides more reliable objective assessment of voiding symptoms than storage symptoms, which may be particularly valuable in resource-limited settings where prioritizing patients for follow-up is necessary.

However, linear regression analysis of symptoms versus uroflowmetric parameters did not completely align with the findings from mean comparisons. Only incomplete evacuation showed a significant negative association with Q_{ave} and a significant positive association with both TV and

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PVRV. Poor stream also contributed to higher residual urine volumes. The discrepancy arises because linear regression accounts for the combined effect of multiple symptoms simultaneously, whereas mean comparisons evaluate each symptom independently.

Incomplete evacuation of urine has a particularly strong impact on uroflowmetry. A high post-void residual volume reduces bladder contractility and impairs flow, leading to lower Q_{max} and Q_{ave}, prolonged voiding time, reduced voided volume, and abnormal flow patterns (e.g., interrupted or plateau-type curves instead of the typical bell shape). These changes reflect underlying detrusor underactivity or bladder outlet obstruction, both of which prevent effective bladder emptying. Furthermore, incomplete evacuation often manifests as daytime frequency, as residual urine lowers the bladder's functional capacity. Even small amounts of new urine can trigger the urge to void, causing patients to urinate more frequently, albeit in small volumes. This may explain the significant decrease in Q_{max} and Q_{ave} observed in patients with daytime frequency compared to those without the symptom, while other storage symptoms did not show any significant differences. Therefore, particular attention should be paid to daytime frequency when interpreting IPSS responses, as it appears to have a stronger association with incomplete evacuation of bladder.

V. CONCLUSION

This study demonstrates a clear association between the IPSS assessed LUTS severity and objective assessment of uroflowmetric parameters. As symptom severity increased, Q_{max}, Q_{ave}, and TV declined, while PVRV rose significantly. Among individual symptoms, incomplete evacuation and increased daytime frequency showed the strongest correlations with poor uroflowmetric outcomes, indicating impaired bladder emptying. These findings highlight the value of uroflowmetry as an objective complement to the IPSS, particularly for assessing voiding symptoms and prioritizing patients for further evaluation in resource-limited settings.

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