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Urodynamic Study of Diabetic Patients with Lower Urinary Tract Symptoms

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Abstract
Background*: - Lower urinary tract dysfunctions secondary to type 2 diabetes are common, chronic and costly disorders. They impose an important threat to the lower urinary tract morbidity and economic burdens for our future generations.*
Material and methods*:- This was a hospital based cross sectional study conducted in the Department of Urology, Regional Institute of Medical Sciences, a tertiary care center in Imphal, Manipur,during the period November 2015 to October 2017 after taking ethical committee approval. Forty Diabetic patients who were presenting with lower urinary tract symptoms were enrolled in our study and underwent Urodynamic assessment.*
Results*:- The urodynamic abnormalities found in our study were impaired first sensation in 25%, increased maximum cystometric capacity in 20%, poor compliance in 37.5%, impaired detrusor contraction in 29.41%, detrusor overactivity in 42.5%, detrusor areflexia in 7.5%, bladder outlet obstruction in 35.29%, high PVR in 40% and detrusor overactivity incontinence in 5% of cases. Diabetic cystopathy was seen in 20% of cases. Normal urodynamic study was seen in 6 (15%) cases.*
Conclusion*:- It is important to consider urodynamic evaluation in patients with diabetes mellitus with persistent voiding complaints for proper management.*
Keywords*:- Compliance, Diabetic Cystopathy, Detrusor Overactivity ,Urodynamics.*

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I. Introduction

The proportions of people with type 2 diabetes and obesity have increased throughout Asia, and the rates of increase show no signs of slowing. The International Diabetes Federation estimates that in 2003, 194 million people had diabetes and that by 2025, 333 million people will have this disease.[1] During recent decades, rapid economic development and urbanization have increased the prevalence of type 2 diabetes in Asia. Lower urinary tract dysfunctions secondary to type 2 diabetes are common, chronic and costly disorders. They impose an important threat to the lower urinary tract morbidity and economic burdens for our future generations.[2]

Diabetes mellitus (DM) has been shown to alter vesicourethral function in a number of ways, from decreased detrusor contractility to bladder overactivity present in up to 61% of diabetic patients.[3] The etiology of detrusor activity (DO) in diabetic patients is not fully understood and is most likely multifactorial. Both central and peripheral mechanisms have been implicated; namely, diabetic cerebral vasculopathy and peripheral nerve stimulation as well as changes in the detrusor muscle and urothelium. [4,5,6]

Diabetic bladder dysfunction is among the most common and bothersome complications of diabetes mellitus. Studies suggest that 40% to 60% of diabetics will have some form of voiding dysfunction.[3] The main focus of diabetes associated lower urinary tract dysfunctions has been referred to as diabetic cystopathy for many years. Prevalence estimates of urodynamically diagnosed bladder cystopathy have ranged from 25% to 90%. The prevalence of unrecognized diabetic bladder dysfunction among diabetic women in clinical settings has reached to 22%.[7] The prevalence of diabetic bladder dysfunction is not related to the sex and age of the patients, but is found to increase with the duration of diabetes mellitus.[9] Although the prevalence of diabetic bladder dysfunction increased with the duration of diabetes, diabetic bladder dysfunction can also occur silently and early in the course of diabetes.[10] One reasonable explanation for the early presentation of diabetic bladder dysfunction is that diabetic patients are hyperglycemic for up to 6 years before being diagnosed.

Diabetic Cystopathy (DCP) may be defined as a disturbance in the function of the urinary bladder in diabetic patients characterized by loss of sensation and increased bladder capacity without signs of mechanical

outlet obstruction.[8] There is increased post voiding residual volumes and enhanced bladder capacity that is accompanied by decreased bladder sensation and contraction secondary to damage of visceral afferent fibers in the bladder wall.[9] This insidious process causes gradual changes in patient's voiding patterns, with a reduced desire to void, which usually occurs at a stored urine volume of 300–400 ml in healthy subjects.[9,10] These patients commonly experience difficulty in initiating and maintaining micturition. Therefore, voiding reflexes appear sluggish and an asymptomatic increase in bladder capacity and urinary retention occurs. On the other hand, diabetic bladder dysfunction can also present as an overactive bladder syndrome usually described as urgency, with or without incontinence, usually with urinary frequency and nocturia. Indeed bladder hypersensitivity and hypercontractility is much more common than bladder hypo-contractility. More than half (55%) of diabetic patients have detrusor hyperreflexia, while another 23% have reduced detrusor contractility and a further 10% demonstrate detrusor areflexia with the remaining 11% showing indeterminate findings.[16] Daneshgari et al[11] presented the "temporal theory of diabetic bladder dysfunction" which proposes that hyperglycemia-induced polyuria plays a major pathophysiological role during the early stages of diabetes polyuria, causing compensatory bladder hypertrophy and associated myogenic and neurogenic alterations. This stage is compatible with findings of a hyperactive bladder during urodynamic evaluation when patients present with bladder storage concerns (urgency or urge incontinence). With time and accumulation of toxic metabolites, decompensation of bladder tissue and function ensues, resulting in the classical signs and symptoms of diabetic cystopathy (hypocontractile detrusor or atonic bladder) in patients with urinary voiding problems.[11]

DCP begins with selective damage to autonomic afferent nerves, leaving motor function intact but impairing the sensation of bladder fullness. Chronic hyperglycemia is associated with loss of myelinated and unmyelinated fibers, wallerian degeneration, and blunted nerve fiber reproduction.[6,15] It has been reported that early changes in bladder function may be due to functional adaptation to bladder over distension and/or an increase in bladder work induced by diuresis caused by hyperglycemia. It has been suggested that nerve growth factor NGF has a role in DCP through its effect on the afferent dorsal root ganglion.[6,13,15]

The patients usually have a varied symptomatic presentation which may be due to the fact that most of these patients may have concomitant lesions such as benign prostatic hyperplasia. Benign prostatic hyperplasia may mimic the symptoms of diabetic cystopathy. In diabetic cystopathy, impaired detrusor function results in a lower maximum flow rate and an increase in post void residual urine.[15,16] Benign Prostatic Hyperplasia (BPH) can also cause lower urinary tract symptoms, including reduced maximum flow rate and increased post void residual urine.[17]However, the underlying pathology is different since BPH does not primarily impair detrusor function but rather enhances bladder outlet resistance via static and dynamic components. Since diabetes and BPH increase in prevalence with age, it has to be expected that a major fraction of patients with BPH concomitantly suffer from diabetes and vice versa.

In developing countries like India where resources are limited, urodynamics is not widely available and hence not much work has been done to study the pattern of voiding dysfunction in diabetics.

It poses a therapeutic challenge to the urologist treating, in deciding the line of management for these patients. It would be a difficult proposition unless and until the pattern of voiding dysfunction is clearly made out for which urodynamics remains the only answer.We conducted this study to characterize the urodynamic profile of diabetic patients who presented to us with lower urinary tract symptoms.Thus the aim of our study is to determine the urodynamic parameters in diabetic patients presenting with lower urinary tract symptoms.

II. Materials And Method

Forty Diabetic patients were enrolled in our hospital based cross-sectional study conducted in the Department of Urology, RIMS from November 2015 to October 2017 who were presenting with lower urinary tract symptoms. Patients who were with urethral stricture disease, urinary tract infection, non-ambulatory patients, with history of stroke and unwilling patients were excluded. All the patients were assessed for the First sensation of filling, Maximum cystometric capacity, Compliance, Impaired detrusor contractility, Detrusor overactivity, Detrusor areflexia, Uroflowmetry Electromyography (Sphincter dyssynergia), Bladder outlet obstruction, Postvoid residual urine. On history, the lower urinary tract symptoms, their duration and IPSS score was recorded. Patients symptoms were classified as mild (0-7), moderate (8-19), or severe (20-35) according to IPSS questionnaire. Patients were also asked about the tingling, numbness, loss of sensation (i.e. touch, pain), and limb weakness. Digital rectal examination was done in all these patients to assess the prostate size, anal tone, perianal sensation and Bulbocavernous Reflex (BCR). Patient right leg and foot were tested for sensation (touch, pain), vibrations, joint position, muscle power, and ankle reflex (DNE scoring system).

Diabetic Neuropathy Examination

Muscle strength 1. Quadriceps femoris: extension of the knee 2. Tibialis anterior: dorsiflexion of the foot	**Reflex** 3. Triceps surae
Sensation: index finger 4. Sensitivity to pinpricks	**Sensation: big toe** 5. Sensitivity to pinpricks 6. Sensitivity to touch 7. Vibration perception 8. Sensitivity to joint position

Only the right leg and foot were tested. Scoring from 0 to 2 (Maximum score- 16 points)

0 = Normal

1 = Mild/moderate deficit

• Muscle strength: Medical Research Council scale 3–4

• Reflex: decreased but present

• Sensation: decreased but present

2 = Severely disturbed/absent

• Muscle strength: Medical Research Council scale 0–2

• Reflex: absent

• Sensation: absent

All patients underwent routine investigations like Hb, TLC, DLC, FBS, Post prandial blood sugar, Urine-R/M, Urine-C/S, Blood Urea, Serum Creatinine and Serum Electrolytes. Ultrasound of abdomen was done to assess the status of the upper tracts, any other lesions in bladder (growth, diverticula or calculi), prostate architecture, size and configuration (median lobe). Urine culture was done to rule out pyuria and UTI. In the presence of UTI, the patients were subjected to a course of antibiotic therapy and urine examination was repeated before performing the urodynamic evaluation. To avoid repetition of the subjects, an ID no. was issued to every subject who was enrolled in the study.All data was recorded in a proforma specially designed for the study. Proctoclysis enema was given on the morning of the UDS. Prophylactic antibiotic (Tab. Levofloxacin 500 mg) was given 1 hour prior to the procedure. All patients were instructed to void just before the study. The patients were instructed in their vernacular language about the urodynamic procedure. The patient was catheterized with a special 8 Fr double lumen catheter, one channel for filling the bladder with normal saline and other for measuring intravesical pressure. All residual urine was evacuated from the bladder by a syringe. Rectal transducer was placed in rectum and connected to pressure transducer for rectal pressure measurement. One channel of per urethral catheter was connected with pump and other to bladder pressure measuring transducer. The electromyography was recorded by using needle electrode inserted percutaneously in the perineal area near the anal verge.

Urodynamics machine was started and calibrated to zero. All the connections were checked. Before and during filling, the individual was asked to cough for checking the correct position of the catheters as we noticed a rise in the abdominal pressure. Than, filling of the bladder was started with isotonic saline at medium filling rate in sitting position. The patient was asked to tell when he/she feels little urge for micturition, normal voiding sensation, strong desire and any painful urge for voiding, all points were marked accordingly. In between, the patients were instructed to cough to look for any urine leak. At the end of the filling phase we recorded the bladder capacity, compliance, and the presence of any uninhibited detrusor contraction.

In the voiding phase, we asked the patient to attempt voiding in sitting position. The results and graphs were electronically visualized on the monitor and printed. After that, all the connections were disconnected. Residual urine was aspirated by the syringe and postvoid residual urine was measured. Double lumen catheter and rectal tube was removed. The duration of antibiotic prophylaxis was extended for another 2 days in the post procedure period.

Once the recordings were obtained, depending upon Bladder Outlet Obstructive Index (BOOI) or Abrams Griffiths No.(AG no.) and Bladder Contractility Index (BCI) the patients were grouped as follows:

BOOI =Pdet Qmax - 2Qmax

BCI =Pdet Qmax + 5Qmax

Patients with BOOI > 40 were classified as patients with bladder outlet obstruction. Patients who had BOOI of >20 and <40 were considered to be Intermediate or Equivocal. BOOI of <20 were considered as unobstructed. Patients who had poorly sustained or weak detrusor contraction (BCI less than 100) were considered to have detrusor underactivity.

Pdet compliance, which equaled the MCC divided by the end filling detrusor pressure was considered low at <20 ml/cm H_2O.Diabetic cystopathy was defined if First sensation >250 ml, Maximum cystometric capacity >600 ml ,Post void residual urine >100 ml and DCI <100

Data collected was analyzed using SPSS Version 21 for Windows (IBM Corp. Chicago, IL, USA). Descriptive statistics like mean, standard deviation and percentages were used. Chi-square test was used to test the significance between the proportions. Independent t test was used to test the significance between two

means. A p-value of <0.05 was taken as significant. The study was taken up after getting clearance from the Research Ethics Board, Regional Institute of Medical Sciences, Imphal.

III. Results And Observations

A total of 40 diabetic patients who presented to us with lower urinary tract symptoms were included in our cross sectional hospital based study conducted at the Department of Urology, Regional Institute of Medical Sciences, Imphal from 1st November 2015 to 30th October 2017. Our results and observations from the study are as below:

Table 1: Age and sex distribution of the patients (n=40)

Age distribution of the patients (years)	No. of patients	Percentage
35-50	5	12.5%
51-65	27	67.5%
>65	8	20%
Total	40	100%

	Male (n=34)	Female (n=6)
Mean age of patients ± SD (years)	56.74 ± 7.63	64.83 ± 4.62

Table 1 shows the age distribution of the patients our study. The majority of patients (67.5%) were in the age group of 51-65 years. The mean age of the male patients were 56.74 ± 7.63 years and female patients were 64.83 ± 4.62 years. In our study male patient constituted 85% of the study population and female 15%.

Table 2: Duration of diabetes mellitus

Duration of diabetes mellitus (years)	No. of patients (percentage)
<10	18 (45%)
>10	22 (55%)
Total	40 (100%)

	Male (n=34)	Female (n=6)
Mean duration of diabetes ± SD (years)	11.06 ± 4.92	13.67 ± 6.74

Table 2 shows the duration of diabetes mellitus in the present study. 55% of the patients had duration of diabetes mellitus >10 years. Mean duration of diabetes mellitus in male patients was 11.06 ± 4.92 years and in female patients was 13.67 ± 6.74 years

Table 3: (A) Focused neurological examination of patients

Focused neurological examination	No. of patients (n=40)
Decreased anal tone	3
Decreased perianal sensation	7
Absent BCR	2

Table 3 A shows focused neurological finding in our study. Decreased anal tone, decreased perianal sensation and absent BCR was seen in 3 patients, 7 patients and 2 patients respectively.

(B) Diabetic neuropathy examination (DNE) score:

	Duration of DM		P value
	<10 yrs (n=18)	>10 yrs (n=22)	
Mean DNE SCORE ± SD	0.333 ± 0.84	1.136 ± 1.81	0.002

Table 4B shows correlation between duration of diabetes mellitus and DNE score. Normal diabetic neuropathy examination was seen in 26 male (n=34) and 3 females (n=6). The remaining 8 males and 3 females had mild neurological deficit. Mean DNE score was 0.333 ± 0.84 in patients having <10 years duration of diabetes and 1.136 ± 1.81 in patients having >10 years of diabetes. Thus, DNE score was more in patients with duration of diabetes mellitus >10 years. The relation of duration of diabetes mellitus and DNE score was found to be statistically significant (p value-0.002). This signifies a higher rate of neurological deficit with increase in duration of diabetes mellitus.

Table 4: Fasting blood sugar (FBS) and Postprandial blood sugar (PPS) level

	Male (n=34)	Female (n=6)
Mean FBS ± SD (mg/dl)	125.08 ± 25.93	117.33 ± 14.05
Mean PP ± SD (mg/dl)	205.23 ± 41.14	190.16 ± 33.65

Table 4 shows the blood sugar levels in the present study. Mean fasting and postprandial blood sugar level in males were 125.08 ± 25.93 mg/dl and 205.23 ±41.14 mg/dl respectively. Mean fasting and postprandial blood sugar level in females were 117.33 ± 14.05 mg/dl and 190.16 ± 33.65 mg/dl respectively.

Table 5: Lower urinary tract symptoms (LUTS)

LUTS	Male (n=34) no. of patients (%)	Female (n=6) no. of patients (%)
Mild (<7)	3 (8.8%)	1 (16.7%)
Moderate (8-19)	18 (52.9%)	4 (66.7%)
Severe (>20)	13 (38.2%)	1 (16.7%)

	Male (n=34)	Female (n=6)	Total
Mean IPSS ± SD	18.18 ± 7.23	15.00 ± 5.86	17.70 ± 7.07

	Patient with DO (n=14)	Patient without DO (n=26)	P value
Mean IPSS ± SD	18.41 ± 3.80	17.17 ± 8.79	0.591

Table 5 shows the distribution of lower urinary tract symptoms among the patients in the present study. Most of the males had moderate (52.9%) lower urinary tract symptoms. 38.2% males were present in severe LUTS group. Only three (8.8%) males had mild LUTS. Four (66.7%) females had moderate LUTS. One female had severe LUTS and one female patient presented with mild LUTS. Mean IPSS in our study was 17.70 ± 7.07. Mean IPSS in males were 18.18 ± 7.23 and in females was 15.00 ± 5.86. Mean IPSS in DO patients was 18.41 ± 3.80 and in patients who had no DO, IPSS was 17.77 ± 8.79. This difference in mean IPSS was insignificant (P value 0.591).

Table 6: Urodynamic profile of the patients

Parameter	Male	Female
First sensation of filling (ml)	216.47 ±96.49	214.17 ± 109.28
MCC (ml)	448.88 ± 177.80	487.17 ± 226.39
Pdet compliance (ml/cm of H_2O)	36.08 ± 30.39	55.77 ± 41.89
Qmax (ml/s)	12.11 ± 5.97	15.97 ± 9.01
Pdet Qmax (cm/H_2O)	47.88 ± 19.80	36.17 ± 20.16
DCI	108.46 ± 42.68	NA
Voided volume (ml)	273.17 ± 124.99	272.83 ± 142.04
PVR (ml)	175.71 ± 255.08	214.33 ± 352.16

Table 7: Distribution of abnormal Urodynamic parameters

S.No.	Parameter	Male (n=34)	Female (n=6)	Overall no. of patients (n=40)
1.	Impaired first sensation (>250 ml)	8(23.52%)	2(33.33%)	10(25%)
2.	Increased MCC (>600 ml)	6(17.64%)	2(33.33%)	8(20%)
3.	Pdet compliance (<20 ml/cm of H_2O)	14(41.17%)	1(16.67%)	15(37.5%)
4.	Detrusor underactivity (DCI <100)	10(29.41%)	NA	-
5.	BOO (AG no. >40)	12(35.29%)	NA	-
6.	Detrusor overactivity	14(41.17%)	3(50.00%)	17(42.5%)
7.	Detrusor overactivity incontinence	2(5.88%)	0 (0%)	2 (5%)
8.	Urodynamic stress incontinence	4(11.76%)	1(16.67%)	5(12.5%)
9.	Detrusor areflexia	2(5.88%)	1(16.66%)	3(7.5%)
10.	PVR (>100 ml)	14(41.17%)	2(33.33%)	16(40%)

Table 8: Correlation of delayed first sensation with duration of diabetes mellitus

Parameter		Males (n=34)			Females (n=6)		
		First sensation			First sensation		
		<250 ml	>250 ml	P value	<250 ml	>250 ml	P value
Duration of DM	<10 yr	15	2	0.106	1	0	0.439
	>10 yr	11	6		3	2	

Table 8 shows correlation between delayed first sensation and duration of diabetes mellitus. In males, 2 patients had first sensation of filling at >250 ml had duration of diabetes mellitus <10 years and 6 patients had duration of diabetes mellitus >10 years (P value- 0.106). In females, 2 patients had first sensation of filling at

>250 ml with duration of diabetes mellitus >10 years and no female patient with duration of diabetes mellitus <10 years had delayed first sensation (P value- 0.439). In both males and females, P value is >0.05 which shows that there is no correlation between duration of diabetes and first sensation of filling in our study.

Table 9: Correlation of maximum cystometric capacity with duration of diabetes mellitus

Parameter		Males (n=34)			Females (n=6)		
		MCC			MCC		
		<600ml	>600 ml	P value	<600 ml	>600 ml	P value
Duration of DM	<10 yrs	16	1	0.072	1	0	0.667
	>10 yrs	12	5		3	2	

Table 9 shows correlation between maximum cystometric capacity and duration of diabetes mellitus. In males, maximum cystometric capacity >600 ml was recorded in 1 patient with duration of diabetes mellitus <10 years and 5 patients with duration of diabetes mellitus >10 years (P value- 0.072). In females, two patient had maximum cystometric capacity >600 ml with duration of diabetes mellitus >10 years and none of the female patients with duration of diabetes mellitus <10 years had maximum cystometric capacity >600 ml (P value- 0.667). In both males and females, p value is >0.05 which indicates that there is no correlation between duration of diabetes and maximum cystometric capacity in our study.

Table 10: Correlation of Pdet compliance with duration of diabetes mellitus

Parameter		Males (n=34)			Females (n=6)		
		Pdet Compliance (ml/cm H_2O)		P value	Pdet Compliance (ml/cm H_2O)		P value
		<20	>20		<20	>20	
Duration of DM	<10 yr	7	10	1.000	0	1	0.624
	>10 yr	7	10		1	4	

Table 10 shows correlation between Pdet compliance and duration of diabetes mellitus. In males, Pdet compliance <20 was recorded in 7 patient with duration of diabetes mellitus <10 years and 7 patients with duration of diabetes mellitus >10 years (P value- 0.100). In females, 4 patients had Pdet compliance >20 with duration of diabetes mellitus >10 years and 1 of the female patients with duration of diabetes mellitus <10 years had Pdet compliance >20 (P value- 0.667). In both males and females, p value is >0.05 which indicates that there is no correlation between duration of diabetes and Pdet compliance in our study.

Table 11: Correlation of postvoid residual urine with duration of diabetes mellitus

Parameter		Males (n=34)			Females (n=6)		
		PVR			PVR		
		<100 ml	>100 ml	P value	<100 ml	>100 ml	P value
Duration of DM	<10 yr	13	4	0.037	1	0	0.667
	>10 yr	7	10		3	2	

Table 11 shows correlation between postvoid residual urine and duration of diabetes mellitus. In males, 10 patients had postvoid residual urine >100 ml with duration of diabetes mellitus >10 years and 4 patients in this group had duration of diabetes mellitus <10 years (P value- 0.037). In females, 2 patients with duration of diabetes mellitus >10 years had postvoid residual urine >100 ml and no female patient in <10 years group had postvoid residual urine >100 ml (P value- 0.667). P value in males is <0.05 which shows that patients with longer duration of diabetes have more chances of high post void residual urine.

Table 12: Correlation of detrusor contractility index with duration of diabetes mellitus in male

Parameter		DCI		P value
		<100	>100	
Duration of DM	<10 yr	2	15	0.024
	>10 yr	8	9	

Table 12 shows correlation between detrusor contractility index and duration of diabetes mellitus. DCI <100 was recorded in 2 patients with <10 years duration of diabetes mellitus and 7 patients in >10 years duration of diabetes mellitus group (p value- 0.024). P value is >0.05 which indicates there is direct correlation between duration of diabetes and impaired detrusor contractility.

Table 13: Correlation of duration of DM with maximum flow rate (Qmax)

	Duration of Diabetes mellitus		
	<10 yrs (n=18)	**>10 yrs (n=22)**	**P Value**
Mean Qmax±SD	15.01±4.74	10.79±7.24	0.040

Table 13 shows correlation between duration of diabetes mellitus and Qmax. Patient with duration of diabetes <10 years has mean Qmax of 15.01 and in >10 years of diabetes mean Qmax is 10.79 (p value- 0.040). P value is <0.05 which shows patients who had long duration of diabetes they had poor urinary flow.

Table 14: Correlation detrusor contractility index (DCI) & maximum cystometric capacity (MCC) in male

	DCI		
	<100 (n=10)	**>100 (n=24)**	**P Value**
Mean MCC±SD	626.40±203.64	374.92±98.61	**0.000**

Table 14 shows correlation between DCI and MCC. Patient with DCI <100 has mean MCC of 626 and in >100 DCI mean MCC is 374 (p value- 0.000). P value is <0.05 which shows that patients who had DCI <100 has higher bladder capacity than DCI >100.

Table 15: Correlation of detrusor contractility index (DCI) and IPSS in male

	DCI		
	<100 (n=10)	**>100 (n=24)**	**P Value**
Mean IPSS±SD	25.80±4.71	15.00±5.53	**0.000**

Table 15 shows correlation between DCI and IPSS. Patient with DCI <100 has mean IPSS of 25.80 and in >100 DCI mean IPSS is 15 (p value- 0.000). P value is <0.05 which shows that patients who had DCI <100 are more symptomatic than DCI >100.

IV. Discussion

Frimodt Moller did an extensive work in voiding dysfunction in diabetics and coined the term Diabetic Cystopathy to describe the involvement of lower urinary tract by this disease.[8]

The prevalence of diabetic cystopathy in patients with DM ranges in studies between 25-95%.[8,9,21] Part of this variation may be accounted for by the fact that while most experts agree on the qualitative criteria for diabetic cystopathy (decreased bladder sensation, increased bladder capacity, and impaired detrusor contractility, and incomplete bladder emptying), the exact quantitative urodynamic parameters that confine this phenomenon are not consistent in the literature.[9,10,25] The pathophysiology of diabetic bladder dysfunction is thought to be multifactorial, related to myogenic, neuronal, urothelial and urethral alterations.[26] Although progression to cystopathy is thought to be related to the duration of diabetes, animal studies suggest that changes to bladder function begin to occur soon after the onset of diabetes. This is seen in animal models in which osmotic polyuria during early diabetes results in bladder remodeling and increased contractility resulting in early bladder hypertrophy and commonly symptoms of detrusor overactivity.[4,20] Over time, prolonged hyperglycemia results in oxidative stress, likely contributing to bladder decomposition and symptoms of diabetic cystopathy.

In our study, the mean age of the male patients was 56.74 ± 7.63 years and in female patients was 64.83 ± 4.62 years. In a study by Chung DE et al[19], mean age for males was 71.2±10.7years and mean age of female patients were 66.1±12.5 years. Ammar FA et al[22] studied 51 diabetic patients with a median age of 61.5 years ranging between (24- 82) years.Mean age distribution in our study matched with the other studies.

In our study (40 patients), males were 85% and females were 15% of the study population. Chung DE[19] studied 257 diabetic patients and included 84 (32.7%) females and 173 (67.3%) males. Ammar FA et al[22] studied fifty-one diabetic patients with majority were males (76.5%) while (23.5%) were females. Kebapci et al[10] did urodynamic study in diabetic patients and had equal number of male and female patient (M/F:27/27). In most of the study males are more common than females as in our study which suggests diabetic males present more commonly with symptoms of diabetic cystopathy.

In our study, 55% of the patients had >10 years duration of diabetes mellitus and 45% had <10 years of diabetes mellitus. Mean duration of diabetes mellitus in male patients was 11.06 ± 4.92 years and in female patients was 13.67 ± 6.74 years. In a study by Bansal R et al[20] mean duration of diabetes mellitus was 11.0 ± 7.5 years. Ragoori D et al[26] reported mean duration of diabetes mellitus as 11 years in their study.

In our study, mean first sensation of filling was at 216.47 ± 96.49 ml in males and 214.17 ± 109.28 ml in female patients. Kaplan et al[9] reported mean first sensation of filling of 298 +/- 67.4 ml. Chung DE et al[19] reported mean first sensation of filling was 194 ± 139 ml in male and 166 ± 104 ml in females. Changxiao et al[21] reported the mean first sensation of filling as 238.1 ml. Our finding is comparable with the reported literature.

Impaired first sensation (>250 ml) of filling was seen in 25% of patients in our study. Bansal R et al[20] reported impaired first sensation in 23.1% of patients. Govindarajan R et al[24] reported delayed first sensation in 18% of patients. There was no correlation between duration of diabetes and impaired first sensation in both males (P value-0.106) and females (P value-0.439) in our study. Our finding is comparable with the literature.

In our study, mean maximum cystometric capacity was 448.88 ±177.80 ml in males and 487.17 ± 226.39 ml in females. Changxiao et al[21] reported mean maximum cystometric capacity of 624 ml.Chung DE et al[19] reported mean bladder capacity of 425 ± 242 ml in males and 378± 191 ml in females in their study.The results in our study are comparable to other studies with regard to MCC.

We observed an increased maximum cystometric capacity in 20% of the patients in our study. Patients those who are having high bladder capacity, they are having good bladder compliance. There was no correlation found between duration of diabetes and increased maximum cystometric capacity in both males (P value-0.072) and females patients (P value-0.667). Bansal R et al[20] recorded increased maximum cystometric capacity in 25.0% of patients. Govindarajan R et al[24] reported large bladder capacity in 26% of patients and they also had no correlation with duration of diabetes mellitus. Thus, our finding is comparable with other studies.

Low detrusor compliance was seen in 37.5% of cases in our study. Bansal R et al[20] recorded low detrusor compliance in 32.7% of patients.Our findings are comparable with their study.

There was increased postvoid residual urine seen in 40% of patients in our study. Govindarajan R et al[24] recorded significant residual urine in 42% of patients in their study. In our study, the P value was 0.037 which implies a significant correlation between duration of diabetes and increased PVR in males which is similar to that as reported by other studies in literature.

Decreased detrusor contractility index (<100 ml) was seen in 29.41% of male patients in our study. Chung DE et al[19] reported detrusor underactivity in 26% of patients. We have observed that patients those who have long duration of diabetes (>10 yrs) have high chances of decreased detrusor contractility index i.e. <100 as compared to short duration of diabetes (<10 yrs) (P value-0.024). Similar results were observed b Govindarajan R et al[24] also reported strong correlation between duration of diabetes and DCI (Pvalue-0.0231).

In patients who were having DCI <100, it was observed that MCC was high as compared to those with DCI >100. This difference in MCC was found statistically significant (P value-0.000). Govindarajan R et al[24] reported high bladder capacity with long duration of diabetes but it was statistically insignificant. The difference in findings may be because of the long duration of diabetes, 2 detrusor areflexia patients and patients with high PVR in near retention in our study.

Patients in our study who had DCI <100 had high IPSS as compared to patients with DCI >100. This difference in IPSS was found statistically significant (p value 0.000). Govindarajan R et al[24] also reported similar result between patient complaints and bladder contractility index (Pvalue-0.0001).

In a study by Ueda et al[27], 25% of patients were reported to have detrusor hyperreflexia but more than half of them did not complain of any irritable urinary symptoms. We noted that mean IPSS in patients with and without detrusor overactivity were not significantly different (18.41 ± 3.80 v/s 17.17 ± 8.79, P value-0.591). Bansal R et al[20]also reported no significant difference in mean IPSS in patients with and without detrusor overactivity (P value-0.56).This can be explained by loss of sensation seen in diabetic cystopathy. Therefore, it was suggested that patients with voiding symptoms are not representative of the total population of diabetic patients with voiding dysfunction which is in line with previous findings as the 25 to 50 % of diabetic patients did not complain of voiding symptoms unless carefully questioned.

The urodynamic abnormalities in the present study were as follows: impaired first sensation in 25%, increased maximum cystometric capacity in 20%, low detrusor compliance in 37.5%, impaired detrusor contraction in 29.41%, detrusor overactivity in 42.5%, detrusor areflexia in 7.5%, bladder outlet obstruction in 35.29%, high PVR in 40% and detrusor overactivity incontinence in 5% of cases. Diabetic cystopathy was seen in 20% of cases. Normal urodynamic study was seen in 6 (15%) cases.

Kebapci et al[10] did urodynamic study in diabetic patients and bladder dysfunction was present in 74.07% of men (Diabetic cystopathy- 50%; BOO- 25%; detrusor overactivity- 25%) and in 59.26% of diabetic women (Diabetic cystopathy- 43.75%; detrusor overactivity- 31%; urge incontinence- 12.5%; stress urinary incontinence 12.5%).

Koubaa S et al[23] studied 40 patients with diabetes mellitus. 15 patients (31.25%) had decreased flow rates. 12 patients (37.5%) had diminished bladder sensation and/or impaired detrusor contractility. 10 patients (25%) had detrusor hyperreflexia and 6 patients had impaired detrusor contractility. Vescico-uretral dyssynergia was found in 2 patients (5%).

Kaplan et al[9] retrospectively analyzed urodynamic studies of 182 diabetic patients associated with voiding dysfunction. Of the 182 patients, 100 (55%) had detrusor hyperreflexia, 42 (23%) had impaired detrusor contractility, 20 (11%) had indeterminate findings, 19 (10%) had detrusor areflexia and 1 (1%) was normal. Bladder outlet obstruction occurred in 66 patients (36%).

Ammar FA et al[22] conducted urodynamic assessment in fifty-one diabetic patients. Of the 51 patients 23(45.3%) impaired detrusor contractility, 18 (35.2%) had detrusor hyperreflexia, 4 (7.8%) had detrusor areflexia, and 6 (11.7%) were normal.

The most common urodynamic finding in our study was detrusor overactivity that was seen in 42.5 % of cases followed by high PVR in 40%, low detrusor compliance in 37.5%, bladder outlet obstuction in 35.29% and detrusor overactivity incontinence in 5% of cases. Diabetic cystopathy was seen in 20% of cases. If we compare our urodynamic parameters with other studies, we have found the results to be similar and comparable.

So, patients with DM and LUTS can present with a myriad of urodynamic findings, apart from the typical DC, including DO with or without incontinence, BOO, and decreased compliance.

V. Conclusion

Diabetic patients with lower urinary tract symptoms may suffer from a spectrum of bladder dysfunction, which are seldom recognised clinically. In the our study, we observed that detrusor overactivity followed by high PVR, low detrusor compliance, bladder outlet obstruction and impaired detrusor contractions are the most common urodynamic findings in our study. Diabetic cystopathy is not the most common finding in our study. There is a strong correlation of DCI with IPSS, duration of diabetes and bladder capacity. The first sensation of bladder filling, MCC and Pdet compliance was more in patients with longer duration of diabetes but it was not statistically significant.

Since there is a plethora of urodynamic outcomes in diabetic patients irrespective of the lower urinary tract symptoms, urodynamics plays a valuable role in management of these symptomatic patients. The practice of urodynamics before treatment in these patients can avoid unnecessary medication, surgeries and treatment failures.

To conclude, it is important to consider urodynamic testing in patients with diabetes mellitus with persistent voiding complaints for proper management.

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