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Clinical and Urodynamic Evaluation of Filling Phase in Type 2 Diabetic Patients

Mohammad A. Abdul-Hussain[1] *MSc*, **Ibrahim A. Mahmood**[2] *PhD,* **Firas S. Alquraishi** *CABS*

[1]Unemployed, [2]Dept. of Physiology, College of Medicine, Al-Nahrain University, Baghdad, Iraq, [3]Dept. of Surgery, College of Medicine, Al-Nahrain University, Baghdad, Iraq

Abstract

Background Type 2 diabetes mellitus (T2DM) causes multiple complications in various body systems.

Objective To look into the effect of the duration of T2DM on the filling phase of the urination process.

Methods One hundred and twenty patients with T2DM and filling (storage) symptoms participated in this cross-sectional study. Each patient's full history was recorded. A full urodynamic test was done. According to T2DM duration, participants were categorized into two groups; short duration (1-10 years) and long duration (>10 years). The patients answered the questionnaire about their symptoms (nocturia, frequency, urge incontinence, and urgency). Then the patients underwent a full urodynamic study and the filling phase parameters were recorded (bladder compliance, bladder capacity, first sensation, normal desire, and strong desire). The association between demographic and clinical parameters and urodynamic study outcomes was investigated.

Results According to subjective symptoms, there was a significant difference between the two groups in term of nocturia (P = 0.001) and no significant difference in other subjective terms. According to urodynamic test findings, there was a significant difference between the two groups in terms of bladder compliance, bladder capacity, first sensation, normal desire, and strong desire (P <0.001) for all mentioned parameters.

Conclusion The longer duration of T2DM has a negative impact on the process of urine storage function.

Keywords Urodynamic test, urgency, urge incontinence, frequency, nocturia, bladder compliance, bladder capacity, first sensation, normal desire, strong desire

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List of abbreviations: T2DM = Type 2 diabetes mellitus

Introduction

Diabetes mellitus can be defined as a group of a chronic progressive heterogeneous metabolic disorders characterized by hyperglycemia and abnormal protein and fat metabolism caused by faults in secretion or activity of insulin, or both [(1)]. Complications of type 2 diabetes mellitus (T2DM) are time-dependent, therefore, patients with early onset of the disease are more vulnerable to developing diabetes-related complications at early ages [(2)]. Voiding dysfunction is a broad term used to describe various symptoms such as difficulty in starting or ending urine flow, sensation of incomplete bladder emptying, weak stream, frequent urination, and urinary incontinence [(3)]. The causes of voiding dysfunction can be divided into several categories including neurological, anatomical, medication-induced, and idiopathic [(4)]. Lower urinary tract symptoms (LUTS) are a general term used to describe voiding

dysfunction symptoms [5]. LUTS more simply, might be defined as failure to store or failure to empty and was once used to explain urinary issues [6]. The filling (storage) symptoms include frequency, nocturia, urgency, and urge incontinence [4,7].

This study aimed to evaluate of the possible effect of T2DM duration on urinary bladder filling function.

Methods

Study design and setting

The present study is a cross-sectional study held out in the Urodynamic Clinic at Nursing Home Hospital in Baghdad Medical City, from December 2022 through June 2023. The sample size is comprised from 120 participants. Patients who were previously diagnosed with T2DM and had symptoms of filling dysfunction were included in this study.

Inclusion criteria

Adult age group, confirmed previously diagnosed with T2DM, presenting with bothersome storage-type lower urinary tract symptoms such as nocturia, frequency, urge incontinence, and urgency.

Exclusion criteria

Patients with advanced renal diseases, bladder or prostatic tumors, history of genitourinary surgery, history of any kind of renal system stones, and those with active urinary tract infection at the time of examination. Patients on medications that are known to interfere with the normal physiological function of the urinary system. Patients who had at the time of the examination one of the acute metabolic complications of T2DM like ketoacidosis or hyperosmolar hyperglycemic state, Females who were previously diagnosed with uterine fibroids, and patients who refused participation in the study

Ethical consideration

Prior to data collection, each participant completed a consent form after being informed about the study's goals. Each patient was given the full freedom to leave at any point in time. Data confidentiality was maintained throughout the experiment, and participants were assured that their data would only be used for research.

Data collection

Starting with taking a proper history from the participant himself or herself, according to inclusion and exclusion criteria, Patient demographics data (age, gender, and duration of T2DM) are obtained by direct interview. Each patient answered about major complaints, comorbidities in a questionnaire in accordance with the American Urological Association Symptoms Index about filling dysfunction symptoms (urgency, urge incontinence, frequency, and nocturia). Mid-stream urine sample for making general urine examination for the participant if he or she had a positive result for general urine examination he or she would be excluded. Participants submitted for urodynamic test by insertion triple lumen vesical catheter size 9French, placing of electromyography electrodes three small electrode patches were placed near the urethra and rectum, start filling the bladder with normal saline solution in a rate of 20-30 ml/min with continuous asking the patient about his sensations, the filling phase is ended when the patient is no longer able to hold his urine (strong desire).

Statistical analysis

In order to conduct statistical analyses, statistical package for social sciences (SPSS) software version 25.0 (Chicago) was used. Continuous data were treated by the Shapiro-Wilk test to determine their normality. Data with a normal distribution were shown as mean and standard deviation and were subjected to Student t-test analysis. Non-normally distributed data were reported as median and range and subjected to the Mann-Whitney U test for analysis. Analysis of variance (ANOVA) was employed to assess the

statistical difference in term of bladder compliance between short and long-duration groups.

Results

Demographic data

The study involved 120 participants suffering from filling dysfunction symptoms. The demographic data of the participants are shown in Table (1). Patient`s age was ranged between 22 and 77 years with a mean of 54.23±12.63 years, slightly more the half of them (56.67%) were females. T2DM duration ranged from one to thirty years with a mean of 7.14±5.46 years.

Table 1. Baseline clinical characteristics and demographic data of the participants (n=120)

Variables		Values
Age (years)	Mean±SD	54.23±12.63
	Range	22-77
Gender (N, (%))	Male	52 (43.33%)
	Female	68 (56.67%)
T2DM duration (years)	Mean ±SD	7.14±5.46
	Range	1.0-30

Participants were categorized broadly into two groups according to the T2DM duration: those with short duration (1.0-10 years) accounting for about three-fourths (75.83%) of the participants, and those with long T2DM duration (>10 years) representing about one-fourth of the participants (24.17%) as shown in figure (1).

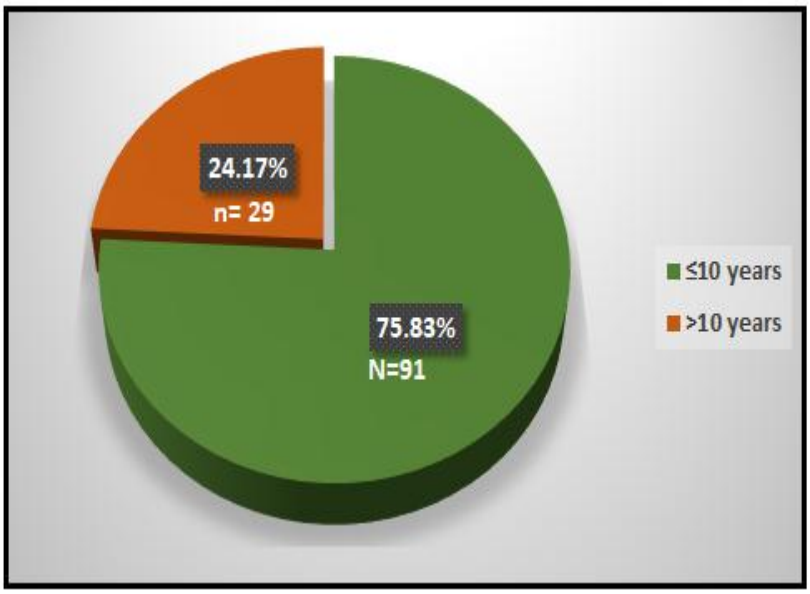

Figure 1. Distribution of participants according to T2DM duration

Association of filling symptoms with T2DM duration

Data regarding filling symptom scores were found to be non-normally distributed. Therefore, these data were presented as median and range, and the non-parametric Mann Whitney U test was used to analyses them. The two groups of T2DM duration did not differ significantly in terms of urgency score, urge incontinence, and frequency score (P = 0.406, P = 0.144, P = 0.203, respectively), although participants in long duration T2DM group had higher score. In contrast, the median nocturia score in long duration T2DM group was 4.0 (range = 0.0-5.0), which was higher than that of short duration group participants (median = 2.0, range = 0.0-5.0) with a significant difference (P = 0.001) as illustrated in table (2).

Table 2. Association of filling symptoms with T2DM duration

Variables		Short duration (n=91)	Long duration (n=29)	Total (n=120)	P value*
Urgency score	Mean±SD	3.16±0.95	3.34±1.2	3.21±1.0	0.406
	Median	3.0	4.0	3.0	
	Range	1.0-5.0	0.0-5.0	0.0-5.0	
Urge incontinence	Mean ±SD	1.53±1.36	1.93±1.5	1.63±1.4	0.144
	Median	1.0	2.0	1.0	
	Range	0.0-5.0	0.0-5.0	0.0-5.0	
Frequency	Mean±SD	2.96±1.06	3.28±1.46	3.03±1.17	0.203
	Median	3.0	4.0	3.0	
	Range	0.0-5.0	0.0-5.0	0.0-5.0	
Nocturia	Mean±SD	2.16±1.46	3.24±1.38	2.43±1.51	0.001
	Median	2.0	4.0	3.0	
	Range	0.0-5.0	0.0-5.0	0.0-5.0	

*P value by Mann Whitney test

Association between urodynamic tests parameters and T2DM duration

Poor bladder compliance was significantly more frequent among participants in long duration T2DM group (75.82%) than those with short duration (34.48%) (P <0.001). Furthermore, normal compliance was more familiar between participants in short than those in long T2DM duration group (58.62% vs. 18.68%) with a clear significant difference (P <0.001). Moreover, the median bladder capacity in participants in long duration T2DM group was 675 cm (range = 184-1155 cm), which was higher than those of short duration (median = 420 cm, range = 90-1050 cm) representing a high significant difference (P <0.001), also in participants with long duration, the median urine volume that induce the first sensation was 367 ml, which was much higher than that of participants in short duration T2DM group (91 ml) with highly significant difference (P <0.001). Furthermore, the median urine volume that induce normal and strong desire for voiding in participants in long T2DM duration group was 535 ml and 630 ml respectively, which is more than double that of participants in short T2DM duration group (208 ml and 301 ml, respectively) with a clear significant difference (P <0.001) (Table 3).

Table 3. Association of filling urodynamic test results with T2DM duration

Variables		Short duration (n=91)	Long duration (n=29)	Total (n=120)	P value*
Bladder Compliance, ml/cm H_2O	Normal Borderline Poor	69 (75.82%) 5 (5.5%) 17 (18.68%)	10 (34.48%) 2 (6.9%) 17 (58.62%)	79 (65.83%) 7 (5.83%) 34 (28.33%)	<0.001
Bladder capacity (ml)	Mean±SD Median Range	421.64±179.5 420 90-1050	671.34±284.46 675 184-1155	481.0±234.4 432 90-1155	<0.001
First sensation (ml)	Mean±SD Median Range	115.5±94.06 91 10-376	311.1±214.5 367 39-820	161±155.11 100 10-820	<0.001
Normal desire (ml)	Mean±SD Median Range	236.2±138.9 208 57-850	495.6±249.87 535 135-953	298.75±204.1 630 57-953	<0.001
Strong desire (ml)	Mean±SD Median Range	337.78±182.4 301 88-1000	580.93±265.34 630 180-1103	396.54±229.5 321 88-1103	<0.001

*P value by Mann Whitney test

Discussion

In the present study, the mean±SD of the participant's age was (54.23±12.63) years. This finding was consistent with Abdul-Hameed and Ismail (2022) [8] observations about the prevalence of diabetic cystopathy in individuals from Iraq who showed that the mean±SD of the age of the participants in their study was (56.50±15.5) years. As well, current findings were in accordance with Dereli Yilmaz et al. (2016) [9] in their study about LUTS in women with T2DM; in that study, the mean±SD of participants age was 55.1±14.7 years.

Regarding participants sex, the majority were females (56.67%). This result was in agreement with Przydacz et al. (2020) [10] who stated in their study that LUTS were more common prevalent in females in comparison with males (57% vs. 43%, respectively)., Additionally, in their study about the incidence and effect of overactive bladder, urine incontinence, and other LUTS, Kogan et al. (2014) [11] documented that LUTS are more common in females in comparison with males (84% vs. 80%). Furthermore, Abdelmoteleb et al. (2016) [12] stated that about 50% of males and nearly 60% of females have symptoms with urine storage and LUTS.

In the current study, it has been found that the mean±SD of disease duration was 7.14±5.46 years, this result is in agreement with Qasrawi et al. (2022) [13] where they found that LUTS were a hidden and unexplained morbidity, and were widespread in diabetes individuals who experienced complex LUTS pathogenesis. Thus, it takes a period of time to be appeared or discovered. Furthermore, Kebapci et al. (2007) [14] found that age and diabetes duration of more than nine years were predictors of bladder dysfunction in Turkish female patients with LUTS and diabetes.

In the current study, participants were categorized broadly into two groups depending on the disease duration; those with short duration (1.0-10 years) accounting for about three-fourths (75.83%) of the participants, and those with long disease duration (>10 years) representing about one-fourth of the participants (24.17%). This distribution was in harmony with Malik et al. (2020) [15] were they stated that a 10-year cutoff considered the optimum cutoff point based on data that was previously published and showed that diabetic

cystopathy was more common in those with diabetes who had had it for more than ten years.

The two groups of participants (long and short duration) did not differ significantly in terms of urgency score, urge incontinence, and frequency score, although participants with long duration had higher scores (P = 0.406, P = 0.114, P = 0.203, respectively), on the opposite hand, the median nocturia score in participants with long duration was significantly greater than participants in short duration T2DM group (P = 0.001)

Although current results about urgency score, urge incontinence, and frequency score showed non-significant scores, but these results were higher in long duration group. Moreover, the present study was a cross-sectional design, so, both groups were patients with T2DM and had elevation in these results. Furthermore, these results were in agreement with Jagadeesan et al. (2022) [16] who stated that urgency and frequency of urination were shown to be higher among T2DM participants in comparison to normal participants, as well, Ebbesen et al. (2007) [17] in their study found a strong relationship between T2DM and urge incontinence, especially for urge incontinence and severe degree of incontinence in their study about diabetes and urinary incontinence in Norway (A case-control study), as well Salari et al. (2022) [18] revealed that one of the most typical signs of diabetes is frequent urination. It could be an indication that the kidneys are removing extra sugar from the bloodstream because blood sugar levels are higher than normal.

Regarding nocturia, current results were in agreement with Yoshimura (2012) [19] who stated that the most significant risk factor for nocturia is diabetes, after a 5- to 16-year follow-up, several longitudinal studies have revealed an increase in the incidence of nocturia. As well as, in their investigation of bladder diary readings and urine output in T2DM women, Fayyad et al. (2010) [20] reported that LUTS was related to an increase in urine output, especially at night. This may be a sign of advanced T2DM, which is characterized by increasing urinary output and a heavier load on the bladder.

Poor compliance was significantly more frequent among participants in long duration T2DM group than those in short duration group (75.82% vs. 34.48%, P <0.001). At the same time, normal compliance was more prevalent among participants in short duration T2DM group than those with long duration T2DM group with a highly significant difference (58.62% vs. 18.68%, P <0.001). Furthermore, the median bladder capacity in participants in long duration T2DM group showed a higher significant difference in comparison with those of short duration (median = 675, 420, respectively, P <0.001). These results were in agreement with Bansal et al. (2011) (21) who mentioned that a variety of urodynamic abnormalities, in addition to the usual diabetic cystopathy, urgency, incontinence, blockage of the bladder outlet, and poor compliance, can be present in patients with T2DM with LUTS. A significant number of such individuals will show signs of neurologic dysfunction (both autonomic and peripheral neuropathy) both clinically and electro physiologically.

Regarding bladder capacity, in their study about alterations that rely on time in diabetic cystopathy in rats, Daneshgari et al. (2006) [22] mentioned that diabetic rats' bladders may change from a compensated to a decompensated state, this change may start 9 to 12 weeks after induction of T2DM, indicating that this impact is time-dependent. P <0.001. Finally, the researchers clarified that diabetic rats showed an increase in bladder weight, capacity, and altered bladder compliance, the results of the current study were concomitant with that of rats' models

The median urine volume that induce the first sensation in participants in long duration T2DM group was 367 ml, which is significantly higher than that in participants with short duration (91 ml) (P <0.001), this result in agreement with Hillson (2018) [23] and Liu and Daneshgari (2014) [24] who listed that decreased bladder sensation, increased bladder capacity, and diminished bladder emptying, with a corresponding rise in post-void residual volume, are the hallmark signs of diabetic

bladder dysfunction. Diabetic bladder dysfunction includes time-dependent and mixed manifestations, that support the result of this study by one of the causes of diabetic bladder dysfunction is time dependent including nerve damage within the bladder and its exit.

Because of the same causes above, the median urine volume that induce normal and strong desire for voiding in participants in long T2DM duration group was 535 ml and 630 ml, respectively which is more than double that of participants in short duration T2DM group (208 ml and 301 ml, respectively) with highly significant differences (p=<0.001).

In conclusion, patients with longer duration of T2DM tend to have more pronounced symptoms of nocturia, frequency, urge incontinence, and urgency, also they have poorer bladder compliance, larger bladder capacities, and higher thresholds for sensation and desire for voiding compared to those with short T2DM duration.

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Author contribution

Abdul-Hussain collected, analyzed and discussed the data. Dr. Mahmood and Dr. Alquraishi supervised the study.

Conflict of interest

There is no conflict of interest stated by the authors.

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Correspondence to Mohammad A. Abdul-Hussain
E-mail: mohammadameralanbari@gmail.com
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