

Effect of Glycemic Control on Urinary Tract Infections in Type 2 Diabetic Mellitus

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Abstract

Background: Type 2 Diabetes Mellitus (DM) is frequently associated with increased risk of Urinary Tract Infection (UTI). Bacterial UTI are common in diabetics and need aggressive treatment. In this study we aim to evaluate the effect of glycemic control on UTI in Type 2 diabetic patients.

Materials and Methods: This is a retrospective study that included patients reporting to the outdoor with type 2 diabetes mellitus and symptomatic UTI from January 2021 to October 2022. Patients were divided into two groups based on glycemic control, Group 1: good glycemic control (HbA1C <7%), Group 2: suboptimal glycemic control (HbA1C ≥ 7%). Quantitative variables were expressed as mean ± standard deviation and analyzed using independent sample t-test. Qualitative variables were expressed as percentage and was analyzed using Fischer Exact test.

Results: We retrospectively collected and evaluated the data of 156 Type 2 DM patients with urinary tract infection. Prevalence of good glycemic control & suboptimal glycemic control was 33.7% & 67.3 % respectively. Prevalence of Gram negative, Gram positive and Candida were 71.8, 19.9% & 14.1% respectively. Acute pyelonephritis was significantly more in suboptimal glycemic control group in comparison to good glycemic control group [24.7% vs. 9.8%, p value 0.0325]. Cystitis was more common in good versus suboptimal glycemic control but was not statistically significant [78.4% vs 67.6%, p=0.19].

Conclusion: In type 2 diabetes mellitus, acute pyelonephritis was more common in suboptimal glycemic control group in comparison to good glycemic control. Age & WBC (White Blood Cell) count was significantly higher while Hemoglobin and GFR was significantly lower in suboptimal glycemic control group in comparison to good glycemic control group.

Keywords: Diabetes mellitus, urinary tract infection, glycemic control, acute pyelonephritis.

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Introduction

Type 2 Diabetes Mellitus (DM) is frequently associated with increased risk of urinary tract infection [1-4]. Poor metabolic control in diabetes along with impaired immune system, microvascular disease in kidney and diabetic cytopathy contribute to it [5-8]. Severe form of urinary tract infections like emphysematous pyelonephritis is more frequent in diabetics [9]. Bacterial UTI are common in diabetics and needs aggressive treatment [10]. *E. coli* is the most common organism causing UTI, other pathogens that are highly prevalent in diabetics are *Klebsiella*, *Enterococci*, *Pseudomonas*, and *Proteus mirabilis*, group B *Streptococci* and fungal infections [11,12]. Improved glycemic control in diabetic cases helps in controlling UTI and proper and accurate screening for UTI in diabetics helps in avoiding complications [13]. There is limited information on glycemic control and UTI in India, therefore we aim to evaluate the effect of glycemic control on UTI in Type 2 Diabetes patients.

Materials and Methods

This is a retrospective study that included patients reporting to the Endocrinology and Urology Out Patient Department (OPD) with type 2 diabetes mellitus and symptomatic UTI from January 2021 to October 2022. Type 1 DM, pancreatic diabetes, steroid induced diabetes, and other types of diabetes were excluded. Further patients sterile on urine culture, pregnant female, patients with asymptomatic bacteriuria, patients on per urethral catheter and patients on maintenance hemodialysis were excluded. Information like patient's age, gender, relevant history, examination, laboratory report and imaging finding were collected from OPD record. Body mass index (BMI, Kg/M²) was calculated by height and weight measurement. The plasma glucose was measured by glucose oxidase method and the HbA1c was measured by Bio-Rad D-10

system using a high-performance liquid chromatography method. DM was diagnosed based on 75-g oral glucose tolerance test (OGTT) and/or glycosylated hemoglobin (HbA1c) or based on record in OPD tickets for previously diagnosed diabetic cases [14]. Patients were divided into two groups based on glycemic control, Group 1: good glycemic control (HbA1C < 7%), Group 2: suboptimal glycemic control (HbA1C ≥ 7%). (14) Midstream urine samples were collected after giving proper instructions. The urine samples were immediately transported to the microbiology laboratory. If the urine specimen was found to be contaminated repeat sample was collected on next day. Smears for Gram's staining, culture and biochemical tests for identifying the species of the pathogens were processed using the standard microbiological procedures. Diagnosis of UTI was made if cultures had >10⁵ colony forming units (CFUs)/mL of a single potential pathogen or two potential pathogens. The presence of yeast in any number was significant. Quantitative variables were expressed as mean ± standard deviation and analyzed using independent sample t-test. Qualitative variables were expressed as percentage and was analyzed using Fischer Exact test. P-value < 0.05 was considered significant.

Results

We retrospectively collected and evaluated the data of 156 patients having diagnosis of Type 2 DM with urinary tract infection. Baseline characteristics has been summarized in Table 1. Most common symptoms were dysuria (96.8%), frequency (94.2%) & urgency (84.6%) followed by sense of incomplete voiding (60.8%), fever (55.1%), straining to void (44.9%), abdominal pain (32.7%), urinary incontinence (14.1%) and hematuria (6.4%). Average duration of diabetes was 8.9 ± 5.7 years & prevalence of newly diagnosed

diabetes was 9.6%. Prevalence of Gram negative, Gram positive and Candida were 71.8, 19.9% & 14.1% respectively (Table 2). In Gram negative, *E. coli* (67.9%) was most common while in Gram positive, *Enterococcus fecalis* (70.9%) was most common organism (Table 2).

Prevalence of good glycemic control & suboptimal glycemic control was 33.7% & 67.3 % respectively. (Table 3). HbA1C [10.5±1.9% vs 6.1±0.6%, p=0.0001] and random plasma glucose 315±146.7 vs 142±52.6 mg/dL= 0.0001] were significantly more in suboptimal versus good glycemic control. Age [56.2±10.3 vs 45.2±8.2 years, p=0.0001] & White Blood Cell (WBC) [16.8±8.5 vs 13.5±5.6 *10³/mm³, p=0.0128] were significantly more in suboptimal

glycemic control group versus good glycemic control group. Hemoglobin [9.26±1.9 vs. 10.5±2.2 gm/dL, p=0.0004] and GFR (Glomerular Filtration Rate) [58±25.6 vs. 72.2±28.4 ml/minutes/1.73m², p=0.002] were significantly lower in suboptimal versus good glycemic control group. Acute pyelonephritis was significantly more in suboptimal glycemic control group as compared to good glycemic control group [24.7% vs. 9.8%, p=0.0325]. Cystitis was more common in good versus suboptimal glycemic control but not statistically significant [78.4% vs 67.6%, p=0.19]. Similarly, there was no significant difference in acute prostatitis and emphysematous pyelonephritis in good versus suboptimal glycemic control group (Table 3).

Table 1: Baseline characteristics of study population

Total number of patients	n=156
Age	52 ± 10.6 years
Male/female	66(42.3%)/90(57.7%)
Duration of diabetes	8.9±5.7 years
Newly diagnosed diabetes	15(9.6%)
Clinical presentation	
Urgency	132(84.6%)
Frequency	147(94.2%)
Dysuria	151(96.8%)
Straining to void	70(44.9%)
Sense of incomplete voiding	95(60.8%)
Abdominal pain	51(32.7%)
Fever	86(55.1%)
Urinary incontinence	22(14.1%)
Hematuria	10(6.4%)
Body mass index	26.8±5.6 kg/m ²
Systolic blood pressure	133.6 ±20.1 mm of mercury
Diastolic blood pressure	81±8.8mm of mercury
Comorbidities	
Hypertension	40.7%
Coronary artery disease	10.8%
Diabetic retinopathy	40.2%
Renal calculi	10%
Primary hypothyroidism	5.6%
Treatment for diabetes	
Metformin	140(89.7%)

Sulfonylurea	136(87.2%)
DPP 4 inhibitor	96(61.5%)
GLP1-analogue	2(1.3%)
SGLT 2 inhibitor	69(44.2%)
Insulin	24(15.4%)
Voglibose	16(10.3%)
Pioglitazones	6(3.8%)

Table 2: Microbial pathogen in urine culture of study population

Gram negative n=112(71.8%)		Gram positive N=31(19.9%)		Yeast
<i>Escherichia coli</i>	76(67.9%)	<i>Staphylococcus epidermidis</i>	7(22.6%)	Candida albicans 22(14.1%)
<i>Klebsiella pneumonia</i>	18(16.1%)	<i>Staphylococcus aureus</i>	1(3.2%)	
<i>Psuedomonas aeruginosa</i>	7(6.3%)	<i>Enterococcus faecalis</i>	22(70.9%)	
<i>Proteus mirabilis</i>	4(3.6%)	<i>Beta hemolytic streptococcus</i>	1(3.2%)	
<i>Proteus aeruginosa</i>	3(2.7%)			
<i>Citrobacter bummanni</i>	4(3.6%)			

Table 3: Comparison between good glycemic control versus suboptimal glycemic control groups

Variables	Good glycemic control =51(32.7%)	Suboptimal glycemic control n=105(67.3%)	P value
Cystitis	40(78.4%)	71(67.6%)	0.1900
Acute pyelonephritis	5(9.8%)	26(24.7%)	0.0325
Acute prostatitis	4(7.8%)	4(3.8%)	0.4395
Emphysematous pyelonephritis	2(3.9%)	4(3.8%)	1.000
HbA1C (%)	6.1±0.6%	10.5±1.9%	0.0001
Random plasma glucose (mg/dL)	142±52.6	315±146.7	0.0001
Age(years)	45.2±8.2	56.2±10.3	0.0001
WBC(10 ³ /mm ³)	13.5±5.6	16.8±8.5	0.0128
GFR(ml/minutes/1.73m ²)	72.2 ±28.4	58±25.6	0.002
Hemoglobin(gm/dL)	10.5±2.2	9.26±1.9	0.0004

Discussion

In our study we found increase incidence of UTI in suboptimal glycemic control diabetics as compared to good control diabetics. Previous study in the past have found diabetic women more predisposed to UTI as compared to those not having diabetes [15]. In this study we found *E. coli* (67.9%) to be

the most common Gram-negative organism followed by *K. pneumoniae* (16.1%) and *Psuedomonas aeruginosa* (6.3%). *E. coli* and *K. pneumoniae* was found to be responsible for about three fourth of gram-negative cases of UTI in Kuwait [13]. Another study found the prevalence of *E. coli*, *K. pneumoniae* and

P. aeruginosa in 71.3%, 13.5% and 8.8% respectively in type 2 diabetic patients in south India [16]. In Gram positive, we found *Enterococcus faecalis* was most prevalent (71%) followed by *Staphylococcus epidermidis* in 22.6 % like another study from south India [16]. We found good glycemic control in one third of the cases and suboptimal glycemic control in two third of cases. Prevalence of good glycemic control has been reported between 13.7 % to 44.8% in different studies in urinary tract infection with diabetic patients [13,16-18].

In our study we found cystitis in 78.4% of cases with good glycemic control as compared to 67.6% of cases of suboptimal glycemic control. Acute prostatitis and emphysematous pyelonephritis were found in 7.8 % and 3.9% respectively in cases of good glycemic control and 3.8% and 3.8% respectively in those having poor glycemic control.

Acute pyelonephritis was found in 9.8% of patients with good glycemic control as compared to 24.7% in those with poor glycemic control (p- value 0.0325). In a study by Washington State Health group pyelonephritis was 4.1 times more common in premenopausal diabetic women than in non-diabetic women [19]. Another study reported patients with diabetes mellitus were 3 times more prone to hospitalization for pyelonephritis as compared to those without diabetes [20]. A Canadian study found 6-15 times more hospitalization for diabetic women as compared to non-diabetics and diabetic men needed 3.4-17 times more hospitalization as compared to non-diabetic men [21]. Risk of acute bacterial prostatitis, prostatic abscess has been found to increase in patients of diabetes mellitus [22,23].

In our study we found random blood glucose, HbA1C, age & WBC counts to be significantly higher while hemoglobin and GFR were significantly lower in suboptimal

glycemic control group in comparison to good glycemic control group (p-value <0.05). Studies have shown increased blood glucose to be related to higher chances of UTI and bacteriuria [24,25]. On contrary to this, one meta-analysis and systemic review showed that increased blood glucose level was not a significant factor for UTI in diabetic patients [26].

A study done in Type 2 diabetes mellitus in females found age more than 40 years is an important risk factor for UTI [27]. Higher HbA1C has been shown to be strongly associated with risk of CKD [28]. The limitations of our study are retrospective nature, single centre study, small sample size, confounding factor like sex was not analyzed, follow up was not included.

Conclusion

In type 2 diabetes mellitus, acute pyelonephritis was more common in suboptimal glycemic control group in comparison to good glycemic control. *E. coli* and *Enterococcus faecalis* was most common organism in Gram negative and Gram-positive bacteria respectively. Age & WBC counts were significantly higher while Hemoglobin and GFR were significantly lower in suboptimal glycemic control group in comparison to good glycemic control group.

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