

Evaluation of risk factors for emphysematous pyelonephritis among patients with type 2 diabetes mellitus

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ABSTRACT

Background: Emphysematous pyelonephritis is an acute and severe form of necrotising infection of kidneys and perinephric tissues. Diabetes mellitus, kidney stones and immune suppression states are recognised risk factors for emphysematous pyelonephritis. This study aimed to identify the risk factors contributing to emphysematous pyelonephritis among type 2 diabetic subjects.

Methods: This case-control study was done in the Department of Nephrology, BIRDEM General Hospital, Dhaka, Bangladesh from 2023 to 2025. Adult type 2 diabetic patients with computed tomography (CT) scan confirmed emphysematous pyelonephritis were cases and age and sex matched type 2 diabetic patients having acute pyelonephritis were controls. Duration of diabetes, status of glycaemic control (HbA1c), hypertension, pre-existing chronic kidney disease, presence of renal and/or ureteric stones, vesico-ureteric reflux and history of prior urinary tract infection were evaluated as risk factors for emphysematous pyelonephritis.

Results: Total patients were 42 including 21 cases and 21 controls. Univariate analysis revealed that high HbA1c [odds ratio (OR) 15.43, 95% confidence interval (CI) 2.81 – 84.72, p 0.0016], duration of diabetes (OR 2.23, 95% CI 0.36 – 13.78, p 0.38), presence of hypertension (OR 1.78, 95% CI 0.52 – 6.10, p 0.35), chronic kidney disease (OR 3.8, 95% CI 0.66 – 21.59, p 0.13) and renal/ureteric stone (OR 1.87, 95% CI 0.38 – 9.12, p 0.43) were risk factors for emphysematous pyelonephritis.

Conclusion: High HbA1c appeared as significant risk factor for emphysematous pyelonephritis among patients with type 2 diabetes mellitus.

Key words: emphysematous pyelonephritis, risk factors, type 2 diabetes mellitus, renal stone, HbA1c.

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INTRODUCTION

Emphysematous pyelonephritis is an acute and severe form of necrotising infection of renal parenchyma, collecting system and perinephric area and the hallmark is the accumulation of gas in these anatomic locations.^{1,2} Risk factors for emphysematous pyelonephritis include diabetes mellitus, obstruction of urinary flow by stone

or tumours and other immunosuppressive states.¹⁻⁴ Gender (female sex), presence of hypertension, chronic kidney disease and poor control of diabetes are reported as risk factors for emphysematous pyelonephritis in literature.⁵⁻⁷ Clinical presentations of emphysematous pyelonephritis are indistinguishable to those of acute pyelonephritis; pneumaturia is a characteristic but

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uncommon feature and asymptomatic cases are rarely reported. Patients with diabetes mellitus are at increased risk for urinary tract infections and complicated urinary tract infections^{4,8,9} but why few patients develop emphysematous pyelonephritis and most develop cystitis and acute pyelonephritis is not well explained. This study was designed to evaluate the risk factors for emphysematous pyelonephritis among patients with type 2 diabetes mellitus.

METHODS

This case-control study was done at the Department of Nephrology, Bangladesh Institute of Research and Rehabilitation in Diabetes, Endocrine and Metabolic Disorders (BIRDEM) General Hospital, Dhaka, Bangladesh from January 2023 to December 2025. BIRDEM General Hospital is the largest hospital in the world dedicated for the care of diabetic patients (predominantly) having 688 in-hospital beds and around 3500 out-patient consultations daily. Hospitalised adult (age ≥ 18 years) type 2 diabetic patients with a clinical diagnosis of acute pyelonephritis were primarily enrolled for the study purpose. Among them, those having emphysematous pyelonephritis, confirmed by computed tomography (CT) scan, were taken as cases and equal numbers of age and sex matched acute pyelonephritis patients were taken as controls. Status of glycaemic control (HbA1c), duration of diabetes mellitus, presence of hypertension, renal and/or ureteric stones, pre-

existing chronic kidney disease (CKD), indwelling catheterisation, prior genitourinary tract instrumentation, prostatic enlargement, vesico-ureteric reflux, prior urinary tract infections and high post-void residue were evaluated as risk factors for emphysematous pyelonephritis. The study protocol was approved by the Ethical Review Committee of Diabetic Association of Bangladesh (BADAS). Informed written consent was taken from the patients before enrolment in the study. Data were analysed by Statistical Package for Social Sciences (SPSS) version 26. A p value of <0.05 was taken as significant.

RESULTS

Total patients were 42 including 21 cases (diagnosed with emphysematous pyelonephritis) and 21 controls (diagnosed with acute pyelonephritis). Mean age of cases was 51.85 years and those of controls was 51.71 years and females (12) were more than males (9) in both groups. Mean duration of diabetes (7.57 years in cases and 4.28 years in controls) and mean HbA1c (9.05% in cases and 7.54% in controls) were higher in cases than controls. Base-line characteristics are shown in Table I. Common clinical presentations included fever (21 in both cases and controls), loin pain and/or tenderness (15 in cases and 19 in controls) and vomiting (16 in cases and 18 in controls). Other features are shown in Table II. No patient had shock, altered sensorium or pneumaturia in either group.

Table I. Base-line characteristics of the study participants (N = 42)

Characteristics	Cases (n = 21)	Controls (n = 21)	P value
Mean age (years)	51.85 $\pm$ 9.37	51.71 $\pm$ 8.90	0.96
Male/Female (number)	9/12	9/12	1
Duration of diabetes (years)	7.57 $\pm$ 6.28	4.28 $\pm$ 2.91	0.03
Mean HbA1c (%)	9.05 $\pm$ 1.38	7.54 $\pm$ 0.49	<0.0001
Hypertension (n, %)	11 (52.38)	8 (38.09)	0.35
Chronic kidney disease (n, %)	6 (28.57)	2 (9.52)	0.12
Renal/ureteric stone (n, %)	5 (23.80)	3 (14.28)	0.25
Thrombocytopenia (n, %)	3 (14.28)	2 (9.52)	0.63
Hyponatraemia (n, %)	6 (28.57)	1 (4.76)	0.04
Acute kidney injury (n, %)	11 (52.38)	1 (4.76)	0.0007
Bacteraemia (n, %)	4 (19.04)	1 (4.76)	0.15
Duration of hospital stay (n, %)	7.80 $\pm$ 1.86	6.23 $\pm$ 1.74	0.00

Among the cases (n = 21), 14 had class 2 emphysematous pyelonephritis, 1 had class 3A, 4 had class 3B, 1 had class 4 and 1 had class 4 emphysematous pyelonephritis with emphysematous cystitis.¹ Right kidney was involved in 15 cases, left kidney in 4 while 2 cases had bilateral renal involvement. In control group (n = 21), 13 patients had right sided involvement, 6 had left and 2 had bilateral renal involvement. In case group, urine culture revealed growth of microorganisms in 19 patients (*E. coli* in 13, *K. pneumoniae* in 5, *Enterococcus* in 1); in control group, 16 patients had growth of microorganisms in urine (*E. coli* in 12, *K. pneumoniae* in 4 patients). Four cases and one control were complicated by bacteraemia. Hyponatraemia (6 in cases and 1 in controls), acute kidney injury (11 in cases and 1 in controls) and thrombocytopaenia (3 in cases and 2

in controls) were also more common in cases (Table I). HbA1c [odds ratio (OR) 15.43], duration of diabetes (OR 2.23), presence of renal and/or ureteric stone (OR 1.87), hypertension (OR 1.78) and chronic kidney disease (OR 3.8) were risk factors for emphysematous pyelonephritis though high HbA1c $\geq 8.5\%$ was significant (p 0.0016) (Table III). Twelve cases were treated by medical management only, five required open drainage, one required open drainage and double J (DJ) stenting, two required DJ stenting and one patient required nephrectomy. None of the controls required any surgical or other forms of intervention. Mean hospital stay was more in cases than controls (7.80 vs 6.23 days) (Table I). All controls recovered while five of the cases had residual renal dysfunction at the time of discharge and there was no death in either group.

Table II. Clinical presentation of the study participants (N = 42)

Clinical features	Cases (n = 21)	Controls (n = 21)	P value
Fever	21 (100)	21 (100)	-
Loin pain and/or tenderness	15 (71.43)	19 (90.48)	0.12
Vomiting	16 (76.19)	18 (85.71)	0.43
Dysuria	14 (66.67)	5 (23.81)	0.005
Increased frequency	11 (52.38)	7 (33.33)	0.21
Suprapubic pain	5 (23.81)	1 (4.76)	0.08

Table III. Univariate analysis for risk factors for emphysematous pyelonephritis (N = 42)

Risk factor	Cases (21)	Controls (21)	Odds ratio	95% CI	P value
Duration of diabetes (years)					
>10	4	2	2.23	0.36-13.78	0.38
≤ 10 years	17	19			
HbA1c (%)					
≥ 8.5	13	2	15.43	2.81-84.72	0.001
< 8.5	8	19			
Hypertension					
Present	11	8	1.78	0.52-6.10	0.35
Absent	10	13			
CKD					
Yes	6	2	3.8	0.66-21.59	0.13
No	15	19			
Renal stone					
Present	5	3	1.87	0.38-9.12	0.43
Absent	16	18			

CI – confidence interval, HbA1c – glycated haemoglobin, CKD – chronic kidney disease

DISCUSSION

Gas forming renal infection (pneumaturia) was first described by Kelly and MacCallum in 1898.¹⁰ Since then, various names were offered to define the entity including “renal emphysema” and “pneumonephritis” and the term “emphysematous pyelonephritis” was adopted in 1962.¹¹ Gas formation in emphysematous pyelonephritis is due to glucose fermentation by *Enterobacteriaceae*,¹ however infections by gas-forming organisms are reported.^{12,13}

In our study, we found high HbA1c as significant risk factor for emphysematous pyelonephritis. Diabetes mellitus is an established risk factor for emphysematous pyelonephritis but regarding the status of glycaemic control, findings varied and cases occurred in non-diabetic subjects as well.¹⁴⁻¹⁷ Duration of diabetes mellitus was reported as a risk factor for emphysematous pyelonephritis¹⁶ but this was not significant in our research (duration of diabetes was more in patients having emphysematous pyelonephritis than those having acute pyelonephritis in present study, OR was 2.23 but p was not significant, may be due to small sample size). Renal or ureteric stones are established risk factor^{1,2,14,18} but our findings did not support that. None of our patients had vesico-ureteric reflux which is a known risk factor for emphysematous pyelonephritis.¹⁶ One systematic review and meta-analysis revealed duration of diabetes, high HbA1c, pre-existing hypertension and chronic kidney disease were risk factors for emphysematous pyelonephritis.³ Another recent meta-analysis also confirmed high HbA1c, renal stones and long duration of diabetes as risk factors for emphysematous pyelonephritis.⁴ Cases having no such risk factors were also reported in literature.^{19,20}

This study had some limitations. It was a single center study and included only a limited number of study participants. So, the results should not be generalised and a multicenter study may be recommended for a more reliable report. Most reported papers had shown that most patients having emphysematous pyelonephritis were diabetic but our study was unique in that we tried to explore whether the degree of glycaemic control have any impact in causing emphysematous pyelonephritis.

In conclusion, our investigation found that high HbA1c appeared as significant risk factor for emphysematous pyelonephritis among patients with type 2 diabetes mellitus.

Authors' contribution: MAR planned the research. SAM collected data. All authors read and approved the final version for publication.

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