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From bacterial pyelonephritis to meningitis: a case report and literature review

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Abstract

Urinary Tract Infections (UTIs) are among the most common infections in individuals with Diabetes Mellitus (DM) and can progress to severe complications. This case report presents a 38-year-old male with poorly controlled DM who developed *Escherichia coli* pyelonephritis complicated by bacteremia and subsequent bacterial meningitis. Despite initial antibiotic therapy for a complicated UTI, the patient developed neurological symptoms, including confusion, drowsiness, and clinically evident nuchal rigidity. Laboratory findings supported bacterial meningitis, though Cerebrospinal Fluid (CSF) cultures remained sterile, likely due to prior antibiotic administration. Blood and urine cultures confirmed E. coli as the causative pathogen. Management included broad-spectrum antibiotics, corticosteroids, insulin, and the placement of a double-J stent. The patient gradually improved and was discharged after two weeks with full recovery. This case underscores the rare but life-threatening progression of pyelonephritis to meningitis in diabetic patients. Clinicians should maintain a high index of suspicion for systemic infections in diabetics presenting with UTIs and neurological symptoms, as early diagnosis and aggressive management are critical for reducing morbidity and mortality.

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Highlights

- *Diabetics & UTIs: diabetic patients are at higher risk for severe UTIs, which can progress to life-threatening infections.*
- *Rare complication: this case highlights the unusual progression of pyelonephritis to E. coli meningitis in an adult.*
- *Diagnostic challenge: sterile CSF cultures may occur due to prior antibiotics, complicating diagnosis.*
- *Urgent management: early recognition and aggressive treatment, including antibiotics and urological intervention, are crucial.*
- *Clinical implication: neurological symptoms in diabetic UTI patients should raise suspicion for meningitis to prevent severe outcomes.*

Introduction

Urinary Tract Infections (UTIs) ranked as the second most common infection among individuals with diabetes, following lower respiratory tract infections, with incidence rates of 51.4 per 1,000 years for men and 147.9 per 1,000 years for women.[1] In hospitalized individuals diagnosed with acute pyelonephritis, Diabetes Mellitus (DM) has been identified as the predominant predisposing factor.[2] Furthermore, the severity of UTIs is exacerbated in patients with DM; the average hospitalization rate for those with acute pyelonephritis is notably higher among diabetics compared to their nondiabetic counterparts.[3] In individuals with DM, pyelonephritis often presents bilaterally and is associated with a higher risk of complications.[4] The immunocompromised state in diabetics can

mask typical signs and symptoms, leading to delayed diagnosis and treatment, which may result in severe infections and increased mortality. Local complications of pyelonephritis in diabetic patients include Emphysematous Pyelonephritis (EPN), perirenal and pararenal abscesses. Progression to meningitis is rare. This article explores a case of acute bacterial meningitis, which is an uncommon complication arising from pyelonephritis. The patient presented to the Emergency Department with symptoms indicative of a urinary tract infection. Within 12 hours, the patient's condition deteriorated, leading to drowsiness and confusion. Neurological examination revealed signs consistent with meningeal irritation, prompting the need for cerebrospinal fluid analysis. The treatment protocol involved the immediate administration of antibiotics, corticosteroids, and supportive care. Meningitis caused by *E. coli* is associated with a significant mortality rate if not swiftly identified, underscoring the importance of early detection and appropriate management for the diagnosis and treatment of this serious condition.

Case Report

A 38-year-old male patient arrived at our hospital with a two-day history of fever and non-radiating back pain, accompanied by dysuria that had persisted for five days. Despite taking analgesics obtained from a local pharmacy, his fever and pain did not improve. The patient had a history of diabetes for the past ten years, which was poorly controlled due to non-compliance with drugs. Considering his diabetic condition and urinary tract infection, a provisional diagnosis of complicated urinary tract infection was established, and he was initiated on intravenous antibiotics. However, twelve hours after admission, he became drowsy, confused, and disoriented regarding time and place, along with symptoms of headache and vomiting, prompting the addition of urosepsis and meningitis to our differential diagnosis.

Upon admission, the patient was agitated and febrile, with a temperature of 39.6°C. His vital signs at the time of admission were recorded as follows: a pulse rate of 121 beats per minute, a respiratory rate of 24 breaths per minute, blood pressure of 100/60 mmHg, and an oxygen saturation level of 94% while breathing room air. Upon examination of the abdomen, tenderness was noted upon palpation, and no organomegaly was detected. The neurological evaluation showed no significant abnormalities except for nuchal rigidity. All cranial nerves were found to be intact.

The patient was swiftly started on broad-spectrum intravenous antibiotics, corticosteroids, insulin, and antipyretics. Blood and urine cultures were collected at the time of admission before the administration of antibiotics; however, the report was received after 72 hours. Laboratory parameters at admission and on the day of discharge are presented in Table 1. A Non-Contrast Computed Tomography (NCCT) scan of the head and an NCCT scan of the abdomen were recommended. The NCCT scan of the abdomen showed an enlarged left kidney along with fat stranding suggestive of pyelonephritis, as demonstrated in Figure 1, while the NCCT scan of the head showed no abnormalities. A lumbar puncture was performed and the Cerebrospinal Fluid (CSF) examination revealed a cloudy and turbid appearance. The protein concentration was markedly elevated at 284 mg/dl, significantly exceeding

Table 1. Laboratory parameters at the time of admission and upon discharge.

Analyte (Reference range)	At admission	At discharge
Hb (13-17 g/dL)	11.2	10.6
TLC (4-11 × 10^9/L)	21,000	7,200
TPC (150-400 × 10^9/L)	120,000	210,000
S. Na (135-145 mEq/L)	134	141
S. K (3.5-5 mEq/L)	3.9	4.4
S. Cl (96-115 mEq/L)	95	108
SGOT (5-40 U/L)	45	32
SGPT (5-40 U/L)	60	25
T. Bilirubin (0.0-2.0 mg/dL)	0.9	0.6
Alkaline Phosphatase (40-129 IU/L)	180	210
Total Protein (6.0-8.3 g/dL)	6.1	6.4
Serum Albumin (3.3-5.2 g/dL)	3.1	3.3
Blood Urea (13-45 mg/dL)	120	40
Serum Creatinine (0.5-1.5 mg/dL)	2.2	1.0
Serum Calcium (8.6-10.3 mg/dL)	8.2	9.0
TSH (0.45-5.0 mIU/L)	1.3	1.3
HbA1c (<5.7%)	10.5	10.5
Procalcitonin (<0.05 mcg/L)	16	0.01
CRP 0.00-1.00 mg/dL)	60	2
Urine Routine Examination (Urine R/E)		
WBCs (2-5/HPF)	18	3
Urine Sugar (0-15 mg/dL)	210	20
Urine Protein (<10 mg/dL)	170	30

Hb, Hemoglobin; TLC, Total Leukocyte Count; TPC, Total Platelet Count; S. Na, Serum Sodium; S. K, Serum Potassium; S. Cl, Serum Chloride; SGOT, Serum Glutamic-Oxaloacetic Transaminase; SGPT, Serum Glutamic-Pyruvic Transaminase; TSH, Thyroid-Stimulating Hormone; HbA1c-Glycated Hemoglobin; CRP, C-Reactive Protein; Urine R/E, Urine Routine Examination; WBCs, White Blood Cells.

the normal range of 15–45 mg/dL. Conversely, glucose levels were considerably low at 22 mg/dL, which is below the normal range of 50–80 mg/dL. Furthermore, the total cell count was recorded at 1700 cells/mm³, whereas the normal range is 0-5 cells/mm³, with neutrophils constituting 90% and lymphocytes 10% of the total cell count. Neutrophils are generally absent in normal CSF. These findings are suggestive of bacterial meningitis. The CSF culture yielded no growth. Urine and blood cultures showed the growth of *E. coli*, while the CSF cultures returned sterile results. The results of the tests conducted on the tropical panel, which encompassed malaria, scrub typhus, salmonella, leptospirae, dengue, and the viral panel, were negative. Additionally, the chest X-ray revealed no abnormalities.

Initially, the patient received Intravenous (IV) ceftriaxone at a dosage of 2 grams administered twice daily, in conjunction with IV fluids and subcutaneous insulin adjusted according to a sliding scale. To address fever and pain, IV paracetamol was also provided at a dosage of 1 gram three times daily. As the patient's condition worsened, displaying symptoms indicative of meningitis, the treatment regimen was modified to incorporate IV vancomycin at a dosage of 1 gram twice daily and IV dexamethasone at 4 grams thrice daily. However, after a period of 72 hours without any notable improvement in the patient's condition, and following positive findings from urine and blood cultures, the IV ceftriaxone was replaced with a higher dosage of IV meropenem at 2 grams administered three times daily. In light of pyelonephritis being identified as the source of infection, consultations with Urology were sought, and the patient was recommended for the placement of a double-J stent. Following the treatment provided, the patient showed gradual improvement, achieving hemodynamic stability and becoming afebrile. All laboratory parameters returned to normal, and he was successfully discharged after a two-week hospital stay, with a complete restoration of sensorium, being alert and well-oriented.

Discussion

Acute pyelonephritis is primarily caused by microorganisms that ascend from the urethra through the bladder into the upper urinary tract. In rare instances, the kidneys may become infected through the bloodstream. This condition poses a greater risk for individuals with diabetes, as it often presents without pain, leading to potential oversight. In diabetic patients, acute pyelonephritis is more likely to be complicated by conditions such as pyonephritis or papillary necrosis, both of which can jeopardize the patient's life or renal function. Additionally, the diabetic kidney is susceptible to a specific form of glomerulopathy characterized by nephroangiosclerosis and interstitial damage, making it imperative that all infections are treated aggressively to prevent further complications.

Acute pyelonephritis is diagnosed when a patient exhibits symptoms such as fever, nausea, vomiting, pain abdomen, dysuria, and hematuria. Ultrasound imaging studies are performed, and findings indicative of pyelonephritis include a combination of an enlarged kidney, the presence of fluid collections, and/or perinephric stranding. The primary causative agent of pyelonephritis is *Escherichia coli,* which is identified in 40–90% of affected individuals. Other frequently implicated organisms include *Proteus mirabilis*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Enterococcus species*.

Meningitis caused by *E. coli* in adults represents a serious medical condition, frequently associated with unfavorable outcomes and a high mortality rate, even when appropriate antimicrobial therapy is administered. In contrast to the general population suffering from bacterial meningitis caused by other pathogens, patients with Gram-negative bacilli meningitis, such as E. coli, tend to present with a higher prevalence of comorbidities.[5] Escherichia coli is an uncommon etiological agent of community-acquired meningitis in adults, accounting for approximately 1% of

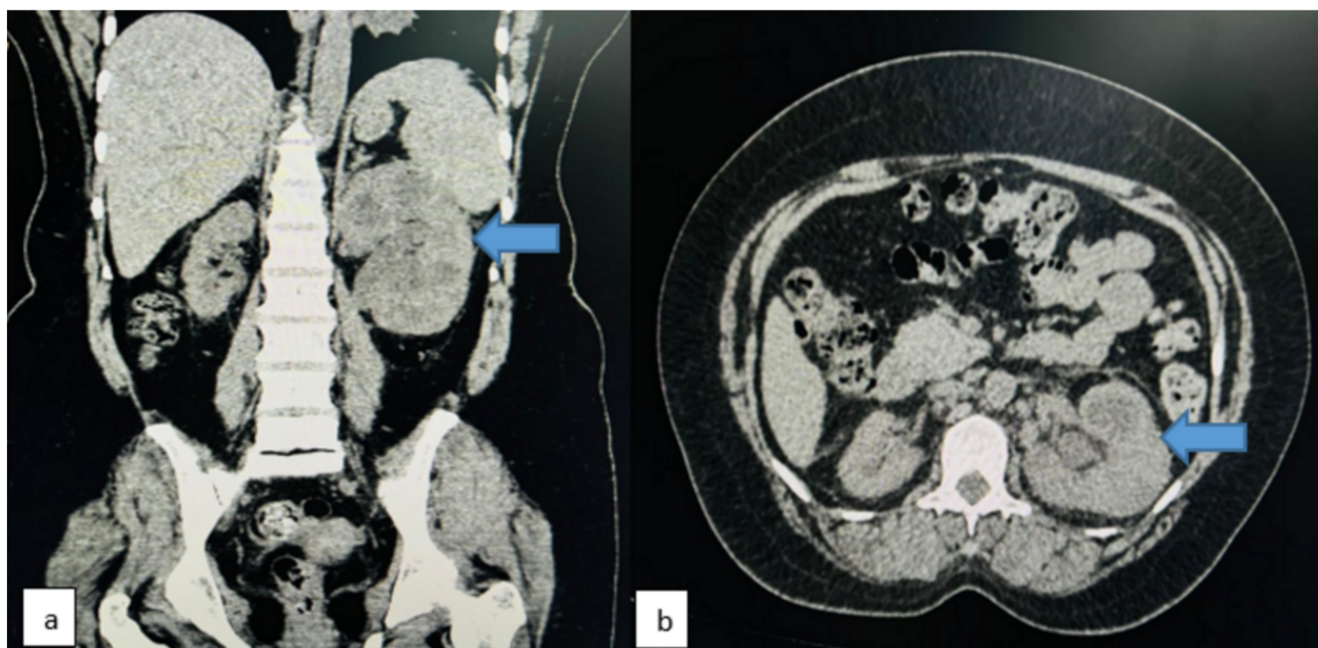

Figure 1. The CT scan reveals an enlarged left kidney exhibiting heterogeneous attenuation, along with perinephric fat stranding, as indicated by the blue arrow in the frontal (**a**) and axial (**b**) views.

all meningitis cases. It typically arises in individuals with predisposing risk factors, including diabetes mellitus, alcoholism, cirrhosis, HIV infection, and various malignancies.[6] The occurrence of *E. coli* meningitis is generally secondary to an infection located either at a distant site or nearby, such as infections of the urinary tract or gastrointestinal system.[7-9]

Emphysematous Pyelonephritis (EPN) is a severe and potentially fatal kidney infection marked by the presence of gas within the renal tissue, collecting system, or perinephric area.[10] This uncommon yet dangerous condition is predominantly caused by poorly controlled blood glucose levels and obstructions in the urinary tract. The prevalence of diabetes in patients diagnosed with EPN ranges from 50% to 90%, making it the most significant risk factor associated with this condition. Treatment options may consist of antibiotic therapy alone, percutaneous drainage combined with antibiotics, or nephrectomy in cases where the disease is advancing or the patient exhibits unstable hemodynamics. The primary pathogen identified in urine and blood cultures is *Escherichia coli*.[11] Cromlin *et al.* documented a case involving O117:K52:H *E. coli* meningitis accompanied by multiple brain abscesses, identifying acute pyelonephritis as the primary source of infection.[12] Gram-Negative Bacilli (GNB) represent a rare etiology of bacterial meningitis, with global incidence rates varying from 0.7% to 7%. *Escherichia coli*, a commensal organism found in the human gastrointestinal tract, is the predominant pathogen responsible for Urinary Tract Infections (UTIs). Additional clinical presentations associated with GNB include nosocomial pneumonia, cholecystitis, peritonitis, cellulitis, osteomyelitis, and septic arthritis.[13,14] The occurrence of multi-organ dysfunction diminishes the likelihood of recovery.[15] In patients with spontaneous bacterial meningitis, factors such as advanced age (≥65 years), positive blood cultures, inappropriate initial antibiotic therapy, and the presence of neurological and systemic complications—including shock, coagulation disorders, and acute renal failure—were linked to an increased risk of mortality.[16] The mortality rate linked to community-acquired *E. coli* meningitis is significantly high, ranging from 50% to 90%, and may reach as much as 100% in individuals suffering from liver cirrhosis.[17]

The optimal management of Emphysematous Pyelonephritis (EPN) remains a topic of ongoing debate, particularly regarding the appropriate timing for surgical intervention. Nonetheless, similar to the management of all forms of pyelonephritis, it necessitates fluid and electrolyte resuscitation, administration of antibiotics, glycemic control, and, when indicated, alleviation of any obstruction. In cases where there is clinical deterioration within 48 hours or a lack of improvement, it may be advisable to either persist with medical management in conjunction with Percutaneous Drainage (PCD) or consider surgical nephrectomy.[18-20]

The situation we encountered led to the conclusion that the underlying condition was pyelonephritis due to *Escherichia coli* infection, which progressed to bacteremia and subsequently seeded into the central nervous system, causing meningitis. While *E. coli* was not detected in the Cerebrospinal Fluid (CSF), this absence can likely be attributed to the administration of antibiotics before the CSF was collected. Nonetheless, the patient exhibited clear signs of acute bacterial meningitis, as supported by the findings from the CSF analyses and the positive clinical findings.

The scenario underscores the necessity of recognizing that severe infections may affect distant organs, including the central nervous system, particularly in individuals with compromised immune systems who are susceptible to rapid deterioration from the dissemination of infection originating from an initial site, such as a urinary tract infection in this instance. Therefore, it is crucial for healthcare professionals operating in emergency settings to maintain a heightened awareness of these potential complications to avoid diagnostic delays and mitigate the risk of mortality.

Conclusions

Meningitis should always be considered as a potential differential diagnosis in patients presenting with signs of infection at a distant site, such as a urinary tract infection, especially when these symptoms are accompanied by fever and changes in mental status. Early diagnosis can significantly improve patient outcomes.

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