Renal papillary necrosis
A forgotten entity

John Fredy Nieto-Ríos, Vanessa López-Montoya • Medellín (Colombia)

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Abstract

Renal papillary necrosis (RPN) is a little-recognized entity defined as ischemic necrosis of one or several renal papillae, caused by various etiologies that must be investigated. Renal papillary necrosis may lead to papillary detachment within the urinary system, causing urethral obstruction, renal fossa pain, acute kidney injury and/or urinary tract infection.

The diagnosis requires laboratory tests and imaging studies like computed tomography urography and magnetic resonance imaging. Treatment is aimed at controlling the underlying cause, unblocking the urinary tract, if necessary, ensuring adequate hydration and avoiding the use of nephrotoxic agents.

Awareness and prompt identification of RPN are essential for preserving kidney function and improving patient outcomes. **(Acta Med Colomb 2025; 50. DOI: https://doi.org/10.36104/amc.2025.4360).**

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Dr. John Fredy Nieto-Ríos: Internista, Nefrólogo Hospital Pablo Tobón Uribe, Universidad de Antioquia; Dra. Vanessa López-Montoya: Residente de Medicina Interna, Universidad de Antioquia. Medellín (Colombia).
Correspondencia: Vanessa López-Montoya. Medellín (Colombia).
E-mail: vanessalopezmontoya@gmail.com
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Introduction

Acute kidney injury (AKI) and acute kidney disease (AKD) are characterized by accelerated renal function deterioration over less than three months. Both conditions are potentially reversible, but have high mortality, especially for critically ill patients, and can leave significant sequelae, such as progression to chronic kidney disease (CKD) (1).

Classically, AKI and AKD are classified in three categories: prerenal or hemodynamic (approximately 50%), renal or intrinsic (40%), and postrenal (10%) (1). The renal cause is, in turn, subdivided into tubular (acute tubular injury, 50%), interstitial (acute tubulointerstitial nephritis, 25%), glomerular (acute glomerulonephritis, 20%), microvascular (vasculitis, thrombotic microangiopathy, <1%), cortical necrosis (<1%) and papillary necrosis (<1%) (2).

Renal papillary necrosis (RPN) is a rare and poorly recognized entity defined as ischemic necrosis of one or more papillae in the medulla of one or both kidneys. This necrosis may trigger sloughing, with papillae passed in the urine, leading to ureteral and urethral obstruction. Clinically, it presents with pain in the kidney region, AKI, hematuria and/or urinary tract infection. Renal papillary necrosis is not a single entity, but rather a condition secondary to various diseases affecting the internal renal medulla (3).

The clinical course of AKI varies depending on the number of papillae involved, keeping in mind that each papilla drains approximately 100,000 nephrons, which stop functioning once they become necrotic. The prognosis worsens with bilateral involvement and multiple papillae affected, possibly leading to AKI requiring dialysis. The clinical course also depends on factors like the underlying cause, comorbidities, functional reserve, prior kidney function and the patient´s age (4).

This review addresses the epidemiology, pathophysiology, clinical course, diagnosis and prognosis of RPN, an often-forgotten entity with outcomes that can be catastrophic for our patients.

To make the review more enjoyable, it will be done using an everyday clinical case.

Clinical case

A male patient in his 20s presented with a history of sickle cell anemia and multiple complications of his disease, including septic arthritis in multiple joints, recurrent pain crises and iron overload secondary to multiple transfusions. He consulted due to fever, intense right flank pain radiating to the testicles, dysuria, frequency and urgency, macroscopic hematuria, and passing of "fleshy masses" in the urine. Laboratory tests showed elevated acute phase reactants, renal hyperfiltration, proteinuria, pyuria, hematuria, bacteriuria and a positive urine culture (Table 1).

Abdominal tomography with and without contrast reported elevated protein in the collecting ducts of the right lower calyx, suggesting papillary necrosis (Figure 1). Cystoscopy showed right-sided hematuria. Based on the history and findings described, he was diagnosed with renal papillary necrosis and an associated complicated urinary tract infection. The patient improved with intravenous hydration and antibiotic treatment.

Discussion

Epidemiology and risk factors

Renal papillary necrosis generally affects middle-aged people, with more than 90% of cases reported in people over the age of 40. However, in younger patients, it may be more frequent in those with hemoglobinopathies like sickle cell anemia (5).

Table 1. *Relevant laboratory tests.*

Laboratory test	Result	Reference value
Hemoglobin	8.8 g/L	13-17 g/L
Leukocytes	8,600/uL	4,500-10,000/ uL
C-reactive protein	6.15 mg/dL	<0.1 mg/dL
Creatinine	0.48 mg/dL	0.7-1 mg/dL
Blood urea nitrogen	10.7 mg/dL	16-39 mg/dL
Urine culture	*Ampicillin-sensitive Enterococcus faecium*	Negative
Urinalysis	pH 7.0 Density: 1.010 Leukocyte esterase: positive Nitrites: negative Protein: 75 mg/dL Glycosuria: negative Ketone bodies: negative Blood: positive Sediment: - Leukocytes: 6-10 per high-power field (HPF) - Erythrocytes: more than 50 per HPF (90% normal) - Bacteria: ++	

Table 2. *Risk factors (8).*

Diabetes mellitus
Sickle cell anemia
Chronic use of nonsteroidal anti-inflammatory drugs (NSAIDs)
Urinary tuberculosis
Upper urinary tract infections
Urinary tract obstruction
Kidney transplant rejection
Systemic vasculitis

It is typically more common in males, diabetic patients and people with urinary tract obstructions. In a series of cases reported up to 1952, out of 160 patients with RPN, 96 had diabetes mellitus, 48 had urinary tract obstruction, and 15 had both conditions (6). The risk factors are listed in Table 2.

Important anatomical characteristics

The renal collecting system begins in the cortex, where the glomeruli responsible for producing plasma ultrafiltrate are found. This ultrafiltrate flows toward the renal tubules and then the collecting ducts, which extend through the renal medulla and empty into the apex of the medullary pyramid: the renal papilla.

The number of renal papillae can range from 4 to 18, although a typical kidney has 7-9. Each papilla is surrounded by its respective minor calyx, which receives urine from the collecting ducts. The minor calyces are the first visible structures in the renal collecting system.

The medulla and renal papillae are especially vulnerable to ischemic necrosis, due to the unique arrangement of their irrigation and their hypertonic environment (7).

Pathophysiology

The pathophysiology of RPN is largely determined by risk factors. Vascular abnormalities are a common mechanism. For example, in sickle cell anemia, the vasa recta may be obstructed by drepanocytes. In the case of nonsteroidal anti-inflammatory drugs, ischemia is caused by inhibition of cyclooxygenase-mediated prostaglandin synthesis.

Generally, most of the pathophysiological mechanisms affect the vasculature, as the medullary interstitial cells produce prostaglandins, and many processes result in direct endothelial damage. Reduced prostaglandin production leads to decreased perfusion, vasoconstriction, and, ultimately, ischemic necrosis (8, 9).

Clinical picture

The clinical course varies and may be classified as acute or chronic. The chronic form is usually diagnosed incidentally through imaging, the passage of sloughed papillae in the urine, or autopsy. When symptoms are present, they are related to urinary tract obstruction or infections that may progress to pyelonephritis (8).

The acute form typically presents with low back pain, often radiating to the inguinal region; macroscopic or microscopic hematuria; passage of papillary fragments in the urine, often mistaken for stones; and acute kidney injury, generally oliguric. It may coexist with pyelonephritis, as occurred in the case we described (6).

Diagnostic aids

Diagnostic tests include urinalysis, which usually shows hyposthenuria, an alkaline pH, hematuria, leukocyte casts, and, often, bacteriuria. The complete blood count may be unremarkable unless there is an active infection. As far as nitrogen compounds, the urea nitrogen/creatinine ratio is typically around 10:1. The urine culture is often positive (3).

If the patient´s condition allows, a complete urological study should be done, including cystoscopy and upper urinary tract imaging, ideally with contrast. Computed tomography urography is the study of choice, although intravenous urography (which has fallen into disuse) has also been employed. Ultrasound has a limited role.

The most common findings include papillary abnormalities and filling defects in the collecting system. A “lobster claw sign” is described, in which papillary necrosis causes elongation of the minor calyces´ cul-de-sacs, creating a claw image. Over time, these cul-de-sacs can connect to

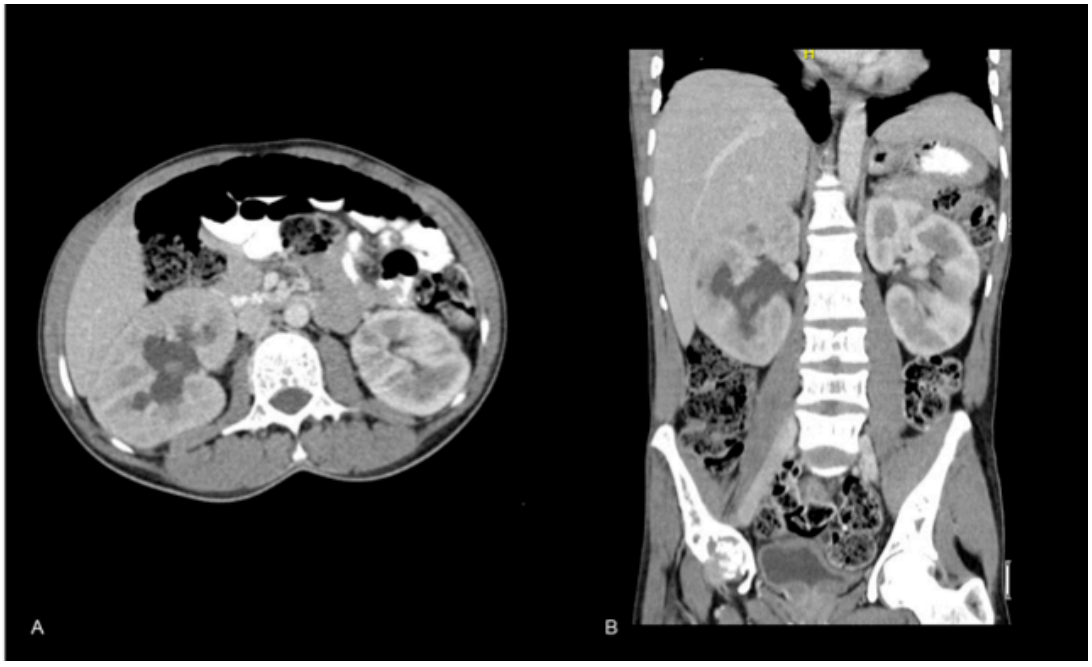

Figure 1. *Space occupied by elevated protein in the collecting ducts of the right inferior calyx group. Bilateral changes due to pyelonephritis. Axial (A) and coronal (B) views.*

each other around the necrotic papilla, forming a "signet ring" image (10).

Although early diagnosis is difficult with CT or intravenous urography, magnetic resonance urography and diffusion-weighted images could allow earlier detection.

In the patient described, the tomographic findings, coupled with his history and clinical symptoms, helped establish the diagnosis.

Treatment

The main focus is to control the underlying cause. Urgent measures include unblocking the urinary tract, if necessary, usually through endoscopic methods, and therefore the urologist plays an essential role. More extreme cases, like emphysematous pyelonephritis, may require a nephrectomy.

Generous hydration is essential, with strict urine output monitoring, guarding against fluid overload. Ultrasound methods, like point-of-care-ultrasound (POCUS), can help guide fluid administration. Any type of unnecessary nephrotoxic medication must be avoided as much as possible.

If iodized contrast must be administered, nephroprotection is essential; and if gadolinium is administered, it should be from group 2 (4).

Alkalinization continues to be an important component, even in non-acute settings, especially in conditions like sickle cell anemia.

Treatment of infectious complications will depend on the need for a urinary diversion, the presence of abscesses, hemodynamic stability, and individual patient factors that predispose them to antibiotic resistance.

The need for dialysis should be evaluated according to the conventional indications, and, when needed, the patients must be assessed for bilateral urinary tract obstruction or additional kidney injury mechanisms like infection, nephrotoxic agents, etc. (4).

Prognosis

This is a serious condition that can potentially result in advanced chronic kidney disease. When RPN occurs, the conditions with the worst prognosis are sickle cell anemia, diabetes, genitourinary tuberculosis, and prolonged obstructions (3).

Conclusion

Renal papillary necrosis is a rare but important cause of acute and chronic kidney injury that often goes undetected in medical practice, contributing to the onset of advanced chronic kidney disease, with or without the need for dialysis or transplantation. Early identification and prompt treatment can significantly improve clinical outcomes.

Rapid treatment of urinary obstruction and infection constitutes a medical emergency to avoid major complications like emphysematous pyelonephritis, which can put the patient's life at risk and irreversibly damage kidney function.

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