

## Pyelovenous backflow caused by ureterolithiasis in combination with renal vein thrombosis detected by computed tomography – case report

*Pijelovenski refluks uzrokovan ureterolitijazom u kombinaciji s trombozom renalne vene, dijagnostificiran kompjuteriziranom tomografijom – prikaz bolesnika*

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### Summary

Pyelovenous backflow is the term for abnormal urinary flow from the renal collecting system to the renal vein. It is a rare condition resulting from a high pressure in the renal pelvis during the acute phase of urinary obstruction. The backflow is usually detected on retrograde pyelography. We present a case of a 78-year-old male, with a left upper pole calyceal-venous backflow, caused by acute ureteral obstruction by ureterolith, which was diagnosed by excretory phase of contrast-enhanced abdominal CT. The patient additionally had a thrombus in the left renal vein and inferior vena cava complicated by a pulmonary embolism of the lower right lobe. He was treated with high doses of low-molecular-weight heparin along with antibiotics and symptomatic therapy, without performing any surgical or interventional procedure on that kidney. After eight weeks, the ureterolith had descended from the level of the L3 vertebra to the level of the ureterovesical junction, and the pyelovenous backflow had disappeared, although the stone had still not been evacuated. To our knowledge, no case of pyelovenous backflow diagnosed by CT urography, which resolved without any medical intervention and without removing the cause of urinary obstruction, has been reported so far. We assume that during the descent of the stone through the ureter, the pressure in the renal pelvis decreased below the limit for pyelovenous backflow, and the pyelovenous backflow disappeared spontaneously. Contrast-enhanced CT can be an effective method in the diagnosis of pyelovenous backflow in the presence of a thrombus in the inferior vena cava, which slows the high venous flow sufficiently to allow visualization of contrast urine in the venous system. Due to the drainage of urine from the renal calyx, the pressure in the renal collecting system is reduced, so the symptoms of urinary obstruction can be mitigated and the diagnosis delayed.

**Key words:** ureteral obstruction, hydronephrosis, pyelovenous backflow, multidetector computed tomography, venous thromboembolism

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### Sažetak

Pijelovenski refluks je naziv za abnormalni protok urina iz bubrežnog sabirnog sustava u bubrežnu venu. To je rijetko stanje koje nastaje zbog visokog tlaka u bubrežnoj zdjelici tijekom akutne faze urinarne opstrukcije. Obično se detektira retrogradnom pijelografijom. Prikazujemo slučaj 78-godišnjeg muškarca s pijelovenskimi refluksom u području gornje grupe čašica lijevog bubrega, uzrokovanim akutnom ureteralnom opstrukcijom kamencem, koji je dijagnostificiran u ekskretornoj fazi CT-a abdomena s kontrastom. Bolesnik je dodatno imao tromb u lijevoj bubrežnoj veni i donjoj šupljoj veni s plućnom embolijom donjeg desnog režnja. Liječen je visokim dozama heparina niske molekularne težine, uz

antibiotike i simptomatsku terapiju, bez izvođenja ikakvog kirurškog ili intervencijskog zahvata na tom bubregu. Nakon osam tjedana ureterolit se spustio s razine L3 kralješka na razinu ureterovezikalnog spoja, a pijeloveniski refluks je nestao, iako kamenac još uvijek nije bio evakuiran. Koliko znamo, do sada nije objavljen niti jedan slučaj pijeloveniskog refluksa dijagnosticiranog CT urografijom, koji se povukao bez medicinske intervencije i bez uklanjanja uzroka urinarne opstrukcije. Pretpostavljamo da se tijekom spuštanja kamenca kroz ureter tlak u bubrežnoj zdjelici smanjio ispod granice za pijeloveniski refluks te je refluks spontano nestao. CT s kontrastom može biti efikasna metoda u dijagnostici pijeloveniskog refluksa u prisutnosti tromba u donjoj šupljij veni koji dovoljno usporava visoki venski protok da se omogući vizualizacija kontrastnog urina u venskom sustavu. Zbog otjecanja urina iz renalne čašice tlak u bubrežnom sabirnom sustavu pada pa se simptomi urinarne opstrukcije mogu ublažiti i odgoditi dijagnozu.

**Ključne riječi:** ureteralna opstrukcija, hidronefroza, pijeloveniski refluks, multidetektorska kompjuterizirana tomografija, venski tromboembolizam

## Introduction

Pyelovenous backflow (PVB) is the term for abnormal urinary flow from the renal collecting system to the renal vein.<sup>1</sup> It is a rare condition resulting from a high pressure in the renal pelvis due to urinary obstruction.<sup>2,3</sup> The backflow has been detected with retrograde pyelography in most cases.<sup>2,3</sup> We present a case of a 78-year-old male, with a left upper pole calyceal-venous backflow, caused by acute urinary obstruction by ureterolith, which was diagnosed by contrast-enhanced CT scan of the abdomen. The most common complication in patients with PVB is urosepsis. However, if sudden decompression of the urinary collecting system is performed for therapeutic purposes, fatal hematuria may occur due to a change in the pressure ratio in the urinary and venous system. Therefore, timely diagnosis of PVB in a patient with urinary obstruction is important to choose the correct therapeutic procedure and avoid fatal complications.

## Case report

A 78-year-old man presented to our Emergency Department with left lower quadrant abdominal pain and nausea, without vomiting or diarrhea, for the past 10 days. His past medical history was unremarkable except for longstanding constipation. On physical examination, the patient was afebrile, with tenderness to palpation of the lower left quadrant of the abdomen, with normal peristalsis, and no signs of peritonitis. Laboratory data showed slightly elevated C-reactive protein (30.1 mg/L; reference value <5 mg/L) and creatinine (159  $\mu\text{mol/L}$ ; reference values: 64-104  $\mu\text{mol/L}$ ). The other laboratory values were normal. Abdominal X-ray and abdominal ultrasound showed no significant changes. The patient received a recommendation for a diet and plenty of hydration and was ordered for a follow-up examination. At the follow-up examination the following day, there was a further increase in CRP (48.0 mg/L) and creatinine

(168  $\mu\text{mol/L}$ ). Due to suspicion of intra-abdominal infection, antibiotic therapy with cephalexin and metronidazole was initiated. He felt better after therapy, but after two weeks he returned to the emergency department due to fever and recurrent abdominal pain. On admission, the body temperature was 38.5°C and CRP increased to 113.2 mg/L. An abdominal X-ray and ultrasound were performed again, but no changes were found. A contrast-enhanced CT scan of the chest, abdomen and pelvis was performed. The nephrographic phase showed good contrast enhancement of the renal parenchyma bilaterally with the absence of contrast opacification of the left renal vein as well as persistent filling defect in the inferior vena cava, indicating a thrombus. The thrombus occupied the left half of the lumen of the vena cava and extended from the level of the left renal vein to just below the confluence of the hepatic veins (Figure 1). Chest CT scan showed a right lower lobe pulmonary embolism. Abdominal CT scan during the excretory phase showed a mild caliectasia in the left kidney associated with ureteral obstruction by a ureterolith at the level of the L3 vertebra. In addition, contrast material was visible exiting the calyces of the upper renal pole into the left renal vein and further into the inferior vena cava, a finding compatible with pyelovenous backflow (Figure 2, Figure 3).

The patient was promptly anticoagulated with high doses of low-molecular-weight heparin along with antibiotics and symptomatic therapy. JJ stenting or percutaneous nephrostomy drainage were not chosen because of the significantly increased risk of bleeding due to direct communication between the urinary and venous tracts, especially in the setting of anticoagulant therapy. The applied therapy resulted in gradual clinical improvement. Due to complex urological problems complicated by pulmonary embolism, two weeks after admission, the patient was transferred to a tertiary center (KBC Sestre milosrdnice Zagreb). Drug therapy was continued there, and no decision was made for any surgical or interventional procedure.

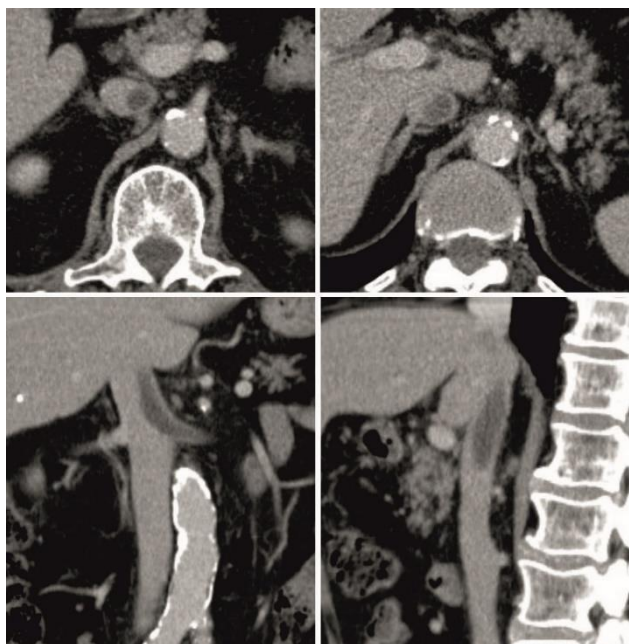


Figure 1 Contrast-enhanced axial CT scans during the parenchymal phase with multiplanar reconstructed coronal and sagittal images show a filling defect in the inferior vena cava extending from the level of the left renal vein to just below the confluence of the hepatic veins, indicating a thrombus.

*Slika 1. Aksijalni presjeci CT-a abdomena s kontrastom u parenhimnoj fazi s rekonstruiranim presjecima u koronarnom i sagitalnom smjeru pokazuju defekt punjenja u veni kavi inferior koji se proteže od razine lijeve renalne vene do neposredno ispod konfluensa hepatalnih vena, a koji ukazuje na tromb.*

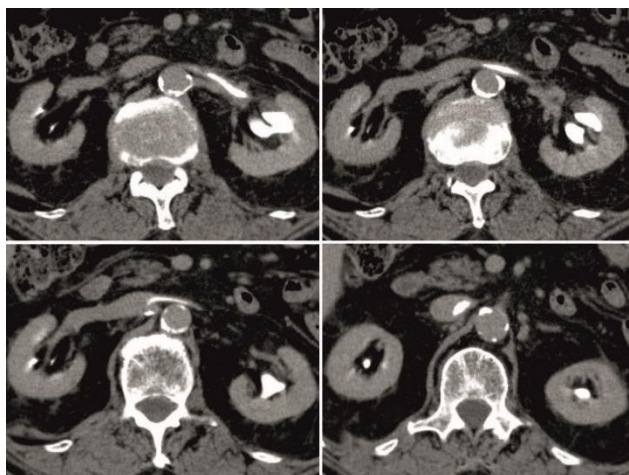


Figure 2 Contrast-enhanced axial CT scans obtained during the excretory phase show contrast material in the left renal vein and inferior vena cava.

*Slika 2. Aksijalni presjeci CT-a abdomena s kontrastom u ekskretornoj fazi pokazuju kontrast u lijevoj renalnoj veni i veni kavi inferior.*

Upon discharge, the patient felt well, but six weeks later he returned to our emergency department

due to fever. On admission, the body temperature was 38.2°C and laboratory tests showed elevated CRP (137.3 mg/L), while creatinine and other laboratory values were normal. A repeat contrast-enhanced CT scan of the abdomen and pelvis showed complete resorption of the thrombus in the inferior vena cava and left renal vein. CT scan obtained during excretory phase showed a ureterolith in the left ureterovesical junction area without hydronephrosis and without a backflow of contrast material from the left renal collecting system into the left renal vein. Upon antibiotic and symptomatic therapy, the patient became afebrile with a decrease in inflammatory parameters and was discharged without symptoms, in good general condition.



Figure 3 Contrast-enhanced three-dimensional reformatted coronal CT image in the excretory phase shows the connection between the calyces of the upper renal pole and the left renal vein.

*Slika 3. Trodimenzionalna rekonstrukcija CT-a abdomena s kontrastom pokazuje spoj između gornje skupine čašica lijevog bubrega i lijeve renalne vene.*

## Discussion

PVB is the term for retrograde urinary flow out of the intrarenal collecting system during the acute phase of urinary obstruction.<sup>2,3</sup> In acute ureteral obstruction, the kidney reabsorbs urine due to

increased pressure in the renal pelvis. This is considered a compensatory mechanism that allows the kidney to continue excreting.<sup>2,3,4</sup> This phenomenon occurs through one of five pathways: pyelolymphatic, pyelotubular, pyelointerstitial, pyelosinus and pyelovenous.<sup>2,3,5</sup>

PVB is rare and was first mentioned in 1923 as the name for the phenomenon of drainage from the renal pelvis into the venous system under certain conditions of back pressure<sup>1</sup>. It occurs after rupture of the calyceal fornix with consequent pyelovenous communication between the ruptured fornix and the adjacent small veins surrounding the fornix.<sup>1,2,3,5</sup>

All five types of renal backflow are usually detected on retrograde pyelography and result from the force of injection.<sup>2,3</sup> In our patient, PVB was detected by the excretory phase of contrast-enhanced abdominal CT. Nemeth et al. reported in 2004 the first case where the excretory phase of CT revealed a PVB entering the inferior vena cava in a patient with a post-cesarean abdominopelvic abscess causing right ureteral obstruction.<sup>6</sup> Their patient also had an associated thrombus in the renal vein extending into the inferior vena cava. They considered that without thrombus in the renal vein and inferior vena cava, CT urography would not detect PVB. Namely, a high venous flow rate would dilute the small amount of absorbed contrast agent before the backflow could be detected. They speculated that a thrombus in the veins slowed the flow enough to allow visualization of the PVB on CT.<sup>6</sup>

In 2018, Li Sian Low et al. reported a pyelovenous communication in the upper pole of the left kidney in a patient with distal ureteral obstruction after abdominal surgery.<sup>7</sup> The patient also had a thrombus in the renal vein and inferior vena cava and a pulmonary embolism of the lower right lobe, similar to our patient.

Sano et al. presented a PVB in a patient with complete obstruction of the right ureter at the ureterovesical junction after hysterectomy.<sup>8</sup> The hydronephrosis was mild and the contrast enhancement of the renal parenchyma was preserved despite the complete ureteral obstruction. The authors believe that PVB was responsible for decompression and reduction of the extent of hydronephrosis, which actually led to a delay in the diagnosis of complete obstruction. In our patient, nephrographic phase images also showed that the left kidney was enhanced to the same degree as the right kidney, with only mild caliectasia. As a result, the obstruction was not recognized during two ultrasound examinations. Cases like these indicate the importance of contrast-enhanced CT in detecting the cause of persistent hydronephrosis, especially in milder forms, when

ultrasound is not a sufficiently sensitive method.<sup>8</sup> Sano et al. also reported a low-density lesion in the inferior vena cava that they initially suspected to be a thrombus. Retrospectively, however, they speculated that the low-density lesion was not a thrombus, but rather PVB before the contrast medium reached the urinary tract, because the lesion and the content in the pyelon had a very similar density and the lesion disappeared immediately without any thrombolytic therapy after ureteroneocystostomy. In our case, however, in addition to a low-density lesion in the inferior vena cava, the patient also had a pulmonary embolism, so there is no doubt that the lesion was a thrombus.

The leading symptoms in our patient were recurrent abdominal pain and fever, and laboratory tests showed elevated creatinine levels and inflammatory markers. Other authors also report urosepsis with fever in patients with PVB.<sup>4,6,7,8</sup> This could possibly be explained by the systemic circulation of uremic toxins and bacteria via pyelovenous communication<sup>4</sup>. Chan et al. state that recirculation of creatinine in patients with pyelovenous communication can result in a biochemical picture of renal failure even in the presence of normal renal function.<sup>4</sup>

Since PVB occurs after rupture of the calyceal fornix into the venous system, some authors use the term calyceal-venous fistula for this condition<sup>4,7</sup>. We believe that these two conditions should still be distinguished. In both, there is direct communication between the urinary and venous systems, but the mechanism of occurrence is different. PVB occurs during the acute phase of urinary obstruction with consequent increased pressure within the renal pelvis, leading to rupture of the fornix and communication with the renal vein. In this condition, the pressure within the renal pelvis is higher than in the renal vein, and the direction of flow is from the renal collecting system to the venous system. Therefore, the most common complication is urinary tract infection, due to the systemic circulation of uremic toxins and bacteria.<sup>4,6,7,8</sup> Hematuria does not occur as long as the pressure ratio in the urinary and venous systems is unchanged. On the other hand, a calyceal-venous fistula is an abnormal connection between the renal calyces and the renal veins. It can be caused by blunt trauma to the kidney with damage to the collecting and vascular systems, iatrogenic trauma associated with procedures such as percutaneous nephrostomy, nephrolithotomy or renal biopsy, neoplasms, inflammatory disease, or congenital conditions.<sup>9,10</sup> Its presentation may vary from severe hemorrhage to intermittent hematuria.<sup>9,11,12</sup> Thus, although both PVB and calyceal-venous fistula are conditions with direct

communication between the urinary and venous tracts, PVB is a transient pressure-related phenomenon, while calyceal-venous fistula is a persistent structural connection. Therefore, PVB disappears once the cause of urinary obstruction is removed and the pressure within the renal pelvis normalizes. In contrast, treatment of calyceal-venous fistula is more complex and includes selective embolization and surgery ranging from elective fistula repair to partial or even total nephrectomy.<sup>12,13</sup>

In all cases of PVB presented in the literature, the cause of ureteral obstruction was treated, resulting in normalization of pressure in the renal pelvis and disappearance of PVB.<sup>6,7,8</sup> Our patient was treated with medication for urinary tract infection and pulmonary embolism, without performing any surgical or interventional procedure. After eight weeks, the ureterolith had descended from the level of the L3 vertebra to the level of the ureterovesical junction, and the PVB had disappeared, although the stone had still not been evacuated. Hong et al. conducted *ex vivo* studies in porcine kidney models in 2023 and found that PVB occurred at elevated intrarenal pressure of  $\geq 90$  mm HG.<sup>14</sup> We assume that in our patient, during the descent of the stone through the ureter, the pressure in the renal pelvis decreased below the limit for PVB, and the PVB disappeared spontaneously, without any intervention.

### Conclusion

PVB is usually detected on retrograde pyelography. Recently, cases of PVB diagnosed by CT urography have been published, mostly in combination with thrombus in the renal vein and inferior vena cava, which slows down high venous flow sufficiently to allow visualization of contrast urine in the venous system. Since PVB results in decompression and reduces the extent of hydronephrosis, it may delay the diagnosis of complete urinary obstruction. Therefore, the important role of contrast-enhanced CT in detecting the cause of persistent hydronephrosis, especially milder forms, should be emphasized. PVB disappears after the cause of urinary obstruction is removed by medical intervention. It can also resolve after spontaneous movement of the concrement as in our case, if the pressure in the renal pelvis decreases below the limit for PVB.

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