Too bad to be true: pseudo-AKI due to traumatic bladder rupture

Young Nephrologists' Arena

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ABSTRACT
Acute Kidney Injury (AKI) is described as a rapid decline in Glomerular Filtration Rate (GFR), reflected by an increase in serum creatinine (SCr) and/or contraction of diuresis. The traditional paradigm considers pre-renal, renal and post-renal causes of AKI. However, there are some settings in which an elevated SCr does not reflect a real decline in GFR. Here we describe the case of a pseudo-AKI, consequence of a massive intraperitoneal urinary leakage due to a traumatic bladder rupture. Besides the pathophysiological considerations, we want to raise awareness about this condition, especially in relation to patients presenting with oliguria, hematuria, apparent AKI, abdominal pain and ascites, particularly after trauma; we do this not only to prevent late diagnosis complications, but also to avoid costly and risky overtreatment.

KEYWORDS: pseudo-AKI, creatinine, urinary ascites, bladder rupture, trauma

Case report

A young adult, whose medical history includes favism, tabagism, alcohol drinking, drug addiction and no reports of kidney disease, was transported by helicopter to the emergency department after a road accident.

His arterial pressure was 190/80 mmHg, heart rate 103 beats per minute, peripheral oxygen saturation 100% with oxygen therapy, Glasgow Coma Scale 14/15.

Suspecting a seat belt trauma, a Focus Assessment with Sonography for Trauma (FAST) evidenced abdominal effusion, no display of the bladder and no signs of pneumothorax. Urine output was scarce and hematuric.

Laboratory findings (summarised in Table I) revealed no signs of bleeding, with white blood cells count 24040 x 10^6/L, hemoglobin 16.8 g/dL, platelets 307000 x 10^6/L; severe impairment of kidney function with serum creatinine (SCr) 6.94 mg/dL, estimated glomerular filtration rate (eGFR) 10 mL/min using CKD-EPI formula, unavailable azotemia, sodium 141 mmol/L, potassium 5.4 mmol/L, creatine phosphokinase 149 U/L, myoglobin 200 ug/L. Arterial blood gas analysis showed pH 7.22, pCO_2 62.3 mmHg, pO_2 570.4 mmHg, HCO_3^- 25.2 mmol/L, chloremia 103 mmol/L, anion gap 19.7 mmol/L. Urine drug test was positive for cocaine and opiates.

White blood cells	24040 x 10^6/L
Hemoglobin	16.8 g/dL
Platelets	307000 x 10^6/L
SCr	6.94 mg/dL
eGFR	10 mL/min
azotemia	n/a
sodium	141 mmol/L
potassium	5.4 mmol/L
creatine phosphokinase	149 U/L
myoglobin	200 ug/L
pH	7.22
pCO_2	62.3 mmHg
pO_2	570.4 mmHg
HCO_3^-	25.2 mmol/L
Chloremia	103 mmol/L
anion gap	19.7 mmol/L

Table I: The patient's laboratory results upon arrival to the emergency room

Because of a persistent psychomotor agitation and tendency to elevated blood pressure, sedation was enhanced, and the patient was subjected to oro-tracheal intubation.

A total body Computed Tomography (CT) scan with iodine contrast media was urgently performed (Fig. 1) and showed a burst breach of 6 cm of the superior-anterior bladder wall with massive spreading of urine in the peritoneal cavity, intact ureters without hydronephrosis and no lesions of other internal organs or bones.

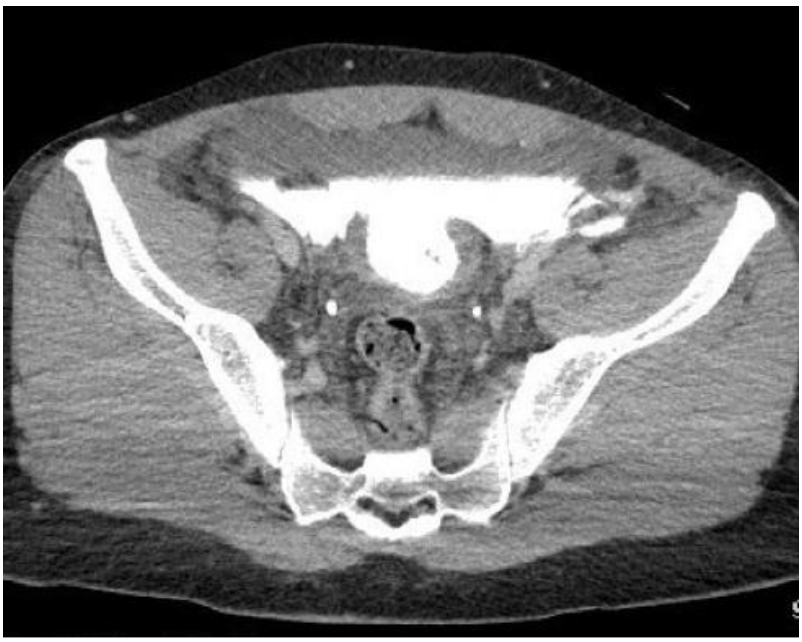

Figure 1: Cross section of CT cystography showing a massive leakage of contrasted urine in the abdomen, originating from a large breach in the bladder dome

The patient underwent an urgent exploratory laparotomy that detected, across all recesses of the peritoneal cavity, the aforementioned massive effusion of about 1 liter of urine mixed with blood. The liquid was aspirated in its entirety, the bladder rupture was surgically repaired and a 3-way bladder catheter for cystoclysis was placed.

Then, he was transferred to the Intensive Care Unit for monitoring. Supporting treatment, besides sedation, included rehydrating electrolyte solution, clonidine for hypertension, methadone (because of history of drug addiction), enteral nutrition and enoxaparin.

A nephrological consultation was requested regarding the severe oliguric kidney impairment with electrolytes and metabolic anomalies. Because the starting level of SCr was disproportionately high and had grown very rapidly after the trauma (2-3 hours), and since we could exclude other causes of Acute Kidney Injury (AKI) such as hypovolemic or hemorrhagic shock, kidney lesions and rhabdomyolysis, we decided not to start Renal Replacement Therapy (RRT) immediately, but preferred a “wait and see” strategy, repeating a laboratory test soon after surgery (3 hours after the previous ones).

The results revealed a rapid improvement of AKI with SCr 5.1 mg/dl, eGFR 15 ml/min, urea 93 mg/dl (first detection), K+ 4.5 mmol/L, improved metabolic acidosis with reduction of the anion gap. The quantification of diuresis was hindered by bladder washouts during cystoclysis. The day after, SCr and urea were reduced to 1.35 mg/dl and 50 mg/dl respectively, while diuresis was effective, after stopping cystoclysis; on the third day of hospital stay, SCr returned to normal values (0.71 mg/dl).

The prompt improvement of biochemical parameters at the resolution of the uroperitoneum suggested a case of pseudo-AKI, in which the laboratory anomalies were not reflecting a real reduction in GFR, but were the result of the rapid diffusion, through the peritoneal membrane, of highly concentrated urinary waste (creatinine, potassium and acids) as in a reverse peritoneal self-dialysis.

Discussion

AKI is described as a rise in SCr concentration and/or a reduction of urine output over a short period of time, as defined by the AKIN criteria [1]. These parameters reflect an abrupt decline in GFR and in the ability to eliminate uremic toxins. Traditionally, AKI is divided in pre-renal, renal, and post-renal causes.

However, under certain conditions, SCr can increase acutely, independently of a decrease in the GFR and reflecting no real change in overall kidney function. This may be due to drug interference with the serum assay (eg. acetoacetate in diabetic ketoacidosis, cefoxitin, flucytosine [2–4]) or a decreased creatinine secretion (eg. cimetidine, trimethoprim, some antiviral drugs and some antitumoral agents such as tyrosine kinase inhibitors [5–9]).

Elevated SCr can also be a consequence of enhanced creatinine production, for example after a large meal comprising of cooked meat (muscle contains creatine, which is converted to creatinine by the heat while cooking); it then returns slowly to the baseline level [10]. It has also been suggested that SCr rises more rapidly with rhabdomyolysis (up to 2.5-3 mg/dL per day) than with any other causes of AKI, because of a massive release of creatinine from the injured muscle [11].

In all these settings, elevated SCr does not reflect a parallel decline in GFR, as is the case for another peculiar situation of pseudo-AKI: urinary ascites (UA). This condition is caused by intraperitoneal urinary effusion, originating from a bladder rupture. Compared to plasma, waste products in the urine (eg. creatinine, urea, acids, potassium) have a higher concentration; this drives a rapid diffusion gradient across the semipermeable membrane constituted by peritoneum, resembling the chemical-physical principle behind peritoneal dialysis, but obviously with a reverse gradient direction.

The clinical presentation of UA includes abdominal pain, peritoneal effusion, oliguria, hematuria and biochemical features of AKI (elevated SCr, azotemia and potassium, metabolic acidosis, hyponatriemia); in this setting, the simultaneous presence of ascites can suggest a superimposed hepatorenal syndrome, whereas the hematuria (or microscopic hematuria with proteinuria in urinary sample) can mimic a rapidly progressive glomerulonephritis [12]. Late presentations include ileus, peritonitis and sepsis [13, 14].

An ascites to serum creatinine ratio of >1.0 is suggestive of an intraperitoneal urinary leak [15]. Subdiaphragmatic lymph vessels are the main drainage routes of intraperitoneal fluid and macromolecules, at a flow rate of approximately 1 mL per minute [16, 17]; as urine production usually exceeds this value, any condition in which urine can freely access the peritoneal cavity would be expect to increase the ratio between ascites and serum creatinine.

Intraperitoneal infusion of urine is known to increase azotemia and SCr. The rapidity of this phenomenon is dependent on volume and time of infusion. For example, a bolus injection of 100 mL of urine into the abdominal cavity elevates SCr, acutely but transiently, from 0.77 to 1.26 mg/dL for 1 hour in normal dogs; surgical rupture of the canine empty bladder also gradually increases SCr to 1.45 mg/dL for 6 hours [18]. In our case, the disproportionately quick and elevated SCr rise (6.94 mg/dL) did not match the timing (2-3 hours earlier) or entity of the trauma, even in the case of a massive release of creatinine due to rhabdomyolysis. For example, in anephric patients on intermittent dialysis, the SCr increase seems to range from 1.3 to 2.0 mg/dl per day [11]. Therefore, in our patient, only the transperitoneal diffusion of about 1 liter of urine leakage could explain such a biochemical abnormality. Alternative tests to support the diagnosis of UA include serum:urinary ascites albumin gradient >1.1 g/dL and the detection of mesothelial cells in urine cytology, suggesting the migration of mesothelial cells from the peritoneal cavity to the bladder [19].

Bladder rupture can be divided into extra-peritoneal, intra-peritoneal and combined. The first occurs in 54-56% of cases [13, 20] and almost exclusively in blunt traumas that fracture the pelvic bone [20]. Intraperitoneal bladder ruptures (38-40% of cases) are caused by a peak in the internal pressure of the bladder, resulting in the rupture of the dome, the most mobile and vulnerable part of the organ [13]. This typically occurs when the bladder is full, pushing its dome above the pelvic inlet and exposing it [20].

Pseudo-AKI due to bladder rupture is reported to be caused by trauma in 51% of cases, and by iatrogenic cause (gynecologic procedures, but also general surgical and urologic procedures) in 49% [21]. Spontaneous ruptures represent only <1% of cases and occur especially in patients with obstructive or retentive pathology, or history of substance abuse [22]. For example, alcohol abuse can predispose some patients to bladder rupture through an enhanced diuretic effect and an alteration in the perception of the need to void [22, 23]. The bladder-distending effects of alcohol can be strengthened by sympathomimetic agents such as cocaine and amphetamines, which increase flow resistance at the bladder neck [22].

The cause of bladder rupture in our case was of course a seat belt trauma, but the history of alcohol drinking and the detection of cocaine in the urine could suggest a distended bladder full of urine with a hypertonic bladder neck.

The diagnostic gold standard is CT cystography, whose sensitivity and specificity for diagnosing intraperitoneal bladder rupture is reported as 78% and 99% respectively in this study [24]. When diagnosis and treatment are prompt, the prognosis for bladder rupture is excellent. Indeed, normalization of biochemical values occurs <24 hours from the surgical repair, which is recommended for intraperitoneal rupture, although conservative therapy could be a treatment option for selected patients [25, 26].

Conclusions

Physicians should consider pseudo-AKI in any patient with blunt abdominal trauma, or who underwent genitourinary surgical procedures or radiation therapy, who develops anuria or oliguria, ascites and an elevated SCr. A delayed diagnosis can lead to several complications, such as ileus, peritonitis and sepsis, but also to the use of unnecessary and potentially harmful medications or hemodialysis.

We learnt from this experience that, even in the frantic context of emergency care, our goal should never be to resolve a laboratory abnormality without considering its causative origin first. We had all the reasons to initiate RRT in a “generic” post-trauma oliguric AKI patient with metabolic anomalies but, by realizing his SCr was “too bad to be true” we prevented costly and risky overtreatment.

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