

The underestimated power of cooked meat in affecting plasma creatinine level: three case reports

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Introduction

The use of plasma creatinine as biomarker for renal function is not foolproof. Pre-analytical factors such as dietary intake of cooked meat can significantly influence plasma creatinine level, giving rise to pseudo-renal failure. We report three cases of paediatric oncology patients who presented with spuriously high plasma creatinine level secondary to ingestion of a large amount of cooked meat, domestically prepared in the form of essence. The frequent occurrence of such practice is likely rooted in the traditional Chinese food culture of ingesting meat essence as a tonic.

Case presentations

Case 1

A drastic increase in plasma creatinine level to 206 $\mu\text{mol/L}$ (reference interval [RI]: 33-59) from normal baseline was noted in a 6-year-old boy with a history of acute lymphocytic leukaemia in remission during a routine pre-clinic blood test taken at 4 pm. Urgent admission was arranged for suspected acute kidney injury (AKI). On admission, his creatinine level measured about 26 hours after the clinic visit had spontaneously normalised in the absence of any treatment. Urgent urinary system ultrasonography and other blood tests were unremarkable. Clinically, the patient was well and asymptomatic. He was discharged uneventfully.

Case 2

Renal function test requested as part of pre-consolidation chemotherapy assessment for a 14-year-old boy with B-cell acute lymphoblastic leukaemia showed a rise of plasma creatinine level to 125 $\mu\text{mol/L}$ (RI: 45-77) from the normal baseline. Intravenous fluid was started for suspected AKI and the plasma creatinine level normalised the following morning. However, a reassessment after

3 days showed an elevated creatinine level once again. A third reassessment after 5 more days revealed a creatinine level of 110 $\mu\text{mol/L}$. The patient was admitted for intravenous rehydration with retesting the following morning showing a normal plasma creatinine level. Consolidation was eventually started 9 days later than the initial planned date. The patient remained well and asymptomatic throughout the course.

Case 3

A sudden increase in creatinine level (154 $\mu\text{mol/L}$, RI: 33-59) from the normal baseline was noted during a pre-clinic blood test at 1 pm in a 5-year-old girl with B-cell acute lymphoblastic leukaemia on maintenance chemotherapy. Clinically, the patient exhibited no symptoms. Subsequent blood tests at 4 pm and 3 days later showed gradual reduction of creatinine levels to 83 $\mu\text{mol/L}$ and 65 $\mu\text{mol/L}$, respectively.

In light of this 'outbreak' of spuriously high creatinine level in multiple paediatric oncology patients, extensive investigations were performed on the residual samples for suspected interference. Analytical interference was excluded by dilution study, and re-analysis performed on alternative analyser platforms with the same enzymatic method and by other methods, including Jaffe and liquid chromatography-tandem mass spectrometry (Table). A normal and stable plasma cystatin C level was detected in Case 1, indicating that the actual renal function remained stable despite the rise in plasma creatinine level. Unfortunately, the residual samples D and E for Cases 2 and 3, respectively, were insufficient for cystatin C testing. The clinical status and other renal function markers of both cases had remained stable during the episode, despite the spurious transient and abrupt increase in creatinine levels. The levels also returned quickly to normal without active management. Furthermore,

TABLE. Temporal change to plasma creatinine, creatine, cystatin C, and intake of meat essence

Case	Age, y/sex	Sample No.	Collection date and time	Creatinine (Roche enzymatic), $\mu\text{mol/L}^*$	Creatinine (Roche Jaffe), $\mu\text{mol/L}$	Creatinine (Vitros enzymatic), $\mu\text{mol/L}$	Creatinine (LC-MS/MS), $\mu\text{mol/L}$	Creatine (LC-MS/MS), $\mu\text{mol/L}^\dagger$	Cystatin C (Roche), mg/L^\ddagger	Intake of meat essence
1	6/Male	A	Day 1, 14:23	206 H	204 H	206 H	212 H	252 H	0.82	Frequency: 3-4 times per week taken with normal meal Amount: 1 cupped handful of pork meat per serving
		B	Day 1, 16:20	257 H	259 H	258 H	266 H	189 H	0.85	
		C	Day 2, 18:17	30	39	33	39	75	0.79	
2	14/Male	D	Day 1, 16:23	125 H	-	-	134 H	214 H	-	Frequency: before every clinic follow-up Amount: 0.3 kg of pork meat per serving
			Day 2, 08:37	49	-	-	-	-	-	
			Day 4, 15:29	87	-	-	-	-	-	
			Day 9, 16:41	110 H	-	-	-	-	-	
			Day 10, 06:51	45	-	-	-	-	-	
3	5/Female	E	Day 1, 13:28	154 H	-	-	164 H	400 H	-	Frequency: at least one serving daily Amount: 5 kg of pork meat with bones per 1 week's servings
			Day 1, 16:15	83 H	-	-	-	-	-	
			Day 4, 10:00	65 H	-	-	-	-	-	
			Day 10, 09:50	42	-	-	-	-	-	

Abbreviations: - = test not done; H = high flag; LC-MS/MS = liquid chromatography–tandem mass spectrometry

* Reference intervals: 33-59 $\mu\text{mol/L}$ for Cases 1 and 3; 45-77 $\mu\text{mol/L}$ for Case 2

† Reference intervals: 1.4–109 $\mu\text{mol/L}$ for Cases 1 and 3; 4.6–98 $\mu\text{mol/L}$ for Case 2

‡ Reference interval: 0.62–1.11 mg/L for Case 1

the creatinine increase was found to be paired with creatine increase in all three cases, up to 2 to 4 times the upper limit of normal, indicating recent creatine and creatinine loads.

Dietary history was pursued. Initially, all parents denied excessive meat, fish, or egg intake, but later disclosed habitual preparation of cooked meat in the form of essence (燉肉汁) for their child. Intriguingly, the caretakers had been frequently preparing tonic by double-boiling a large amount of pork meat in a slow cooker, a cooking method resembling that of 'chicken essence,' a popular traditional health remedy in Asia, especially in Chinese.

Discussion

Renal function can be conveniently estimated by plasma creatinine level but it has its limitations that should not be overlooked. The level can be influenced by multiple patient factors such as age, sex, muscle mass, tubular secretion, and dietary intake of cooked meat.¹

Foods rich in creatine include meat, fish, and poultry. Red meat and fish contain 4 to 10 g creatine per kilogram.² The average daily creatine intake is estimated to be 0.54 to 0.60 g in children and 0.81 to 0.87 g in adults.² Cooking enhances the in vitro conversion of creatine in meat to creatinine that is readily absorbed in the gastrointestinal tract. Experiments showed that a single cooked meat

meal (225 g boiled beef) can lead to a sharp and transient increase in plasma creatinine, with a peak postprandial increase in adults of 52%, followed by a gradual decrease to baseline after 12 to 24 hours.^{3,4} This phenomenon, also known as 'goulash effect,' may affect clinical interpretation of plasma creatinine level and the estimated glomerular filtration rate.⁵⁻⁷

The three paediatric cases described above demonstrated a transient exaggerated increase in creatinine following consumption of homemade meat essence. The rise in plasma creatinine level was 7.5-fold in Case 1 and mimicked a stage 3 AKI. Clinical features including normal urine output and stable haemodynamics hinted at an inaccurate estimate of renal function by plasma creatinine level. An alternative blood test that is less susceptible to interference such as cystatin C would provide comforting reassurance as illustrated in Case 1. Locally, Lee et al⁸ reported a case of pseudo-renal failure (creatinine level of 222 $\mu\text{mol/L}$) in a healthy 14-month-old boy secondary to consumption of domestically prepared concentrated meat broth. Aggarwal et al⁹ reported a case of fluctuating plasma creatinine level in a transplant recipient who consumed homemade meat soup before blood taking, hindering optimal clinical management. In this series, the caretakers had been preparing meat essence as tonics for their sick child, a healthy remedy favoured among Chinese parents. It is worth noting that this important piece of history might

be missed if medical professionals do not question parents about their child's diet. Pseudo-renal failure secondary to consumption of homemade meat essence resulted in unnecessary hospital admissions, blood taking and imaging studies, as well as a delay in scheduled chemotherapy treatment.

This series highlights domestic preparation of meat essence as a recurring cause of pseudo-renal failure in the local population. Medical professionals should be alert to the influence of cooked meats on plasma creatinine level. Early recognition can prevent excessive or unnecessary treatment and investigations. An alternative blood test for renal function, eg, cystatin C, should be considered in the presence of a spurious rise in plasma creatinine level. Serum cystatin C test is recently available in our laboratory in the Hong Kong Children's Hospital. Parental advice to avoid excessive cooked meat intake prior to blood taking will also reduce future occurrence.

Author contributions

All authors contributed to the concept or design, acquisition of data, analysis or interpretation of data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

Conflicts of interest

All authors have disclosed no conflicts of interest.

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Ethics approval

The study was approved by the Hong Kong Children's Hospital Research Ethics Committee (Ref No.: HKCH-REC-2021-059). The requirement for patient consent was waived by the Committee due to the retrospective nature of the study and the use of anonymised data.

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