EDITORIAL

# Kidney and the Contrast Media ; Risks, and the Possible Alternatives

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With about 697.5 million chronic kidney disease (CKD) patients worldwide, CKD is a global burden to health systems.[1] This burden will be intensified with the multifaceted co-morbidities and interventions. Coronary artery disease (CAD) and peripheral arterial disease (PAD) are significant causes of morbidity and mortality among CKD patients.

CKD patients have an increased risk of procedural complications (including renal injury) from coronary or peripheral angiography, revascularization, or contrast-enhanced CT.[2] This concern dates back to the 1950s, with reports of high risk of renal injury in patients with pre-existing renal disease who underwent intravenous pyelography.[3]

Three questions arise regarding this issue. The first is if it is contrast-induced or associated nephropathy? The second, can we prevent it, and how? Third, is there any safe alternative to contrast media?

Acute kidney injury (AKI) after intravenous contrast injection may or may not be causally related to contrast material. The historical term of contrast-induced nephropathy is based on poorly designed studies that lacked comparable control groups. It is not easy to have a plausible conclusion and generalize the word to different clinical settings. More recently, nephrology and radiology communities have also adopted the term contrast-associated nephropathy because it is impossible to exclude other causes of AKI in many clinical and research settings.[4,5]

Contrast-associated nephropathy refers to AKI that shortly occurs after contrast. It may or may not be directly caused by the contrast media. Many cases of such AKI could be related to coincident factors present when contrast material was administered, like hypovolemia, cardiac output failure, and sepsis.[5]

Contrast-induced nephropathy is the subset of post-contrast AKI that could be causally linked to IV contrast administration. Although some experts argue that even a thorough clinical evaluation may fail to reveal an alternative aetiology, it would be impossible to establish causality. However, this is also the case for other causes of AKI, such as sepsis-induced acute tubular necrosis (ATN), or ATN caused by an alternative nephrotoxic agent.[5]

This terminology will reflect on the actual incidence of AKI in the context of contrast administration. However, it also emphasizes pre-procedural risk stratification and avoids depriving patients of a beneficial diagnostic or therapeutic procedure.

A low glomerular filtration rate (GFR) at the time of contrast injection is considered the most critical risk for developing post-contrast AKI. However, patients with severely decreased eGFR, who are at the highest risk of CI-AKI, were underrepresented in many studies. Indeed, this will affect the true incidence.[6]

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Collaborative action is mandatory to determine a patient's risk before using contrast media. It would be the duty of all physicians and not the job of a nephrologist alone.

Like all other AKI scenarios, post-contrast is potentially preventable. Here, prevention means early risk recognition and implementation of preventive measures. In 2020, the American College of Radiology and the National Kidney Foundation released a joint consensus statement on the use of intravenous iodinated contrast media in patients with kidney disease. They recommended holding nephrotoxic medications like diuretics, pre-procedure saline infusion, and the lowest possible contrast media dose.[7]

Is there an alternative to contrast media? A renal safe alternative should provide good image quality and permit intervention at an acceptable cost without hampering other organs' functions. The possible options are either diluted iodinated contrast media or carbon dioxide.

A diluted contrast would be limited by the total volume needed for a particular procedure, and an overly diluted contrast may not provide optimal image quality. In addition to the inability to use it in a patient with contrast allergy.[8]

In this issue, Khamas et al. presented a cohort of CKD patients and limb ischemia who underwent carbon dioxide (CO2) based angiographic intervention.[9] They tackled the critical issue of PAD in CKD patients. According to the 2018 United States Renal Data (USRDS) report, PADs were even more common than myocardial infarction and cerebrovascular accidents among all renal replacement therapies, and 13% of CKD patients are suffering from critical conditions limb ischemia (CLI).[10] The main conclusion of Khamas et al. was that CO2-based angiography is a renal safe alternative to contrast media. Furthermore, it was well-tolerated during the endovascular intervention of lower extremity arterial disease.[9] It contrasts with previous Iraqi reports that looked for the incidence and possible risk factors for post-contrast AKI for CAD patients with mostly normal GFR.[11,12]

The case series also described the potential use of a homemade inexpensive CO2 delivery system in a resource-limited situation. [9] They reported the 48 hours AKI incidence comparable to other reports. However, no patients mandated renal replacement therapy. [13] They did not report the use of prophylactic isotonic saline before the procedure but described the process of risk evaluation.

The main limitations were the small sample size and the lack of comparing image quality with contrast media. The delivered volume in this study is larger than the volume used in other studies (900 + 239 vs. 87.4 ml). 14 Although they did not report complications, larger volumes of injected CO2 may lead to gas trapping and overestimating vessel diameter on imaging. Delivering a large volume in such a homemade system may carry the risk of air contamination, but the authors described multiple purging to remove air.[9]

In conclusion, post-contrast AKI needs to be revisited and managed according to each patient's risk profile. Pre-procedural optimization of the patient's clinical status and avoiding nephrotoxic medications. Then, whenever a safe and effective alternative is available, we could go ahead. Here, CO2 angiography would be a good alternative to iodinated contrast for CKD patients with PADs.

## REFERENCES


1. Carney, E.F. The impact of chronic kidney disease on global health. *Nat Rev Nephrol* 16, 251 (2020). https://doi.org/10.1038/s41581-020-0268-7.
2. Afsar B, Elsurer Afsar R, Kanbay M. Management of Coronary Disease in Patients with Advanced Kidney Disease. *N Engl J Med*. 2020 Sep 10;383(11):1090-1091. DOI: 10.1056/NEJMc2024023. PMID: 32905688.
3. Mehran R, Dangas GD, Weisbord SD. Contrast-Associated Acute Kidney Injury. *N Engl J Med*. 2019 May 30;380(22):2146-2155. DOI: 10.1056/NEJMra1805256. PMID: 31141635.
4. Davenport MS, Cohan RH, Khalatbari S, Ellis JH. The challenges in assessing contrast-induced nephropathy: where are we now? *AJR Am J Roentgenol* 2014; 202:784.
5. Mehdi A, Taliercio JJ, Nakhoul G. Contrast media in patients with kidney disease: An update. *Cleve Clin J Med*. 2020 Nov 2;87(11):683-694. DOI: 10.3949/ccjm.87a.20015. PMID: 33139262.
6. Dawson DB, Telles-Garcia NA, Atkins JL, Mina GS, Abreo AP, Virk CS, Dominic PS. End-stage renal disease patients undergoing angioplasty and bypass for critical limb ischemia have

worse outcomes compared to non-ESRD patients: Systematic review and meta-analysis. *Catheter Cardiovasc Interv*. 2021 Apr 6. DOI: 10.1002/ccd.29688. Epub ahead of print. PMID: 33825331.

7. Davenport MS, Perazella MA, Yee J, Dillman JR, Fine D, McDonald RJ, Rodby RA, Wang CL, Weinreb JC. Use of Intravenous Iodinated Contrast Media in Patients with Kidney Disease: Consensus Statements from the American College of Radiology and the National Kidney Foundation. *Radiology*. 2020 Mar;294(3):660-668. DOI: 10.1148/radiol.2019192094. Epub 2020 Jan 21. PMID: 31961246.
8. Nadolski GJ, Stavropoulos SW. Contrast alternatives for iodinated contrast allergy and renal dysfunction: options and limitations. *J Vasc Surg*. 2013 Feb;57(2):593-8. DOI: 10.1016/j.jvs.2012.10.009. Epub 2012 Dec 14. PMID: 23246079.
9. Khamas AM, Jabir SN, Hussein AM, Ali A Sh. Peripheral Angiography with Carbon Dioxide for Iraqi Patients with Chronic Kidney Disease: A Single Centre Study. *Iraqi New Medical Journal* 2022;8(15):22-28.
10. The United States Renal Data System. 2020 USRDS Annual Data Report: Epidemiology of kidney disease in the United States. National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, Bethesda, MD, 2020.
11. Alhasan Mujtaba, Mohammed Abbas Taher, Hayder Kadhum AlRubay, Mazin Abed Hazza, Hasan Mohammed Al-Rubaye, Hamid AbdulWahab, AbdulAmeer AbdulBari. The Incidence of Contrast-Induced Nephropathy-Acute Kidney Injury after cardiac catheterization in Basra Cardiac Catheterization Center. A Prospective Cohort Study. *Indian Journal of Forensic Medicine & Toxicology* [Internet]. 2020Jan.16 [cited 2021May18];14(1):557-63.
12. Al-Saffar H, Yassin A, Ali A. Delayed Recovery of Contrast-Induced Kidney Injury Post Angiography: Rate and Risk Factors. *J Fac Med Bagdad* [Internet]. 1Oct.2015 [cited 18May2021];57(3):183-7.
13. Abdelbary M, Mohamed AE, Abdel-Hamid A. Accuracy and safety of CO2 digital subtraction angiography during endovascular treatment of symptomatic peripheral artery occlusive disease. A prospective study on Egyptian patients. *The Egyptian Journal of Radiology and Nuclear medicine* 2018; 49: 76-84.
14. Madhusudhan KS, Sharma S, Srivastava DN, Thulkar S, Mehta SN, Prasad G, Seenu V, Agarwal S. Comparison of intra-arterial digital subtraction angiography using carbon dioxide by 'home made' delivery system and conventional iodinated contrast media in the evaluation of peripheral arterial occlusive disease of the lower limbs. *J Med Imaging Radiat Oncol*. 2009 Feb;53(1):40-9. DOI: 10.1111/j.1754-9485.2009.02035.x. PMID: 19453527.

**Abbreviations list**: Acute kidney injury (**AKI**), Acute tubular necrosis (**ATN**), Carbon dioxide (**CO2**), Chronic kidney disease (**CKD**), Contrast induced-Acute kidney injury (**CI-AKI**), computerized tomography (**CT**), Coronary artery disease (**CAD**), Critical conditions limb ischaemia (**CLI**),Estimated glomerular filtration rate (**eGFR**), Glomerular filtration rate (**GFR**), Peripheral arterial disease (**PAD**), United States Renal Data (**USRDS**)

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