www.nephropathol.com DOI: 10.15171/jnp.2019.42 J Nephropathol. 2019;8(4):e42

Journal of Nephropathology

Contrast-associated acute kidney injury, new findings and old believes

Mohamad Ali Dayani[1], Mohammadali Mohajel Shoja[2], Mohammadreza Ardalan[3*]

[1]Department of Radiology, Shahrekord University of Medical Sciences, Shahrekord, Iran
[2]Division of Nephrology and Hypertension, VA Medical Center, University of Arizona, Tucson, AZ, USA
[3]Kidney Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

ARTICLE INFO

Article type:
Epidemiology and Prevention

Article history:
Received: 8 August 2019
Accepted: 10 October 2019
Published online: 24 October 2019

Implication for health policy/practice/research/medical education:
Contrast-associated acute kidney injury may predict future development toward chronic kidney disease.

Please cite this paper as: Dayani MA, Mohajel Shoja MA, Ardalan MR, Sibiri B. Contrast-associated acute kidney injury, new findings and old believes. J Nephropathol. 2019;8(4):e42. DOI: 10.15171/jnp.2019.42.

Keywords: Contrast-induced nephropathy, Nephrotoxin, Contrast-associated acute kidney injury, Contrast medium, Reactive oxygen species, Contrast-induced nephropathy,

Epidemiology and Prevention

The administration of contrast medium to increase the diagnostic accuracy of computed tomography is usual. However, contrast material has the risk of renal toxicity (1,2). Contrast-induced nephropathy firstly detected in 1950, in a group of patients with underlying kidney disease who underwent coronary angiography. Since that time, it is considered as a nephrotoxin, while numerous amount of interventions and literature has devoted to this issue. In fact, post-contrast acute kidney injury is one of the furthermost common causes of acute renal failure (1). Various mechanisms like direct toxicity of contrast agents to the tubular epithelial cells, running to apoptosis and necrosis of epithelial cells and finally dysfunction of tubules. Accordingly, an indirect mechanism of contrast-induced nephropathy is vasomotor alteration in kidney due to vasoactive substances like endothelin, nitric oxide and prostaglandins, which leads to ischemic injury (3-5). Then ischemic injury directs to intra-renal vasoconstriction and diminution of glomerular blood flow. Diminution of glomerular blood flow attributed to the release of reactive oxygen species and consequently ischemia of the outer part of the medulla, furthermore deteriorating renal tubular cell damage. Contrast-induced nephropathy has been detected to be related to the poor clinical consequences, comprising augmented lengthened duration of hospital admission, the necessity for renal replacement therapy and an increase in major adverse cardiac events, and also increase of morbidity and mortality (1,6,7). However, the risk of acute renal failure after the use of contrast agents is also predisposed by patients' condition and the type of procedure. Therefore, prompt recognition of the risk factors to eradicate the potentially avoidable acute kidney injury after contrast medium administration is a serious healthcare issue. Pre-existing chronic renal failure, high osmolality agents, diabetes mellitus, hemodynamic instability, high volume of contrast agent and intra-arterial iodine administration are the risk factors for contrast-induced nephropathy. In critically ill individuals with acute kidney injury, it is difficult to discriminate the role of contrast medium and other probable factors to the extension of acute kidney injury, since some additional factors like inflammation, hypotension, infection, and other nephrotoxic substances may aggravate the condition (8-10). In a report by Weisbord et al, no advantage of intravenous sodium bicarbonate above intravenous sodium chloride or of oral acetylcysteine above placebo for the prevention of death, the need for dialysis, or permanent deterioration in renal function at 90 days or the prevention of contrast-induced nephropathy was seen. In this study unlike most previous trials their primary end-point was not the most broadly accepted definition

*Corresponding author: Prof. Mohammadreza Ardalan,
Email; ardalan34@yahoo.com and ardalanm@tbzmed.ac.ir

of contrast-associated acute kidney injury (increase in serum creatinine 25% or at least 0.5 mg/dL from baseline at 3 to 5 days after angiography) (11). In our mind, consideration on this new end point is logical. In a recent study by Nijssen et al, no prophylaxis to be non-inferior and cost-saving in stopping contrast-associated renal injury compared with intravenous hydration regarding the present clinical practice guidelines was mentioned (12). More recently, Mehran et al highlighted an important insight toward contrast-associated acute kidney injury as a marker of increased risk of chronic kidney disease and long-term death. A small and transient elevation in the plasma creatinine should be considered as a marker of poor outcomes rather than a mediator of the outcome (13). In fact, kidney with its high energy requirements and complex microvascular network is particularly susceptible to contrast-associated acute kidney injury including vasoconstriction, tubule toxicity, medullary hypoxia, and reactive oxygen species injury. Preventive consideration of sodium bicarbonate, oral acetyl cysteine and hydration are hypothetically toward those underlying mechanism (1,14). We can consider contrast-associated acute kidney injury as a stress test that reveals an existing generalized micro-vascular abnormality. We can compare the contrast-associated acute kidney injury with cardiac stress test that reveals an existing underlying cardiac abnormality, since most of the early creatinine elevation returns to normal. However, underlying pathophysiologic mechanisms still remain unclear even after normalization of serum creatinine. Therefore, if we are considering the acute creatinine elevation as our primary target, just we are targeting an epiphenomenon. Even we can make an analogy between this condition and micro-albuminuria as the later predicts the target organ involvement in the future but not directly predispose to cardiovascular risks. Hence, contrast-associated acute kidney injury may predict future development toward chronic kidney disease (15).

Authors' contribution

MAD prepared the first draft. MRA and MAMS revised the manuscript. All authors read and signed the final paper.

Conflicts of interest

The authors declared no competing interests.

Ethical considerations

Ethical issues including plagiarism, double publication, and redundancy have been completely observed by the authors.

Funding/Support

None.

References

1. Mehran R, Aymong E D, Nikolsky E, Lasić Z, Iakovou I, P Fahy M, et al. A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention: development and initial validation. J Am Coll Cardiol. 2004;44:1393-9. doi: 10.1016/j.jacc.2004.06.068.
2. Rudnick MR, Leonberg-Yoo AK, Litt HI, Cohen RM, Hilton S, Reese PP. The controversy of contrast-induced nephropathy with intravenous contrast: what is the risk? Am J Kidney Dis. 2019. pii: 0272-6386(19)30844-3. doi: 10.1053/j.ajkd.2019.05.022
3. Hu X, Zhuang XD, Li Y, Li FF, Guo Y, DU ZM, et al. A nomogram to predict contrast induced nephropathy in patients undergoing percutaneous coronary intervention: Is the "anti-aging" agent klotho a candidate predictor? Int Heart J. 2017;58:191-6. doi: 10.1536/ihj.16-213.
4. Bienholz A, Wilde B, Kribben A. From the nephrologist's point of view: diversity of causes and clinical features of acute kidney injury. Clin Kidney J. 2015;8:405-14. doi: 10.1093/ckj/sfv043.
5. Sato A, Hoshi T, Aonuma K. No prophylaxis is non-inferior and cost-saving to prophylactic intravenous hydration in preventing contrast-induced nephropathy on requiring iodinated contrast material administration. J Thorac Dis. 2017;9:1440-2. doi: 10.21037/jtd.2017.05.59.
6. Liu Y, Liang X, Xin S, Liu J, Sun G, Chen S, et al. Risk factors for contrast-induced acute kidney injury (CI-AKI): protocol for systematic review and meta-analysis. BMJ Open. 2019;9:e030048. doi: 10.1136/bmjopen-2019-030048.
7. Balghith MA.The Effect of Contrast Administration on Renal Function after Cardiac Catheterization in Saudi Patients. Heart Views. 2019;20:83-86. doi: 10.4103/HEARTVIEWS.HEARTVIEWS_69_19.
8. Gurm HS, Seth M, Kooiman J, Share D. A novel tool for reliable and accurate prediction of renal complications in patients undergoing percutaneous coronary intervention. J Am Coll Cardiol. 2013;61:2242-8.
9. Akyuz S, Karaca M, Kemaloglu Oz T, Altay S, Gungor B, Yaylak B, et al. Efficacy of oral hydration in the prevention of contrast-induced acute kidney injury in patients undergoing coronary angiography or intervention. Nephron Clin Pract. 2014;128:95–100. doi: 10.1159/000365090.
10. Do C. Intravenous contrast: friend or foe? a review on contrast-induced nephropathy. Adv Chronic Kidney Dis. 2017;24:147-9. doi: 10.1053/j.ackd.2017.03.003.
11. Weisbord SD, Gallagher M, Jneid H, Garcia S, Cass A, Thwin SS, et al. Outcomes after angiography with sodium bicarbonate and acetylcysteine. N Engl J Med. 2018;378:603-614. doi: 10.1056/NEJMoa1710933.
12. Nijssen EC, Rennenberg RJ, Nelemans PJ, Essers BA, Janssen MM, Vermeeren MA, et al. Prophylactic hydration to protect renal function from intravascular iodinated contrast material in patients at high risk of contrast-induced nephropathy (AMACING): a

prospective, randomised, phase 3, controlled, open-label, non-inferiority trial. Lancet. 2017;389:1312-22. doi: 10.1016/S0140-6736(17)30057-0.
13. Mehran R, Dangas GD, Weisbord SD. Contrast-Associated Acute Kidney Injury. N Engl J Med. 2019; 380:2146-2155. doi: 10.1056/NEJMra1805256.
14. Liu K, Zhou LY, Li DY, Cheng WJ, Yin WJ, Hu C, et al. A novel rat model of contrast-induced nephropathy based on dehydration. J Pharmacol Sci. 2019. pii: 1347-8613(19)35705-6. doi: 10.1016/j.jphs.2019.09.003.
15. Matsushita K, Coresh J, Sang Y,Chalmers J, Fox C, Guallar E, et al. Estimated glomerular filtration rate and albuminuria for prediction of cardiovascular outcomes: a collaborative meta-analysis of individual participant data.Lancet Diabetes Endocrinol. 2015;3:514-25. doi: 10.1016/S2213-8587(15)00040-6.