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Original Article

Frequency of contrast-induced nephropathy in patients under contrast-enhanced computed tomography with intravenous nonionic, iso-osmolar contrast in Shahrekord, Iran

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Abstract

Background and aims: Contrast-induced nephropathy (CIN) is a common and serious complication related to the intravenous injection of iodinated contrast media. Thus, the aim of this study was to evaluate CIN frequency and the relationship of some variables with CIN in patients who were referred to Hajar hospital, Shahrekord, Iran.

Methods: The study was performed on 200 patients who were candidates for contrast-enhanced computed tomography with intravenous contrast in Shahrekord, Iran, in 2018. Metformin and non-steroid anti-inflammatory drugs were discontinued from 48 hours before to 48 hours after the contrast prescription. Almost 100 mL of nonionic, iso-osmolar contrast media (Visipaque or Dixopaque) were used for patients. After 48 hours of contrast injection, blood urea nitrogen and serum creatinine (Cr) were checked, and the related data were collected. Cr rising>0.3 mg/dL of baseline and Cr rising>0.5 mg/dL were considered acute kidney injury (AKI) and CIN, respectively.

Results: The mean age of patients was 63.65±20 years. In addition, the mean serum Cr of patients before and after the contrast injection was 1.13±0.83 mg/dL and 1.10±0.72 mg/dL, respectively (P=0.44). The frequency of AKI nephropathy (serum Cr rising>0.3 mg/dL) was 11.5% (n=23). However, with a 0.5 mg/dL increase in serum Cr, it was 4.5% (n=9). Only the age of patients was found to be a risk factor for CIN.

Conclusion: CIN was not common in cases with normal or near-normal renal function. However, contrast prescription should be performed more carefully in old age patients.

Keywords: Contrast-induced nephropathy, Acute kidney injury, Serum creatinine

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Introduction

Contrast-induced nephropathy (CIN) is an important and frequent cause of acute kidney injury (AKI). The prevalence of CIN was reported at 5%–20% based on the type and quantity of contrast media, emergent or elective condition, and age of the cases (1-3). CIN is defined as an enhancement of the serum creatinine (Cr) level greater than 0.5 mg/dL or 25% more than baseline. However, based on KDIGO (Kidney Disease: Improving Global Outcomes) guidelines or the Acute Kidney Injury Network, stage 1 AKI is defined as an increase in the serum Cr of≥0.3 mg/dL baseline (4). The diagnosis of CIN is based on the clinical presentation and ruling out of other causes of AKI. The pathogenesis of CIN is not defined exactly; however, intra-renal vasoconstriction and direct tubular injury play a role in this regard (5). CIN is usually transient and reversible, but in some cases, it leads to irreversible renal failure or permanent exacerbation of renal failure in patients with chronic renal failure (6). There are three forms of intravenous contrast media; the first generation of contrast media was ionic hyperosmolar, and the second generation was ionic and hypo-osmolar compared to the first generation. Finally, the third generation included non-ionic and iso-osmolar (osmolality about 290 mOsmol/kg). A higher rate of CIN mainly occurs with the first generation of contrast media consumption in comparison with the second or third generation of contrast (7). CIN occurs 24–48 hours after contrast injection and recovery of renal function after 5–7 days. Some risk factors of CIN are advanced age, diabetes mellitus, effective circulatory volume depletion, non-steroid anti-inflammatory drug consumption, and chronic kidney disease (CKD) (8, 9). CIN is more common in the cases of coronary angiography compared to contrast computed tomography (CT) scans, probably due to the higher amount of contrast media in angiography; thus, CIN after contrast-enhanced CT (CECT), is uncommon even in patients with CKD (10). The incidence of CIN

in patients who received intravenous contrast in the emergent setting is more common than in elective settings (11). The low dose of contrast media (less than 125 mL or 5×kg body weight/serum Cr) is associated with a lower occurrence of CIN (12).

There are different and controversial reports of CIN prevalence in previous studies, especially with the third-generation of contrast media. In addition, most of these reports are about the high dose of contrast usage, like coronary angiography. Accordingly, this study seeks to investigate the frequency of CIN in patients undertaking a contrast CT scan with a low dose (approximately 100 mL) of third-generation of contrast media.

Methods and Materials

Overall, 200 patients who were candidates for CECT were enrolled in the cross-sectional distributive study. The study was conducted at Hajar and Kashani Hospital of Shahrekord, Iran, in 2018. The inclusion criteria included consent to participate in the study and no history of sensitivity to intravenous contrast. On the other hand, the exclusion criteria were severe renal failure (stage 5) and hemodialysis patients, uncontrolled hyperthyroidism, and a history of multiple myeloma. All patients received a mean volume of 100 mL of the third generation of contrast media, iodixanol (Dixopaque or Visipaque). Serum Cr was checked before the injection of contrast media and rechecked after 48 hours. Metformin and non-steroid anti-inflammatory drugs were discontinued 48 hours before the contrast media injection. AKI and CIN were defined as increasing serum Cr greater than 0.3 mg/dL from baseline (stage 1 AKI based on KDIGO guidelines) and increased serum Cr > 0.5 mg/dL baseline, respectively.

At the end of the study, all data were entered into SPSS software (Statistical Package for the Social Sciences, version 20.0, SPSS Inc., Chicago, Ill., USA) and then analyzed using the paired t-test, independent t-test, and Chi-square test, and *P* values less than 0.5 were considered significant.

All data were kept confidential, so at the beginning of the study, informed consent was obtained from patients for taking samples.

Results

In this study, 200 patients were enrolled, of whom 91 (45.5%) were female and 109 (54.5%) were male. The mean age of the patients was 63.65 ± 20, and the mean serum Cr before and after the injection of contrast media was 1.13 ± 0.83 mg/dL and 1.10 ± 0.72 mg/dL, respectively ($P = 0.44$). Moreover, the mean age of the patients with CIN (elevated serum Cr > 0.5 mg/dL) was greater than that of patients without CIN ($P = 0.036$). With the definition of stage 1 AKI (increase Cr > 0.3 mg/dL baseline) and CIN (increase Cr > 0.5 baselines), the frequency of CIN was 11.5% (n = 23) and 4.5% (n = 9), respectively (Table 1). The occurrence of CIN in patients (based on an increase of > 0.5 mg/dL baseline) was related to age ($P = 0.023$). Further, AKI (based on an increase of Cr > 0.3 mg/dL baseline) was associated with age ($P = 0.36$, Table 1). The occurrence of CIN or AKI was not related to hypertension, gender, diabetes, smoking, and body mass index (Tables 2 and 3).

Discussion

Our findings showed that the frequencies of CIN (Cr rising > 0.5) and stage 1 of AKI (Cr rising > 0.3) were 4.5% and 11.5%, respectively, in patients under CECT. The frequency of CIN was reported at 5%–20% in different studies. Controversy in the results is due to the type and dose of contrast, emergency or elective condition, and underlying disease. For example, the prevalence of CIN was 11% in the study of Mitchell et al on 633 patients under contrast-enhanced CT in the emergency department (13). In the study by Cicin et al on 90 cases, the corresponding value was 25.5% and 11% in patients with and without cancer, respectively (14). In another study on 171 patients who received intravenous contrast for the evaluation of pulmonary thromboembolism, Mitchell et al reported the incidence of CIN at 12% (15). Kim et al, evaluating 520 CKD patients, found that the overall incidence of CIN was 2.5%, and in patients with glomerular filtration rate (GFR) < 30 mL/min, it was 12.1% (16). In the study performed by Iakovou et al on 8,628 patients with coronary angioplasty, the incidence of CIN was 16.5%, and it was higher in females compared to males (17). Investigating 8357 patients under percutaneous coronary intervention, Mehran et al indicated that the incidence of CIN was 13.1%. They generated a risk score system for the prediction of CIN after percutaneous coronary intervention, including CKD, hypotension, congestive heart failure, intra-aortic balloon pump, anemia, diabetes, the volume of contrast, and age > 75 years (18). In the study by Lakhal et al on

Table 1. Mean (±SD) of the Age, BMI, and pre- and post-serum cr in patients based on CIN (Cr rising ≥ 0.5) and AKI (Cr rising ≥ 0.3)

Variables	CIN (Cr rising ≥ 0.5 mg/dL)			Cr Rising ≥ 0.3 mg/dL (AKI)		
	With CIN	Without CIN	*P* value	With CIN	Without CIN	*P* value
Age	73.7 ± 14	63.17 ± 20	0.023	71.9 ± 15	62.5 ± 20	0.036
BMI	22.53 ± 1.8	20.4 ± 1.9	0.921	22.54 ± 1.9	20.42 ± 1.3	0.785
Pre Cr	1.80 ± 0.9	1.09 ± 0.8	0.001	1.20 ± 0.7	1.11 ± 0.8	0.348
Post Cr	2.7 ± 1.1	1.02 ± 0.5	0.001	1.80 ± 1.7	1.01 ± 0.6	0.001
P value	0.0002	0.0065		< 0.001	< 0.01	

Note. SD: Standard deviation; CIN: Contrast-induced nephropathy; Cr: Creatinine; AKI: Acute kidney injury; BMI: Body mass index.

Table 2. Relationship of CIN with some variables in patients (CIN as an increase in serum Cr>0.5 of baseline)

Variables	Number (%)		*P* value	Odd ratio
	With CIN, 9 (4.5)	Without CIN, 191 (95.5)		
HTN	7 (77.8)	75 (39.2)	0.20	3.24
IHD	1 (11)	45 (23.6)	0.18	0.23
Diabetes	4 (44.4)	38 (19.9)	0.29	2.25
Renal stone	0 (0)	14 (7.3)	0.87	0.82
Smoking	3 (33)	51 (26.7)	0.46	1.82
Previous contrast injection	2 (22.2)	45 (23.6)	0.70	0.71
Female	6	85	0.38	2.3
Male	3	106		

Note. CIN: Contrast-induced nephropathy; HTN: Hypertension; IHD: Ischemic heart disease.

Table 3. Relationship of AKI with some variables in patients (AKI as an increase in serum Cr>0.3 of baseline)

Variables	Number (%)		*P* value	Odd ratio
	With CIN, 23 (11.5)	Without CIN, 177 (88.5)		
HTN	12 (52)	70 (39.5)	0.71	1.20
IHD	4 (9)	46 (26)	0.18	0.44
Diabetes	5 (22)	37 (21)	0.82	0.88
Renal stone	1 (4)	14 (8)	0.64	0.59
Smoking	5 (22)	49 (28)	0.79	1.18
Previous contrast injection	5 (22)	42 (24)	0.72	0.81
Female	15 (65)	76 (43)	0.10	2.33
Male	8 (35)	101 (57)		

Note. CIN: Contrast-induced nephropathy; HTN: Hypertension; IHD: Ischemic heart disease; AKI: Acute kidney injury.

299 patients in the intensive care unit, the incidence of CIN was 14% (19). The incidence of CIN after 48 hours and 7 days after CECT was 5% and 15%, respectively, in patients with multiple myeloma in the study by Pahade et al (20). In 124 renal transplant patients, the incidence of CIN was 5.6%. Nough et al evaluated 250 patients after coronary angiography or angioplasty and concluded that the incidence of CIN was 12.8%, and recent myocardial infarction and a history of hypertension were the risk factors reported for CIN (21). In another study, Grossman et al examined 13,126 patients undergoing peripheral vascular intervention and found CIN in 3% of the patients. In their study, predictors of CIN were high and low body weight, diabetes mellitus, and emergent procedures (22). Steven et al studied 421 patients with GFR<60 mL/m who received non-emergent CECT and observed that the incidence of CIN was 6.5% (23). Based on the results of a study by Kroneberger et al on 120 patients with GFR<60 mL/m, who received intra-arterial contrast media for the evaluation of perivascular disease, CIN did not occur in any patients with GFR>45 mL/m; however, it occurred in 10.9% of patients with GFR<45 mL/m (24).

The incidence of CIN with the third generation of contrast media (iso-osmolar and nonionic) was reported lower than a second generation (low osmolar and non-ionic). For example, Aspelin et al compared CIN incidence with iodixanol (third generation) versus iohexol (second generation) in 129 diabetic patients with CKD who were candidates for coronary or aorto-femoral angiography, and the incidence of CIN was 3% and 26% in iodixanol and iohexol, respectively (25).

As previously mentioned, contradictions in the results of studies about CIN incidence may be due to study sample size, type of procedure (angiography or CECT), emergent or elective procedure, type and amount of contrast media, and underlying disease of the patients.

In our study, the only risk factor for CIN was advanced age. Some other risk factors mentioned in previous studies are diabetes mellitus, a low effective circulatory volume such as congestive heart failure, underlying CKD, and use of first-generation contrast media.

Conclusion

CIN is not common by using third-generation (isotonic and nonionic) contrast media; however, in high-risk patients such as old age patients, contrast media should be prescribed with careful monitoring of renal function. The study had some limitations, such as a small sample size and short duration of follow-ups (serum Cr rechecked after 5 and 7 days). Hence, it is recommended that future studies consider a larger sample size and longer duration of patient follow-ups.

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Authors' Contributions

Conceptualization: Abdolmajid Taheri, Fatemeh Karimi, Ali Ahmadi, and Ali Momeni.
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Competing Interests

The authors declare that there is no conflict of interests in the study.

Ethical Approval

The study was approved by the Ethics Committee of Shahrekord University of Medical Sciences (code No. IR.SKUMS.REC.1397.102).

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References

1. Wu MY, Lo WC, Wu YC, Lin TC, Lin CH, Wu MS, et al. The incidence of contrast-induced nephropathy and the need of dialysis in patients receiving angiography: a systematic review

and meta-analysis. Front Med (Lausanne). 2022;9:862534. doi: 10.3389/fmed.2022.862534.
2. Solomon R. The role of osmolality in the incidence of contrast-induced nephropathy: a systematic review of angiographic contrast media in high risk patients. Kidney Int. 2005;68(5):2256-63. doi: 10.1111/j.1523-1755.2005.00684.x.
3. Lencioni R, Fattori R, Morana G, Stacul F. Contrast-induced nephropathy in patients undergoing computed tomography (CONNECT) - a clinical problem in daily practice? A multicenter observational study. Acta Radiol. 2010;51(7):741-50. doi: 10.3109/02841851.2010.495350.
4. Palevsky PM, Liu KD, Brophy PD, Chawla LS, Parikh CR, Thakar CV, et al. KDOQI US commentary on the 2012 KDIGO clinical practice guideline for acute kidney injury. Am J Kidney Dis. 2013;61(5):649-72. doi: 10.1053/j.ajkd.2013.02.349.
5. Goldenberg I, Matetzky S. Nephropathy induced by contrast media: pathogenesis, risk factors and preventive strategies. CMAJ. 2005;172(11):1461-71. doi: 10.1503/cmaj.1040847.
6. Maeder M, Klein M, Fehr T, Rickli H. Contrast nephropathy: review focusing on prevention. J Am Coll Cardiol. 2004;44(9):1763-71. doi: 10.1016/j.jacc.2004.06.075.
7. Bucher AM, De Cecco CN, Schoepf UJ, Meinel FG, Krazinski AW, Spearman JV, et al. Is contrast medium osmolality a causal factor for contrast-induced nephropathy? Biomed Res Int. 2014;2014:931413. doi: 10.1155/2014/931413.
8. Shams E, Mayrovitz HN. Contrast-induced nephropathy: a review of mechanisms and risks. Cureus. 2021;13(5):e14842. doi: 10.7759/cureus.14842.
9. Toprak O, Cirit M. Risk factors for contrast-induced nephropathy. Kidney Blood Press Res. 2006;29(2):84-93. doi: 10.1159/000093381.
10. Rear R, Bell RM, Hausenloy DJ. Contrast-induced nephropathy following angiography and cardiac interventions. Heart. 2016;102(8):638-48. doi: 10.1136/heartjnl-2014-306962.
11. Senoo T, Motohiro M, Kamihata H, Yamamoto S, Isono T, Manabe K, et al. Contrast-induced nephropathy in patients undergoing emergency percutaneous coronary intervention for acute coronary syndrome. Am J Cardiol. 2010;105(5):624-8. doi: 10.1016/j.amjcard.2009.10.044.
12. Aoun J, Nicolas D, Brown JR, Jaber BL. Maximum allowable contrast dose and prevention of acute kidney injury following cardiovascular procedures. Curr Opin Nephrol Hypertens. 2018;27(2):121-9. doi: 10.1097/mnh.0000000000000389.
13. Mitchell AM, Jones AE, Tumlin JA, Kline JA. Incidence of contrast-induced nephropathy after contrast-enhanced computed tomography in the outpatient setting. Clin J Am Soc Nephrol. 2010;5(1):4-9. doi: 10.2215/cjn.05200709.
14. Cicin I, Erdogan B, Gulsen E, Uzunoglu S, Sut N, Turkmen E, et al. Incidence of contrast-induced nephropathy in hospitalised patients with cancer. Eur Radiol. 2014;24(1):184-90. doi: 10.1007/s00330-013-2996-6.
15. Mitchell AM, Jones AE, Tumlin JA, Kline JA. Prospective study of the incidence of contrast-induced nephropathy among patients evaluated for pulmonary embolism by contrast-enhanced computed tomography. Acad Emerg Med. 2012;19(6):618-25. doi: 10.1111/j.1553-2712.2012.01374.x.
16. Kim SM, Cha RH, Lee JP, Kim DK, Oh KH, Joo KW, et al. Incidence and outcomes of contrast-induced nephropathy after computed tomography in patients with CKD: a quality improvement report. Am J Kidney Dis. 2010;55(6):1018-25. doi: 10.1053/j.ajkd.2009.10.057.
17. Iakovou I, Dangas G, Mehran R, Lansky AJ, Ashby DT, Fahy M, et al. Impact of gender on the incidence and outcome of contrast-induced nephropathy after percutaneous coronary intervention. J Invasive Cardiol. 2003;15(1):18-22.
18. Mehran R, Aymong ED, Nikolsky E, Lasic Z, Iakovou I, 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(7):1393-9. doi: 10.1016/j.jacc.2004.06.068.
19. Lakhal K, Ehrmann S, Chaari A, Laissy JP, Régnier B, Wolff M, et al. Acute Kidney Injury Network definition of contrast-induced nephropathy in the critically ill: incidence and outcome. J Crit Care. 2011;26(6):593-9. doi: 10.1016/j.jcrc.2011.05.010.
20. Pahade JK, LeBedis CA, Raptopoulos VD, Avigan DE, Yam CS, Kruskal JB, et al. Incidence of contrast-induced nephropathy in patients with multiple myeloma undergoing contrast-enhanced CT. AJR Am J Roentgenol. 2011;196(5):1094-101. doi: 10.2214/ajr.10.5152.
21. Nough H, Eghbal F, Soltani M, Nejafi F, Falahzadeh H, Fazel H, et al. Incidence and main determinants of contrast-induced nephropathy following coronary angiography or subsequent balloon angioplasty. Cardiorenal Med. 2013;3(2):128-35. doi: 10.1159/000351981.
22. Grossman PM, Ali SS, Aronow HD, Boros M, Nypaver TJ, Schreiber TL, et al. Contrast-induced nephropathy in patients undergoing endovascular peripheral vascular intervention: Incidence, risk factors, and outcomes as observed in the Blue Cross Blue Shield of Michigan Cardiovascular Consortium. J Interv Cardiol. 2017;30(3):274-80. doi: 10.1111/joic.12379.
23. Weisbord SD, Mor MK, Resnick AL, Hartwig KC, Palevsky PM, Fine MJ. Incidence and outcomes of contrast-induced AKI following computed tomography. Clin J Am Soc Nephrol. 2008;3(5):1274-81. doi: 10.2215/cjn.01260308.
24. Kroneberger C, Enzweiler CN, Schmidt-Lucke A, Rückert RI, Teichgräber U, Franiel T. Contrast-induced nephropathy in patients with chronic kidney disease and peripheral arterial disease. Acta Radiol Open. 2015;4(6):2058460115583034. doi: 10.1177/2058460115583034.
25. Aspelin P, Aubry P, Fransson SG, Strasser R, Willenbrock R, Lundkvist J. Cost-effectiveness of iodixanol in patients at high risk of contrast-induced nephropathy. Am Heart J. 2005;149(2):298-303. doi: 10.1016/j.ahj.2004.07.020.