Contrast-Induced Nephropathy among adults after administration of intravenous material in the Emergency department at King Abdul-Aziz university hospital

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Abstract

Background: Contrast-induced nephropathy (CIN) is known as the third most common cause of iatrogenic acute kidney injury after severe hypotension and surgery.

Objectives: to assess the risk and estimate the incidence of contrast-induced nephropathy in low-risk patients.

Methods: A retrospective study was done in King Abdul-Aziz University hospital (KAUH), Jeddah, Saudi Arabia. Data about adult patients who underwent CT was collected from electronic records of the Emergency Department. Patients were divided into two groups with and without injections of IV contrast, evenly. Data about patients' demographics, diagnosis, chronic comorbidity, nephrotoxic medication, and serum creatinine were collected.

Results: No significant difference was found in the pre-contrast serum creatinine in both groups, while eGFR was significantly higher among those receiving contrast media. Serum creatinine after 48 hours showed a significantly lower level while eGFR was significantly higher among those receiving contrast media. Before and 48 hours after the radiology, significant improvement was found between serum creatinine and eGFR levels among all patients, while the eGFR showed significant improvement among patients who received contrast media. About 26% of patients showed rising serum creatinine; of them and 10.5% of them matched the KDIGO guidelines for the diagnosis of acute kidney injury. Patients with worsening kidney function were older, diabetics and hypertensives. Age was the most independent predictor for worsening of kidney function..

Conclusion: In the current clinical setting, the administration of contrast media is not associated with an increased incidence of acute kidney injury.

Key words: Nephropathy, Contrast, Emergency, Induced, Risk

List of abbreviations
CIN Contrast–induced nephropathy
ED Emergency Department
IV Intravenous
eGFR Glomerular Filtration Rate
AKI Acute Kidney Injury
DM Diabetes Mellitus
HTN Hypertension
CHD Chronic Kidney Disease

Introduction

After severe hypotension and surgery, CIN is the third most common cause of iatrogenic acute renal damage (1). It is defined as an increase in creatinine level of 0.3 mg/dl or more within 48 hours or 50% above baseline within 7 days after injection of iodinated material used to enhance the vision of critical organs and structures in imaging using X-ray technology (2). As a result, it's been linked to an elevated likelihood of negative consequences. Stroke, dialysis commencement, renal failure, myocardial infarction, and mortality are among the conditions (3).

Contrast-induced nephropathy accounted for 14% of the study's findings, which were conducted in the emergency department (ED) (3). The precise pathophysiology that leads to CIN is unknown (4). Ischemic damage and direct toxic action, on the other hand, are proposed as contributing factors (4).

The highly concentrated contrast will cause the fluid viscosity therapy to increase, lowering the flow rate of tubular epithelial cells and vascular endothelium and increasing the contact time between contrast and tubular epithelial cells, resulting in the generation of radical oxygen species and cell damage (4). Furthermore, the iodine concentration in contrast material is classed as high or low osmolality, which may contribute to an increased risk of harmful effects (5).

Intravenous (IV) contrast material is used in computed tomography (CT) scans to improve tissue quality and visibility, which helps to improve diagnostic accuracy, particularly in vascular diseases. The majority of CT scans performed without contrast enhancement, on the other hand, are based on clinical indications (6).

Risk factors for contrast-induced nephropathy (CIN) include patients with a history of elevated serum creatinine levels as a result of diabetic nephropathy, who are at a higher risk (7). Even though the serum creatinine is in the normal range, the presence of diabetes mellitus is considered dangerous (7). There are also other factors that are specific to the individuals, such as drug-induced nephrotoxicity, heart disease, and being over 70 years old (7).

Amin et al. presented a study from 2000 to 2008 in 2012 that explains the incidence of AKI in patients with acute myocardial infarction who received IV contrast. Despite an increase in the average age of patients from 66.5 to 68.6 years and an increase in the prevalence of AKI risk factors, the incidence of AKI has decreased from 26.6 percent in 2000 to 19.7 percent in 2008. This finding, on the other hand, could indicate adequate pre-contrast assessment (8).

McDonald (2014) conducted a retrospective analysis to compare contrast with non-contrast groups, however the results were unable to replicate relationships between intravenous contrast material delivery and AKI, even in a patient with comorbidities (6).

In 2016 the previous retrospective study of Heller between May 2005 to May 2010 was done in the emergency department to compare between two groups of adult population undergoing computerized tomography scan (CT) with one receiving IV contrast and the other not. The primary goal of this study was to determine the outcomes, which are either dialysis or death as well as the incidence of CIN after using IV contrast media and to compare with the similar group receiving CTs without contrast. The result was there was no significant difference between those two groups (9).

According to recent evidence, around 80 million doses of intravenous contrast media are utilised each year. 3.10, the physician emphasises is the critical importance of confirming the danger of intravenous contrast injection in patients getting contrast-enhanced CT scans in the emergency department (ED). This study aimed to find out the risk and estimate the incidence of contrast-induced nephropathy in low-risk patients.

Subjects and Methods

This was a retrospective cohort approach done in King Abdul-Aziz University hospital (KAUH), Jeddah, Saudi Arabia. This study took place to allow effective comparison between contrast and a non-contrast group of patients who underwent computed tomography scans.

The adult patients who underwent CT were 489 and all data were identified and reviewed from the electronic hospital records system, on emergency department between Feb 2017 and Dec 2017. Of these, 289 cases were excluded due to insufficient serum creatinine data, and the remaining 200 patients were divided into two groups with and without injections of IV contrast evenly.
The study is based on a data collection sheet which involves: adult age patients >18 years, gender, nationality, diagnosis, chronic comorbidity, nephrotoxic medication, serum creatinine measured 8 hours before CT and an after CT measurement 48-72 hours later and whether contrast was used or not. Excluded were patients without established creatinine level either before or following contrast media injection, pregnant patients, and those with a history of kidney transplantation, or ongoing or previous renal dialysis. The research ethical committee at KAUH approved this study.

Ethical Approval: The present study was approved by the research ethics committee of King Abdulaziz University, Jeddah, Saudi Arabia (approval number 595-21, Date : 21 Dec 2021)

Data analysis: Data were analyzed statistically using (SPSS) version 26. To test the relationship between variables, qualitative data was expressed as numbers and percentages, and the Chi-squared test ($\chi 2$) was used. Quantitative data was expressed as mean and standard deviation (Mean ± SD), and non-parametric variables were tested using the Mann-Whitney and Kruskal Wallis tests. Binary logistic regression analysis was done to assess the predictors for worsening of kidney function and a p-value of 0.05 was considered statistically significant.

Results

The baseline demographic and biochemical characteristics for all patients are listed in Table 1. There was no significant difference between the two groups as regards age but the patients who received contrast media were younger. On the other hand, there were no significant differences between the two groups as regards Diabetes Mellitus, HTN, and CHF with (p=0.61, 0.53, and 1) respectively.

Among patients overall, 61% were on more than one medication with potential nephrotoxicity,

15.5% of patients on a single medication, and 23.5% were on no nephrotoxic medications. There was no significant difference between the two groups regarding the medications with potential nephrotoxicity with p=0.062. Among patients overall, radiology was done as a part of sepsis workup in 22% of patients, for differential diagnosis of acute stroke in 13.5% of patients, cancer workup in 11.5% of patients, for acute abdomen diagnosis in 11.5%, for kidney and ureteric calculi diagnosis in 7% of patients,7%, 5.5%, 3.5% and 2.5% of patients were presented with trauma, intestinal obstruction, pulmonary disorders, and sickle cell crisis respectively. At the same time, 16% of our patients were presented with different etiologies, including post-chemotherapy, arthritis, cervical, lumbosacral disc, and others. The clinical presentation was not significantly different between the two groups with p=0.642, as shown in Table 1.

Among study patients overall, radiology evaluation for abdomen and pelvis was done in 55%, for the brain in 18%, pulmonary angiogram in 9.5%, cerebral angiogram in 5.5%, and spine evaluation was done in 4% of patients. Among those who received contrast media abdomen and pelvis, evaluation was done in 71%, pulmonary and cerebral angiograms were done in (18, 11%) respectively. In the other group of patients, 39% were evaluated for abdomen and pelvis, while 44% were evaluated for brain and spinal disorders.

This study showed no significant difference in the pre-contrast serum creatinine in both groups of patients, while eGFR was significantly higher among those who received contrast media with p (0.094, 0.021) respectively. On the other hand, re-evaluation of serum creatinine after 48 hours of the study showed significantly lower serum creatinine level and significantly higher eGFR among those who received contrast media compared to those who did not receive contrast media with p (0.033, 0.003) respectively as shown in Table 2.

Comparison between serum creatinine and eGFR before and 48 hours after the radiology showed significant improvement in serum creatinine and eGFR levels among the studied patients as a whole with p (0.0001). While the eGFR showed significant improvement among patients who received contrast media with p (0.001) as shown in Table 3.

Patients were subdivided according to changes that occurred in serum creatinine level after 48 hours of radiology, 52 (26%) of our patients showed rising serum creatinine in comparison to basal serum creatinine level. Out of them, 21 (10.5%) patients were matching KDIGO guidelines for the diagnosis of acute kidney injury and serum creatinine increased >26 mmol/dl above their basal levels. On the other hand, 148 (74%) of patients showed either improvement or stabilization of their serum creatinine level as shown in Table 4.

Comparison between patients' subgroups was done as shown in Table 5. Patients with worsening kidney function were older with more prevalent diabetes mellitus and hypertension in comparison to others with p (0.003, 0.012, and 0.032) respectively. Out of the 52 patients who showed worsening of their creatinine level, only 19 (36.5%) patients received contrast media.

Binary logistic regression analysis showed that the most independent predictor for worsening of kidney function was patients' age as shown in Table 6.

Table 1: Clinical and demographic criteria of the studied groups of patients

Parameters	Total patients (200)	Contrast (100)	Without contrast (100)	P
Demographic data:				
- Age mean(SEM) years	55(1.4)	51.6(1.92)[a]	58.44(1.92)[a]	0.051
- Gender n(%)				0.849
o Male n(%)	126(63)	65(65)	61(61)	
o Female n(%)	74(37)	35(35)	39(39)	
- Race n(%)				0.1
o Saudi n(%)	176(88)	83(83)[a]	93(93)[a]	
o Non-Saudi n(%)	24(12)	17(17)[a]	7(7)[a]	
Associated co-morbidities and chronic diseases: n(%)				
- Hypertension n (%)	78(39)	35(35)	43(43)	0.61
- DM n (%)	73(36.5)	33(33)	40(40)	0.532
- CHF n (%)	8(4)	4(4)	4(4)	1
Patients on medications with possible nephrotoxicity: n(%)				0.062
- None n(%)	47(23.5%)	29(29%)	18(18%)	
- Single medication n(%)	31(15.5%)	18(18%)	13(13%)	
- More than one medication n(%)	122(61%)	53(53%)	69(69%)	
Indication for Radiology n(%)				
- Infection n(%)	44(22%)	26(26%)	18(18%)	0.642
- Stroke n(%)	27(13.5%)	10(10%)	17(17%)	
- Malignancy n(%)	23(11.5%)	17(17%)	6(6%)	
- Acute Abdomen n(%)	23(11.5%)	16(16%)	7(7%)	
- Kidney/Ureter calculi n(%)	14(7%)	1(1%)	13(13%)	
- Trauma n(%)	11(5.5%)	0	11(11%)	
- Intestinal obstruction n(%)	7(3.5%)	3(3%)	4(4%)	
- Pulmonary embolism n(%)	6(3%)	6(6%)	0	
- Sickle cell disease n(%)	5(%)	4(4%)	1(1%)	
- Other lung disorders n(%)	8(4%)	4(4%)	4(4%)	
- Others n(%)	32(16%)	13(13%)	13(13%)	
Site for Radiology n(%)				
- Abdomen and pelvis n(%)	110(55%)	71(71)	39(39)	0.0001
- Brain n(%)	36(18%)	0	36(36)	
- Pulmonary angiogram n(%)	19(9.5%)	18(18)	1(1)	
- Cerebral Angiogram n(%)	11(5.5%)	11(11)	0	
- Spine n(%)	8(4%)	0	8(8)	
- Chest n(%)	6(3%)	0	6(6)	
- Renal n(%)	3(1.5%)	0	3(3)	
- Others n(%)	7(3.5%)	0	7(7)	

Table 2: Laboratory characteristic of the studied groups of patients

Parameters	Total patients (200)	With Contrast (100)	Without contrast (100)	P Group-1 Vs. Group-2
Serum Creatinine pre-contrast Mean (SEM)	91.7(3.3)	85.1(4.2)	98.4(5.1)	0.094
eGFR pre-contrast Mean(SEM)	88.4(2.98)	94.6(4.1)	82.1(4.3)	0.021
Serum Creatinine post-radiology Mean (SEM)	87.2(3.3)	81.1(4.5)	93.3(4.84)	0.033
eGFR post-radiology Mean (SEM)	98.1(3.96)	106.9(5.3)	89.03(5.8)	0.003

Table 3: Comparison of laboratory data before and after 48 hours of the radiology study in patients who received contrast media

Parameters	Before Contrast	after contrast	P
Serum Creatinine Mean(SEM)	85.1(4.2)	81.1(4.5)	0.255
eGFR Mean(SEM)	94.6(4.1)	106.9(5.3)	0.001
Comparison laboratory data in patients who did not receive contrast media			
Serum Creatinine Mean(SEM)	98.4(5.1)	93.3(4.84)	0.192
eGFR pre-contrast Mean(SEM)	82.1(4.3)	89.03(5.8)	0.061
Comparison laboratory data in all patients			
Serum Creatinine Mean(SEM)	91.7(3.3)	87.2(3.3)	0.0001
eGFR Mean(SEM)	88.4(2.98)	98.1(3.96)	0.0001

Table 4: Serum creatinine changes in the studied groups of patients after radiology

Parameters	Total patients (200)	With Contrast (100)	Without contrast (100)	P Group-1 Vs. Group-2
Stable and improved creatinine n(%)	148(74%)	81(81%)	67(67)	0.04
Rising serum creatinine<26mmole/dl	31(15.5%))	10(10%)	21(21)	
Rising serum creatinine>26mmole/dl	21(10.5)	9(9%)	12(12)	

Table 5: Clinical and demographic criteria of the studied groups of patients according to renal outcome

Parameters	Total patients (200)	Contrast (100)	Without contrast (100)	P
Demographic data:				
- Age mean(SEM) years	55(1.4)	51.6(1.92)[a]	58.44(1.92)[a]	0.051
- Gender n(%)				0.849
o Male n(%)	126(63)	65(65)	61(61)	
o Female n(%)	74(37)	35(35)	39(39)	
- Race n(%)				0.1
o Saudi n(%)	176(88)	83(83)[a]	93(93)[a]	
o Non-Saudi n(%)	24(12)	17(17)[a]	7(7)[a]	
Associated co-morbidities and chronic diseases: n(%)				
- Hypertension n (%)	78(39)	35(35)	43(43)	0.61
- DM n (%)	73(36.5)	33(33)	40(40)	0.532
- CHF n (%)	8(4)	4(4)	4(4)	1
Patients on medications with possible nephrotoxicity: n(%)				0.062
- None n(%)	47(23.5%)	29(29%)	18(18%)	
- Single medication n(%)	31(15.5%)	18(18%)	13(13%)	
- More than one medication n(%)	122(61%)	53(53%)	69(69%)	
Indication for Radiology n(%)				
- Infection n(%)	44(22%)	26(26%)	18(18%)	0.642
- Stroke n(%)	27(13.5%)	10(10%)	17(17%)	
- Malignancy n(%)	23(11.5%)	17(17%)	6(6%)	
- Acute Abdomen n(%)	23(11.5%)	16(16%)	7(7%)	
- Kidney/Ureter calculi n(%)	14(7%)	1(1%)	13(13%)	
- Trauma n(%)	11(5.5%)	0	11(11%)	
- Intestinal obstruction n(%)	7(3.5%)	3(3%)	4(4%)	
- Pulmonary embolism n(%)	6(3%)	6(6%)	0	
- Sickle cell disease n(%)	5(%)	4(4%)	1(1%)	
- Other lung disorders n(%)	8(4%)	4(4%)	4(4%)	
- Others n(%)	32(16%)	13(13%)	13(13%)	
Site for Radiology n(%)				
- Abdomen and pelvis n(%)	110(55%)	71(71)	39(39)	0.0001
- Brain n(%)	36(18%)	0	36(36)	
- Pulmonary angiogram n(%)	19(9.5%)	18(18)	1(1)	
- Cerebral Angiogram n(%)	11(5.5%)	11(11)	0	
- Spine n(%)	8(4%)	0	8(8)	
- Chest n(%)	6(3%)	0	6(6)	
- Renal n(%)	3(1.5%)	0	3(3)	
- Others n(%)	7(3.5%)	0	7(7)	

Table 6: Predictors for worsening of kidney function

		B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	age	.022	.011	4.354	1	.037	1.022	1.001	1.044
	Contrast	-.624-	.349	3.198	1	.074	.536	.271	1.062
	DM	.526	.420	1.569	1	.210	1.693	.743	3.857
	HTN	.054	.435	.015	1	.902	1.055	.450	2.476
	Constant	-2.897-	.716	16.350	1	.000	.055		

a. Variable(s) entered on step1: age, Contrast, DM, HTN.

Discussion

The majority of CIN research was done on patients who have had percutaneous coronary procedures (PCI) (10,11).

This is one of the few studies addressing CIN in the emergency department that we are aware of, and it is the only one in Saudi Arabia. In 2015, a study was conducted in a Saudi tertiary care hospital to assess the incidence and characteristics of CIN victims (12).

All individuals who had a CT scan at an emergency department between February and December 2017 were included in this study. The goal of the study was to determine the risk of contrast-induced nephropathy and estimate the incidence in low-risk patients.

There was no significant difference in the incidence of CIN between those who had a CT scan with contrast and those who did not. This matches the findings of a prior study by J. McDonald et al, 2014 (6).

When blood creatinine levels were re-evaluated after 48 hours of the trial, individuals who received contrast media had significantly lower serum creatinine levels and significantly greater eGFR than those who did not get contrast media. Previous research has found the same thing (13.14.15).

The greatest independent predictor of decreasing kidney function was patients' age, according to binary logistic regression analysis. This conclusion conflicts with Hinson et al 2017 (3), who found no independent influence other than age.

In comparison to others, individuals with decreasing kidney function were older and had greater diabetes mellitus and hypertension, according to this study. Contrast agents have been discovered to be retained by the kidney, causing tubular toxicity and the formation of reactive oxygen species, both of which can exacerbate renal damage (16,17,18).

Furthermore, numerous studies found that patients over the age of 65 had a higher prevalence of CIN, presumably reflecting a deterioration in renal function with age. Increased arterial stiffness, decreased endothelial function, and diminished vasodilator responses, as well as a lower ability for vascular repair with pluripotent stem cells, are all linked to advanced age. All of these variables raise the risk of CIN in older people and limit their ability to recover quickly (19).

Diabetics with CKD have a fourfold increased chance of acquiring CIN as compared o those without diabetic nephropathy (18,20,21,22).

Diabetes mellitus with renal insufficiency has been established as an independent risk factor for contrast nephropathy, with up to 56% of individuals diagnosed developing irreversible renal failure. Diabetics with advanced chronic kidney disease (serum creatinine >3.5 mg/dL) are more likely to acquire CIN (21,22).

Limitations

The small sample size and wide range of serum creatinine levels at presentation (0.23 mg/dL to 312 mg/dL) were two of the study's shortcomings.

Conclusion

The use of a randomized prospective trial to determine the link between intravenous contrast media and the development of contrast-induced nephropathy is beneficial. The findings of this study show that in today's clinical setting, contrast media delivery is not linked to an elevated risk of acute renal injury.

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