Intravenous contrast medium and renal outcomes in pre-existing acute kidney injury - a multicenter propensity-score adjusted study

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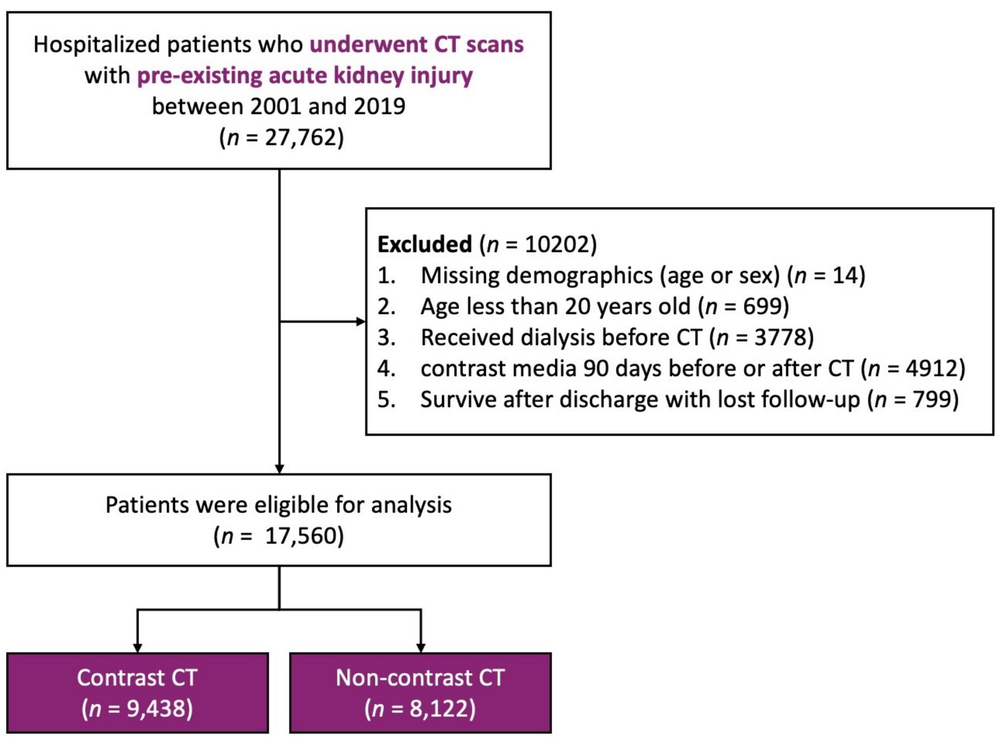
Introduction

Intravenous contrast media are commonly used with CT to enhance image quality and diagnostic precision in hospitalized patients. Recent studies have suggested that the likelihood of developing contrast-induced acute kidney injury (CI-AKI) is trivial, and the etiology of post-contrast AKI appears to be multifactorial, including concurrent sepsis, volume depletion, and nephrotoxic drug use. Even so, the concern for CI-AKI persists in clinical settings. Nonetheless, although contrast-enhanced CT is occasionally critical for the clinical management of hospitalized patients with pre-existing AKI, evidence is limited addressing the subsequent risk of evolving to persistent AKI, acute kidney disease (AKD), and the requirement of dialysis.

Methods and Materials

This retrospective multicenter study included hospitalized patients with pre-existing acute kidney injury (AKI) who underwent CT scans from 2001 to 2019 and had at least two serum creatinine (Scr) values within 7 days prior the index CT. Figure 1 shows the flowchart of the study. To control for confounding factors when comparing outcomes between patients with and without contrast media, we used the inverse probability of treatment weighting (IPTW) based on propensity score estimated by generalized boost model. The balance of covariates between the groups was checked using the absolute value of standardized difference (STD), where a value less than 0.1 was considered negligible difference. The association between contrast media and renal outcomes was estimated using logistic regression in the IPTW-adjusted cohort.

Figure 1. Flow chart of the study population



Results

A total of 17560 patients (mean age, 66.3 ± 15.3 years; 57.1% men) were enrolled; 9438 received contrast CT, and 8122 received non-contrast CT (**Table 1**). Before weighting, patients who underwent non-contrast CT were older, had more comorbidities (eg, diabetes mellitus: 41.7% vs 32.5%), and had higher preadmission Scr. Patients who underwent non-contrast CT also had more severe pre-CT AKI, as evidenced by higher peak Scr (3.1 ± 2.3 vs 1.9 ± 1.4) and a greater prevalence of AKI stage 3 (34% vs 21%), and higher pre-CT Scr (2.7 ± 2.2 vs 1.3 ± 1.0). After applying IPTW, baseline characteristics including pre-CT AKI condition and conditions within 7 days before index CT were similar and balanced between contrast CT group and non-contrast CT group (**Table 1**).

Table 2 shows the outcomes in the IPTW-adjusted cohort. The overall weighted incidence of post-CT 7-day AKI (19.0 vs. 19.1%) was similar between contrast CT and non-contrast CT group, but post-CT 7-day dialysis rates was significantly higher in the contrast group (5.9 vs. 4.8%, OR: 1.23, 95% CI: 1.12, 1.36, P<0.001). However, no significant differences were found in the 30-day AKD rate (21.0 vs 20.7%, OR: 1.02, 95% CI: 0.97, 1.08, P=0.443) and the 30-day dialysis rate (5.0 vs 4.7%, OR: 1.08, 95% CI: 0.98, 1.20, P=0.122) between contrast CT and non-contrast group.

Table 1. Baseline patient characteristics

Variable	Before GBM-IPTW‡			After GBM-IPTW†	
	Contrast (*n* = 9438)	Non-contrast (*n* = 8122)	*STD*	Contrast	Non-contrast
Age, year	64.6 ± 15.3	68.4 ± 15.2	-0.25	65.9 ± 15.2	66.7 ± 15.4
Male	5481 (58.1)	4546 (56.0)	0.04	57.4	57.0
Comorbidity					
Diabetes mellitus	3,072 (32.5)	3,388 (41.7)	-0.19	34.7	38.3
Chronic kidney disease	1,332 (14.1)	2,838 (34.9)	-0.50	22.3	24.6
CCI score	4.5 ± 3.0	4.5 ± 2.9	0.01	4.4 ± 3.0	4.4 ± 2.9
Preadmission Scr, mg/dl	0.8 ± 0.6	1.2 ± 1.2	-0.44	1.0 ± 1.0	1.0 ± 1.0
Pre-CT AKI condition					
Peak Scr, mg/dl	1.9 ± 1.4	3.1 ± 2.3	-0.63	2.3 ± 1.8	2.5 ± 2.0
AKI stage 1/2/3, %	47/32/21	34/32/34	-0.30	43/32/25	40/33/27
Days from AKI to CT	8.1 ± 11.5	4.7 ± 8.9	0.33	6.8 ± 10.7	6.4 ± 10.6
Pre-CT Scr, mg/dl	1.3 ± 1.0	2.7 ± 2.2	-0.80	1.8 ± 1.6	2.0 ± 1.8
Conditions within 7 days before CT					
Admitted to ICU	4,701 (49.8)	4,462 (54.9)	-0.10	53.7	53.5
Sepsis	6,622 (70.2)	5,618 (69.2)	0.02	69.6	70.2
Mechanical ventilation	2,234 (23.7)	2,470 (30.4)	-0.15	27.5	28.4
Norepinephrine use	756 (8.0)	935 (11.5)	-0.12	10.4	10.2
Crystalloid hydration	3,083 (32.7)	2,715 (33.4)	-0.02	34.6	33.4
Prescribed medication					
NSAID	2,613 (27.7)	1,693 (20.8)	0.16	26.1	22.9
Vancomycin	1,024 (10.8)	670 (8.2)	0.09	10.3	9.1
Aminoglycoside	1,198 (12.7)	721 (8.9)	0.12	11.9	10.2
ACEI/ARB	1,692 (17.9)	1,761 (21.7)	-0.09	19.1	20.9
Diuretics	5,156 (54.6)	4,518 (55.6)	-0.02	55.1	54.6

Abbreviation: GBM-ITPW, generalized boosted modeling-inverse probability of treatment weighting; STD, standardized difference; CCI, Charlson comorbidity index; Scr, serum creatinine; AKI, acute kidney injury; ICU, intensive care unit; NSAID, non-steroidal anti-inflammatory drugs

Table 2. Outcomes of total event rate after GBM-ITPW

Outcome	Contrast	Non-contrast	OR (95% CI) of contrast	P value
Post-CT 7 days				
AKI	**19.0 %**	**19.1 %**	**0.995 (0.94, 1.05)**	**0.851**
Stage 1	6.0 %	5.7 %	1.04 (0.95, 1.14)	0.437
Stage 2	3.5 %	3.5 %	0.99 (0.88, 1.12)	0.924
Stage 3 or dialysis	9.6 %	9.9 %	0.97 (0.90, 1.04)	0.417
Dialysis only	5.9 %	4.8 %	1.23 (1.12, 1.36)	<0.001
Post-CT 30 days				
AKD	**21.0 %**	**20.7 %**	**1.02 (0.97, 1.08)**	**0.443**
Stage 1	6.4 %	6.2 %	1.04 (0.95, 1.14)	0.371
Stage 2	4.3 %	4.4 %	0.97 (0.87, 1.08)	0.612
Stage 3 or dialysis	10.3 %	10.0 %	1.03 (0.96, 1.11)	0.426
Dialysis only	5.0 %	4.7 %	1.08 (0.98, 1.20)	0.122

Conclusions

The utilization of contrast-enhanced CT scans in patients with pre-existing acute kidney injury (AKI) was not associated with a higher risk of post-CT AKI; however, it was associated with a higher risk of 7-day dialysis, while no significant association was observed with the incidence of post-CT 30-day acute kidney disease (AKD) and dialysis.

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