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Risk of Acute Kidney Injury, Dialysis, and Mortality in Patients With Chronic Kidney Disease After Intravenous Contrast Material Exposure

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Abstract

Objective: To examine the effect of intravenous iodinated contrast material administration on the subsequent development of acute kidney injury (AKI), emergent dialysis, and short-term mortality using a propensity score–adjusted analysis of computed tomographic scan recipients with chronic kidney disease (CKD).

Patients and Methods: In this institutional review board–approved retrospective study, all patients with CKD who received a contrast-enhanced (contrast group) or unenhanced (noncontrast group) computed tomographic scan from January 1, 2000, to August 1, 2013 were identified. Patients were subdivided into CKD stage III (baseline estimated glomerular filtration rate, 30-59 mL/min per 1.73 m^2) and CKD stage IV-V (baseline estimated glomerular filtration rate, <30 mL/min per 1.73 m^2) subgroups and separately underwent propensity score generation, stratification, and 1:1 matching. Rates of AKI, 30-day emergent dialysis, and mortality were compared between contrast and noncontrast groups. Sensitivity analyses examining only patients with stable prescan serum creatinine levels and incorporating intravenous fluid administration at the time of the CT scan into the model were also performed.

Results: A total of 6902 patients (4496 CKD stage III, matched: 1220 contrast and 1220 noncontrast; 2086 CKD stage IV-V, matched: 491 contrast and 491 noncontrast) were included in the study. After propensity score adjustment, rates of AKI, emergent dialysis, and mortality were not significantly higher in the contrast group than in the noncontrast group in either CKD subgroup (CKD stage III: OR, 0.65-1.00; $P<.001$-.99 and CKD stage IV-V: OR, 0.93-2.33; $P=.22$-.99). Both sensitivity analyses revealed similar results.

Conclusion: Intravenous contrast material administration was not associated with an increased risk of AKI, emergent dialysis, and short-term mortality in a cohort of patients with diminished renal function.

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Concern for the development of acute kidney injury (AKI) after the administration of iodinated contrast material, also known as contrast-induced nephropathy (CIN), often limits the use of contrast material in patients at risk of developing this complication.[1,2] However, recent research suggests that the incidence and severity of CIN have been overestimated by previous uncontrolled studies.[3-5] In these previous studies, all instances of AKI after contrast material administration were routinely ascribed to CIN, even though there are myriad causes of AKI in hospitalized patients. Controlled studies with clinically similar patients who did not receive contrast material are essential to help differentiate true CIN from contrast-independent AKI.

Two recent large retrospective studies by Davenport et al[6] and McDonald et al[7] used propensity score matching to compare contrast-enhanced computed tomographic (CT) scan recipients and clinically similar patients who underwent an unenhanced CT scan. Both studies found that the rate of AKI was similar between

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contrast recipients and control groups in patients with baseline estimated glomerular filtration rate (eGFR) greater than 30 mL/min per 1.73 m^2, providing evidence that CIN may not be a clinical concern in these patients. However, disparate results were reported for patients with baseline eGFR less than 30 mL/min per 1.73 m^2, with the study by McDonald et al reporting similar rates of AKI between the 2 groups and the study by Davenport et al reporting significantly higher rates of AKI in contrast recipients ($P<.05$), suggestive of CIN. Several potential explanations for these dissimilar results have been postulated, including differences in clinical covariates included in the studies' propensity score models, differences in the clinical and demographic characteristics of the patient populations, and whether the study included or excluded patients with unstable serum creatinine (SCr) before their CT scan.[8,9]

The objectives of the present study were to perform a more rigorous propensity score analysis of CT scan recipients with renal insufficiency (eGFR, <60 mL/min per 1.73 m^2) and to determine the risk of AKI, emergent dialysis, and mortality after exposure to intravenous contrast material.

PATIENTS AND METHODS

Study Design and Clinical Data Retrieval

Design and execution of this single-center retrospective study were subject to institutional review board oversight and Health Insurance Portability and Accountability Act privacy guidelines. The need for informed consent was waived. All clinical data were extracted from our electronic medical record (EMR) using a combination of relational database software (DDQB, IBM Corp) and manual chart review. Additional details of data retrieval and analysis are provided in the Supplemental Appendix (available online at http://www.mayoclinicproceedings.org).

Inclusion and Exclusion Criteria

Many patients in the present study were included in previous publications that examined the incidence of AKI, emergent dialysis, and mortality in patients who received a contrast-enhanced or unenhanced CT scan.[7,10,11] We wanted to improve on these previous studies by (1) including a more comprehensive list of clinical variables related to renal insufficiency in the propensity score model to reduce confounding and better match contrast recipients and control patients; (2) performing a full chart review of the patient's record to confirm comorbidities and medical conditions instead of relying on *International Classification of Diseases, Ninth Revision* (*ICD-9*) diagnostic codes, which have been shown to be inaccurate in some cases;[12-14] and (3) including CT scans performed through July 2013 to better reflect current clinical practices.

Adult patients (18 years or older) were included in the present study if they (1) received an unenhanced (noncontrast group) or intravenous contrast-enhanced (contrast group) abdominal, pelvic, and thoracic CT scans from January 2000 to August 2013 at our institution; (2) had at least 2 prescan (in 24 hours before the scan) SCr results and at least 1 postscan (24-72 hours after the scan) SCr result; and (3) had a baseline eGFR of less than 60 mL/min per 1.73 m^2 at the time of the CT scan, as calculated below. Patients were excluded if they (1) had preexisting renal dialysis requirements; (2) did not have the pre- and postscan SCr results, as described above; (3) were missing any clinical variables included in the propensity score model (listed in Table 1); or (4) received intravenous or intra-arterial contrast material from another examination or procedure within a 14-day period of the CT scan. When a patient received multiple CT scans over the study time frame, only the last CT scan was included in the analysis to eliminate sampling bias and maximize the probability of identification of disease. Detailed information regarding inclusion and exclusion criteria is given in the Supplemental Appendix.

Baseline Renal Function

All SCr data associated with each CT scan record were extracted from the EMR and temporally sorted with respect to the date of the scan. Baseline eGFR was calculated for each patient from the SCr result(s) 24 hours before the CT scan using the Modification of Diet in Renal Disease equation based on the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (KDOQI) recommendations, as described previously.[7] Patients were stratified by baseline eGFR into 30 to 59 mL/min per 1.73 m^2 (CKD stage III) and less than 30 mL/min per 1.73 m^2 (CKD stage IV-V) subgroups to mirror the KDOQI classification of chronic kidney disease (CKD).[15]