Acute Kidney Injury After Computed Tomography: A Meta-analysis

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Study objective: Computed tomography (CT) is an important imaging modality used in the diagnosis of a variety of disorders. Imaging quality may be improved if intravenous contrast is added, but there is a concern for potential renal injury. Our goal is to perform a meta-analysis to compare the risk of acute kidney injury, need for renal replacement, and total mortality after contrast-enhanced CT versus noncontrast CT.

Methods: We searched MEDLINE (PubMed), the Cochrane Library, CINAHL, Web of Science, ProQuest, and Academic Search Premier for relevant articles. Included articles specifically compared rates of renal insufficiency, need for renal replacement therapy, or mortality in patients who received intravenous contrast versus those who received no contrast.

Results: The database search returned 14,691 articles, inclusive of duplicates. Twenty-six unique articles met our inclusion criteria, with an additional 2 articles found through hand searching. In total, 28 studies involving 107,335 participants were included in the final analysis, all of which were observational. Meta-analysis demonstrated that, compared with noncontrast CT, contrast-enhanced CT was not significantly associated with either acute kidney injury (odds ratio [OR] 0.94; 95% confidence interval [CI] 0.83 to 1.07), need for renal replacement therapy (OR 0.83; 95% CI 0.59 to 1.16), or all-cause mortality (OR 1.0; 95% CI 0.73 to 1.36).

Conclusion: We found no significant differences in our principal study outcomes between patients receiving contrast-enhanced CT versus those receiving noncontrast CT. Given similar frequencies of acute kidney injury in patients receiving noncontrast CT, other patient- and illness-level factors, rather than the use of contrast material, likely contribute to the development of acute kidney injury. [Ann Emerg Med. 2017;■:1-10.]

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INTRODUCTION

Background

Computed tomography (CT) is an important imaging modality used for the analysis of a variety of disorders, with more than 75.6 million CT scans performed in the United States in 2013 alone.[1] Intravenous contrast is required for certain scans, including CT angiograms to diagnose aortic dissection or pulmonary embolism, and may improve imaging quality in other cases.[2]

The concern over postcontrast acute kidney injury, historically referred to as contrast-induced nephropathy, has caused many institutions to adopt guidelines requiring measurement of renal function before contrast administration or restricting the use of intravenous contrast in patients with possible renal insufficiency. Postcontrast acute kidney injury is loosely understood as an increase in creatinine level or decrease in glomerular filtration rate after contrast administration. However, there is no consistent definition of postcontrast acute kidney injury that has been used across studies. The most common descriptions include an increase in creatinine level by 25% after contrast administration or an absolute increase of 0.3 to 0.5 mg/dL within 3 days.[3,4] Because postcontrast acute kidney injury is a laboratory-based diagnosis, its potentially adverse effects on various patient-centered outcomes are less clear.

Importance

The incidence of postcontrast acute kidney injury is imprecise, with one meta-analysis reporting occurrences ranging from 1% to greater than 20%.[5] Possible explanations include heterogeneous definitions of postcontrast acute kidney injury, differences in rates of postcontrast acute kidney injury after procedures versus CT scans, and differing characteristics of the patient populations. Recent recommendations from the American

Editor's Capsule Summary

What is already known about this topic

Recent literature suggests that patients receiving contrast for computed tomography (CT) imaging may be at less risk for postcontrast acute kidney injury than previously feared.

What question this study addressed

What is the risk of acute kidney injury, renal replacement therapy, and mortality after CT with intravenous contrast compared with noncontrast CT?

What this study adds to our knowledge

This meta-analysis of 28 observational studies including more than 100,000 patients found no significant association between contrast CT and examined outcomes.

How this is relevant to clinical practice

There are various definitions of postcontrast acute kidney injury, potential selection bias, and differing populations, exposures, and comorbidities in published studies. Clinicians should continue to follow current practices, which appear to be effective in avoiding postcontrast acute kidney injury.

College of Radiology attribute much of the incidence of postcontrast acute kidney injury to the patient's underlying comorbidities rather than to the contrast material, but the studies reporting postcontrast acute kidney injury after CT scans vary in quality and association with intravenous contrast.[2]

Goals of This Investigation

We performed a systematic review and meta-analysis of the available published literature to compare the rates of acute kidney injury, the receipt of renal replacement therapy, and mortality in adult populations receiving contrast-enhanced CT versus those receiving noncontrast CT.

MATERIALS AND METHODS

This meta-analysis was registered on the PROSPERO registry and performed according to the Preferred Reporting Items for Systematic Reviews and Meta-analyses and the Meta-analysis of Observational Studies in Epidemiology guidelines.[6]

Literature Search and Selection of Studies

Our goal was to identify all adult human studies that compared the incidence of renal insufficiency in patients who underwent contrast-enhanced CT scans with patients who received noncontrast CT scans. With the aid of a medical librarian (J.L.B.), we searched MEDLINE (PubMed), the Cochrane Library, CINAHL, Web of Science, ProQuest, and Academic Search Premier up to December 2016 for relevant published studies, using a search strategy that included variations of the terms "contrast media," "computed tomography," and "nephropathy." The search strategy is included in Figure E1, available online at http://www.annemergmed.com. The authors hand searched the references of systematic reviews and meta-analyses for additional original articles. Conference abstracts between 2009 and 2016 from the American Society of Nephrology, the American College of Radiology, and the Society for Academic Emergency Medicine were hand searched for abstracts meeting inclusion criteria. This search was conducted iteratively until no new potential citations were found. One author (E.M.S.) subscribed to PubMed alerts and articles-in-press feeds of high-impact emergency medicine, radiology, and nephrology journals to identify new articles through the end of the abstract screening process. The final articles included in this meta-analysis were then searched in Google Scholar for any additional prospectively discovered citations. Two authors (R.D.A. and L.M.W.) independently screened all titles and abstracts for our predefined inclusion and exclusion criteria. The same 2 authors independently read the retained full-text articles for fulfillment of inclusion criteria, which included noninterventional, adult studies assessing renal insufficiency with contrast-enhanced CT and noncontrast CT arms. There were no language restrictions. Because we aimed to assess the risk of postcontrast acute kidney injury after CT scan in the acute care setting, we excluded articles on pediatrics and intra-arterial procedures (including percutaneous coronary angiography), studies on prevention strategies (eg, *N*-acetylcysteine, sodium bicarbonate drips), case reports, review articles, clinical guidelines, and other meta-analyses.

Data Extraction

Data were extracted independently from articles with a piloted, standardized data collection form (CTCIA; Tufts Medical Center, Boston, MA). Discordances at all stages were resolved through discussion. When data were unclear, we contacted authors of potentially includable articles by e-mail and social media (LinkedIn, Twitter, and ResearchGate) to clarify our questions. Extracted information included body area scanned, study setting, total