Incidence of Radiocontrast Nephropathy in Patients Undergoing Acute Stroke Computed Tomography Angiography

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Background and Purpose—Minimal research has evaluated the renal safety of emergent computed tomography angiography (CTA) procedures, consecutive contrast medium application, and the long-term outcome in acute stroke patients. We investigated the incidence of contrast-induced renal impairment in these populations.

Methods—We retrospectively reviewed patients with acute stroke syndrome who received a CTA of the brain with or without the neck within 24 hours from onset of symptoms. All creatinine results and additional conventional angiography findings were recorded. With a positive history of renal disease, contrast administration was delayed until creatinine results were available. Radiocontrast nephropathy (RCN) was defined as a ≥25% increase in serum creatinine from the baseline value up to 5 days after CTA.

Results—Four hundred eighty-one patients were reviewed, and 224 met the inclusion criteria. There were 7 of 224 (3%) who fulfilled the criteria for RCN. A number of patients underwent emergent CTA without knowledge of their creatinine value; 2 of 93 (2%) developed RCN. There were 36 patients who received an additional digital subtraction angiogram, and none of these developed subsequent RCN. No patients required dialysis, and 9 of 68 (13%) had a >25% increase in their creatinine levels at a late (>30 days) follow-up.

Conclusions—Overall, these results illustrate that there is a low incidence of RCN in acute stroke patients undergoing emergency CTA. **(*Stroke*. 2007;38:2364-2366.)**

Key Words: CT angiography ■ digital subtraction angiography ■ radiocontrast nephropathy ■ renal impairment

Computed tomography (CT) bolus techniques have the advantage of minimizing treatment delays but require the use of a nonionic contrast agent. One apprehension surrounding these techniques is the concern of causing radiocontrast nephropathy (RCN). RCN is defined as an increase in the serum creatinine value by >25% occurring within 3 days after the administration of contrast medium.[1]

First, the time from stroke onset to thrombolysis treatment is strongly associated with subsequent outcome in acute stroke.[2] In acute stroke when time is critical, treatment delay due to waiting for a creatinine result is not desirable.[3] Only 1 study has examined the rate of RCN in patients with unknown baseline creatinine levels.[4]

Second, it is known that the risk for RCN is proportional to the dose of radiocontrast medium administered.[5–7] It has been suggested that multiple, consecutive procedures requiring the use of contrast medium application implies a greater risk for RCN.[8] There have been no large studies examining the safety of consecutive contrast media application in acute stroke for CT angiography (CTA) and digital subtraction angiography (DSA).

Third, the long-term outcome in patients undergoing radiocontrast application is unknown. Although serum creatinine levels may return to baseline shortly after receiving contrast medium, some patients may encounter permanent renal sequelae requiring additional medical care.[9]

This study sought to determine the frequency of renal sequelae in both the short and long term in acute stroke patients as well as in patients who underwent additional contrast studies for angiography within 24 hours.

Patients and Methods

In a retrospective analysis, all patients who presented with an acute stroke syndrome to our Emergency Department from April 2002 until April 2005 and who received CTA of the Circle of Willis with or without the neck were reviewed. Inclusion criteria were as follows: (1) a baseline creatinine result, (2) CTA examination performed within 24 hours of symptom onset, and (3) an available early (<5 days after CTA) follow-up creatinine result.

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Demographic information including known risk factors for RCN (presence of diabetes, known renal disease, or use of metformin) was collected. All available follow-up creatinine results were collected from day 1 to day 5 after the baseline CTA. A late follow-up creatinine result (>30 days) was recorded when available.

As per institutional protocol, 75 to 100 mL of the nonionic, low-osmolar contrast agent Ioversol (Optiray 320) was administered during the CTA. Patients receiving further DSA imaging were recorded, and the additional dose of contrast agent was noted. We documented whether a patient experienced acute renal failure requiring dialysis.

If there was no history of renal disease, emergency CTA without knowledge of a creatinine result was performed. If patients had known kidney disease, CTA was performed if their creatinine values did not exceed 100 μmol/L for women and 120 μmol/L for men. Patients were grouped according to 3 criteria: (1) creatinine result was unavailable at the time of CTA, (2) creatinine result was available at the time of CTA, and (3) additional DSA was performed within 24 hours of the initial CTA. RCN was defined as a ≥25% increase from the baseline creatinine value to the peak value of creatinine within 5 days after CTA.[1]

Results

A total of 481 patients with suspected stroke who underwent CTA within 24 hours of symptom onset were reviewed for the study, and 224 patients met the inclusion criteria. There were 257 patients who were excluded from analysis for not having a short-term follow-up creatinine result. There were 86 (38%) female patients, the mean±SD age was 68.2±14.1 years, and the median time from symptom onset to CTA was 216 minutes (range, 31 to 1444 minutes). There were 21 (9%) patients on metformin, 2 (0.9%) with a history of renal disease (baseline creatinine was known before CTA), and 85 (38%) with diabetes.

Ninety-three patients underwent CTA without knowledge of their baseline creatinine result. Only 2 patients (2%) developed RCN. The median absolute increase in creatinine levels was −9 μmol/L (range, −118 to 26 μmol/L). The late follow-up creatinine result was available for 19 patients (mean, 356 days) and was elevated by ≥25% in 2 (11%) patients. The median absolute increase in creatinine in the long term was −8 μmol/L (range, −72 to 24 μmol/L).

Conversely, there were 131 patients who underwent CTA examination after their creatinine laboratory result was available. RCN was identified in 5 (4%) patients. The median absolute increase in creatinine levels was −5 μmol/L (range, −95 to 41 μmol/L). The late follow-up creatinine result was available for 49 patients (mean, 306 days) and was elevated by ≥25% in 7 (14%) patients. The median absolute increase in creatinine in the long term was −3 μmol/L (range, −61 to 74 μmol/L).

Thirty-six patients received an additional DSA within 24 hours of the CTA examination. The additional dose of contrast agent was available for 30 (83%) patients, with a mean dose of 110 mL (range, 34 to 231 mL). No patients in this group experienced RCN. The long-term creatinine value was available for 7 patients (mean, 390 days) and was elevated by 25% from baseline in none of these patients. The median absolute increase in creatinine was −1 μmol/L (range, −22 to 23 μmol/L).

Overall, in the 481 patients studied, no patient experienced renal failure needing dialysis. The rate of RCN was 7 of 224 (3%) in patients with an early follow-up creatinine result, and 9 of 68 (13%) patients had a >25% rise in their late creatinine result.

Discussion

Only 1 study has examined RCN in acute stroke patients undergoing contrast-enhanced studies without prior knowledge of a creatinine result.[4] Those authors found that no patients experienced severe effects related to contrast medium administration.[4] Another study confirmed low RCN rates (4.8%) in a review of 1075 acute and subacute stroke patients undergoing CT bolus techniques.[3] The low incidence of RCN in those studies and confirming evidence from our data emphasize that CTA can be used safely without delaying patient treatment.[3,4]

This study is the first to evaluate DSA and CTA sequentially in acute stroke that revealed no increased risk for RCN when there was no history of renal impairment. This study also evaluated the safety of contrast medium application in the long term in a subset of patients. A small percentage (10%) of patients had a >25% rise in their creatinine result, but no one experienced renal failure. Although a late rise in creatinine values was seen in a small percentage of patients, this rise may not have been solely due to the radiocontrast agent administered. Many factors such as dehydration, drugs administered, and hemodynamic complications might have contributed to a rise in creatinine values.

One limitation to this study was that we did not consider the estimated glomerular filtration rate to determine the risk for developing RCN. However, it is known that baseline creatinine values are an independent predictor of RCN.[6,7] An added limitation was that only a small proportion of patients received additional acute DSA or a late follow-up creatinine result. Finally, because this study was retrospective, patient groups (unknown versus known creatinine groups) cannot be compared. A study with a randomized allocation to contrast versus noncontrast groups might produce different results.[10]

Patients undergoing emergency CTA at our center had a low incidence of early RCN and a low incidence of long-term renal impairment. RCN was not increased in patients without an available creatinine result at the time of CTA when the history was negative for renal disease. RCN was also low when both CTA and subsequent conventional angiography were performed. The low risk of RCN and the high benefit (minimizing treatment delays) provide justification for the use of contrast agents in the absence of a creatinine result.

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Correction

In the article entitled "Incidence of Radiocontrast Nephropathy in Patients Undergoing Acute Stroke Computed Tomography Angiography" by Krol et al,[1] all references to mmol/L should be corrected to μmol/L. The authors regret this error.

The corrected version of this article can now be viewed online at http://stroke.ahajournals.org.

[1] *[Correction for Vol 38, Number 8, August 2007. Pages 2364–2366.]*
(*Stroke*. 2007;38:e97).