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Extravasation Risk Using Ultrasound Guided Peripheral Intravenous Catheters for Computed Tomography Contrast Administration

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Abstract

Objective—Ultrasound guided intravenous catheter (USGIV) insertion is increasingly being used for administration of intravenous contrast for computed tomography (CT) scans. The goal of this investigation was to evaluate the risk of contrast extravasation among patients receiving contrast through USGIV catheters.

Methods—A retrospective observational study of adult patients who underwent a contrast-enhanced CT scan at a tertiary-care emergency department during a recent 64-month period was conducted. The unadjusted prevalence of contrast extravasation was compared between patients with an USGIV and those with a standard peripheral IV inserted without ultrasound. Then, a two-stage sampling design was used to select a subset of the population for a multivariable logistic regression model evaluating USGIVs as a risk factor for extravasation while adjusting for potential confounders.

Results—In total, 40,143 patients underwent a contrasted CT scan, including 364 (0.9%) who had contrast administered through an USGIV. Unadjusted prevalence of extravasation was 3.6% for contrast administration through USGIVs and 0.3% for standard IVs (relative risk: 13.9, 95% CI: 7.7 to 24.6). After adjustment for potential confounders, CT contrast administered through USGIVs was associated with extravasation (adjusted odds ratio: 8.6; 95% CI: 4.6, 16.2). No

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Potential Conflict of Interest:

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patients required surgical management for contrast extravasation; one patient in the standard IV group was admitted for observation due to extravasation.

Conclusions—Patients who received contrast for a CT scan through an USGIV had a higher risk of extravasation than those who received contrast through a standard peripheral IV. Clinicians should consider this extravasation risk when weighing the risks and benefits of a contrast-enhanced CT scan in a patient with USGIV vascular access.

INTRODUCTION

Ultrasound guided peripheral intravenous catheter (USGIVs) insertion is increasingly used in emergency department (ED) patients after initial attempts with standard insertion techniques have failed.¹ With the expanded use of USGIVs, contrast media for computed tomography (CT) scans is now being administered through USGIVs in many EDs. Recent small studies have suggested USGIVs may be associated with a high risk of extravasation, but the risk of extravasation with USGIVs compared to standard peripheral IVs has not been well studied.² Therefore, we compared the risk of CT scan IV contrast media extravasation between patients with USGIV catheters and standard peripheral IV catheters placed without ultrasound.

METHODS

Study Design, Setting and Population

This was a retrospective, observational study conducted between January 2009 and April 2014 in an academic, tertiary-care ED in the United States. During this time, treating physicians had the option of inserting an USGIV as part of routine care after initial attempts at peripheral IV access failed.

Adults (≥ 18 years old) who underwent a CT scan with IV contrast in the study ED were included. These patients were categorized into two exposure groups according to the type of IV catheter used for contrast administration: USGIV or standard IV placed without ultrasound.

Outcome Measures

The primary outcome of the study was extravasation of IV contrast during the CT scan. By radiology departmental policy, contrast extravasation was considered a patient safety incident and required mandatory reporting by CT technologists using an electronic reporting system. Using this system, study investigators identified patients with a reported contrast extravasation event in the ED and reviewed medical records to confirm a true extravasation event. Extravasation events were classified as having no change in clinical management vs. any change in clinical management. Changes in clinical management included: (1) plastic surgery consultation; (2) unexpected hospital admission due to extravasation; and (3) surgical intervention.

Data Analysis

Analyses were conducted with a two-staged sampling design.^{3,4} First, the entire study population of unique patients who underwent a CT scan with IV contrast was analyzed to calculate the risk (prevalence) of contrast extravasation in the USGIV and standard IV groups. Unadjusted relative risk and risk difference were calculated using the standard IV group as the referent.

Second, a sub-cohort of the study population was analyzed to assess the association of using an USGIV for contrast administration and extravasation while adjusting for patient-level covariates in a multivariable model. Including the full study population (n=40,143) in the multivariable analysis was not feasible due to the large sample size and the need to collect covariate data by chart review. Using a 2×2 contingency table, patients in the full study population were classified based on the primary exposure (USGIV vs standard IV) and outcome (extravasation vs no extravasation). A sub-cohort of the study population was then selected based on exposure and outcome status. Because the exposure (USGIV) and the outcome (extravasation) were both rare (<1%), all exposed patients and case patients were selected. Then, a 2% random sample of unexposed control patients (standard IV and no extravasation) was selected.

A multivariable logistic regression model was conducted on the sub-cohort to assess potential risk factors for contrast extravasation. The inverse sampling probability weighting method was applied to account for sampling.^{3,4} Contrast extravasation was the dependent variable. IV catheter type (USGIV versus standard IV) was the primary exposure variable. Based on literature review⁵⁻⁷ and biological plausibility, we selected the following covariates for the model: age, sex, history of IV drug use, active chemotherapy, vascular disease, body mass index (BMI), and history of hospital admission in the past year. The variable “vascular disease” included a history hypertension, diabetes mellitus, end stage renal disease, and atherosclerotic peripheral vascular disease.

Analyses were performed with STATA 12.0 (Stata Corp. College Station, TX).

RESULTS

During the 64-month study period, 40,143 unique patients underwent a CT scan with IV contrast, including 364 (0.9%) who had contrast administered through an USGIV. The sub-cohort for multivariable analysis included all patients with an USGIV (n=364), all patients with a standard IV and extravasation event (n=102), and a 2% random sample of patients with a standard IV and no extravasation (n=794). Compared with the standard IV group, patients in the USGIV group were older, and were more likely to have a history of IV drug use, active chemotherapy, vascular disease, and hospitalizations in the past year (Table).

Overall, 115 (0.3%; 95% CI) patients experienced an extravasation event, including 13 (3.6%) events among 364 patients with an USGIV and 102 (0.3%) among 39,779 patients with a standard IV (relative risk: 13.9; 95% CI: 7.9, 24.6; absolute risk difference: 3.3%; 95% CI: 1.4%, 5.2%).

In the multivariable logistic regression model, USGIV was strongly associated with increased risk of extravasation (adjusted odds ratio: 8.6; 95% CI: 4.6, 16.2). Other factors associated with extravasation included female sex (aOR: 1.8, 95% CI: 1.1, 2.9), hospitalization in the past year (aOR: 2.0, 95% CI: 1.3, 3.1), and IV drug use (aOR: 5.8, 95% CI: 1.7, 19.9).

None of the extravasation events led to surgical management. One extravasation event in the standard IV group resulted in an unexpected hospital admission. A similar proportion of extravasation events led to plastic surgery consultation in the USGIV group (23.1%) compared with the standard IV (32.4%) group (relative risk: 0.71; 95% CI: 0.25, 2.00).

DISCUSSION

We found the risk of subcutaneous extravasation of CT contrast media to be low (3.6%) in patients who had contrast administered through an USGIV placed by an emergency physician trained in the procedure. However, this risk was significantly higher than in patients who had contrast administered through a standard IV catheter placed in the ED without the use of ultrasound. High-risk features for extravasation, including vascular disease, IV drug use, hospitalization in the past year, chemotherapy and a high BMI, were more common in patients who received an USGIV. However, after adjusting for these high-risk features in a multivariable model, contrast administration through an USGIV remained strongly associated with extravasation. Although residual confounding is possible, these results suggest that use of an USGIV to administer IV contrast may be an independent risk factor for extravasation.

Clinicians should consider this increased extravasation risk when treating patients with USGIVs who have an indication for a contrast-enhanced CT scan. This includes heightened awareness of the possibility of catheter dislodgement and vigilance about confirming intravascular placement immediately prior to contrast administration. Depending on the clinical situation and urgency of CT scanning, alternatives to injecting contrast media into an USGIV include placing another peripheral catheter for contrast administration after fluid resuscitation, and pursuing a CT scan without contrast or another imaging modality, such as ultrasound or magnetic resonance imaging.

However, when a contrast-enhanced CT scan is urgently needed and a peripheral catheter cannot be obtained using standard techniques, our data suggest using an USGIV is a reasonable choice. Greater than 95% of the contrast boluses administered through USGIVs in this study were successfully delivered without extravasation; furthermore, the 13 extravasation events that did occur with USGIVs did not require hospital admission or any surgical procedures as the result of the extravasation. Alternative strategies to establish vascular access and deliver contrast media after failed attempts at standard peripheral IV placement include central venous catheters and intra-osseous catheters.⁸ However, USGIVs compare favorably to these alternatives in terms of pain and complications associated with insertion.^{8–10}

LIMITATIONS

Several limitations to our study should be noted. First, we studied USGIVs placed by emergency physicians in a single academic ED with a dedicated ultrasound training program. Generalizability of our findings to other settings is unknown. Second, both 1.75-inch and 2.5-inch catheters were used for USGIV placement in this study and we were unable to distinguish between these two lengths in the study patients. Third, study data were collected retrospectively. Although guidelines for high-quality retrospective data collection were followed, data misclassification was possible. Fourth, due to the large sample size of patients with a standard peripheral IV included in the study, a two-stage sampling technique was used to collect data for the multivariable model. Accuracy of this technique relies on the random sample selected from the unexposed controls at the second stage being representative. Fifth, risk factors for contrast extravasation are not well characterized in the literature. We developed a model of risk factors for extravasation based on the existing literature, mechanistic plausibility, and clinical expertise to guide variable selection. However, unmeasured characteristics, such as the anatomic location of IV catheters and number of IV attempts, may have led to residual confounding.

CONCLUSIONS

USGIVs are a viable option for establishing IV access when attempts at standard peripheral IV catheter placement have failed and provide a method for administering IV contrast media in patients who otherwise may not be able to receive contrast. However, patients receiving contrast through an USGPIV in this study had higher risk of contrast extravasation than those with a standard peripheral IV. Clinicians should consider this extravasation risk when pursuing a contrasted CT scan using an USGIV. Further research investigating strategies to mitigate the extravasation risk associated with USGIVs would be useful.

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Table

Patient characteristics. Data are presented as count (column percentage) except where otherwise noted.

Characteristic	Ultrasound Guided IV (n = 364)	Standard IV (n = 39,779)
Median Age (IQR), years	47.9 (35.7, 56.6)	43.2 (30.3, 57.3)
Female	240 (65.9)	18950 (47.6)
Race/Ethnicity		
Non-Hispanic White	240 (65.9)	31,200 (78.4)
Non-Hispanic Black	116 (31.9)	6,624 (16.7)
Hispanic	2 (0.6)	1,155 (2.9)
Other	6 (1.6)	800 (2.0)
Median Body Mass Index (IQR), kg/m ²	28.1 (23.7, 34.0)	26.8 (23.0, 31.7)
CT contrast phase		
CT venous phase	200 (55.0)	26,984 (67.8)
CT arterial phase	164 (45.0)	12,795 (32.2)
Body Region Imaged by CT *		
Head	33 (9.1)	4,013 (10.1)
Chest	186 (51.1)	19,500 (49.0)
Abdomen/pelvis	226 (63.1)	26,893 (67.6)
Other	29 (8.0)	5,354 (13.5)
Chief Complaint		
Chest pain	48 (13.2)	2,564 (6.4)
Shortness of breath	42 (11.5)	2,054 (5.2)
Abdominal pain	121 (33.2)	9,804 (24.6)
Fever	12 (3.3)	651 (1.6)
Vomiting/diarrhea	10 (2.3)	902 (2.3)
Trauma/injury	56 (15.4)	13,774 (34.6)
Other	75 (20.6)	10,030 (25.2)
Recreational IV drug use	13 (3.6)	402 (1.0)
Active chemotherapy	10 (2.8)	704 (1.8)
Vascular Disease (composite)	173 (47.5)	15,533 (34.0)
Hypertension	154 (42.3)	11,882 (29.9)
Diabetes mellitus	75 (20.6)	4,361 (11.0)
End stage renal disease	27 (7.4)	502 (1.3)
Peripheral vascular disease	12 (3.3)	550 (1.4)
1 hospitalization in past year	198 (54.4)	7,781 (19.6)
Hospitalized after index ED visit	256 (70.3)	20,514 (51.6)

* Body Region Imaged by CT: not mutually exclusive; some patients had multiple body regions imaged during the same procedure.