

MRI and CT contrast media extravasation

A systematic review

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Abstract

Background: This systematic review combines data from multiple papers on contrast media extravasation to identify factors contributing to increased extravasation risk.

Methods: Data were extracted from 17 papers reporting 2191 extravasations in 1,104,872 patients (0.2%) undergoing computed tomography (CT) or magnetic resonance imaging (MRI).

Results: Extravasation rates were 0.045% for gadolinium-based contrast agents (GBCA) and nearly 6-fold higher, 0.26% for iodinated contrast agents. Factors associated with increased contrast media extravasations included: older age, female gender, using an existing intravenous (IV) instead of placing a new IV in radiology, in-patient status, use of automated power injection, high injection rates, catheter location, and failing to warm up the more viscous contrast media to body temperature.

Conclusion: Contrast media extravasation is infrequent but nearly 6 times less frequent with GBCA for MRI compared with iodinated contrast used in CT.

Abbreviations: CT = computed tomography, GBCA = gadolinium-based contrast agents, IV = intravenous, MRI = magnetic resonance imaging.

Keywords: computed tomography, contrast material, extravasation, magnetic resonance imaging, risk factors

1. Introduction

In 2015, an estimated 38 million computed tomography (CT) and 17 million magnetic resonance imaging (MRI) examinations were performed in the United States using intravenous (IV) contrast agents^[1,2] reflecting their essential role in the detection, characterization, and staging of disease.^[3] Ideally, contrast agents should be injected and eliminated from the body without any adverse effects. Although the currently available contrast agents are considered to be safe, their use is not completely without risk^[4] and considerable attention has been focused on allergic reactions, physiologic reactions, nephrotoxicity, nephrogenic systemic fibrosis, and gadolinium deposition in tissues.^[4,5–11]

Contrast medium extravasation is another well-recognized event, which is rarely serious but can include serious complications like compartment syndrome, severe skin ulceration, and

tissue necrosis.^[11–13] Less serious consequences include exposure to ionizing radiation without the benefit of diagnostic images, swelling, tightness, stinging, burning pain, edema, erythema, or tenderness at the injection site.^[4,12–16]

In early series, the rate of extravasation during CT ranged from 0.03% to 0.17%.^[16–18] Later reports with larger numbers of patients, published after automated mechanical injectors and higher injection rates began to be routinely used for contrast material injection, extravasation rates increased, ranging from 0.25% to 0.9%.^[15,19,20] Gadolinium-based contrast agents (GBCA) extravasation has also been reported, albeit less frequently.^[21–23] Given these widely disparate rates of contrast media extravasation, it is likely that a systematic review could identify risk factors which can help with prevention and risk minimization. The purpose of this systematic review is to combine data from multiple papers on contrast media extravasation using similar methodology in order to identify the factors contributing to increased extravasation risk.

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2. Methods

2.1. Search strategy

No industry support was provided for this systematic review, which was conducted according to the Preferred Reporting Items for Systematic Reviews guidelines.^[24] Inclusion criteria included original articles on human subjects (letters, review articles, and comments were excluded) reporting extravasation rates during IV contrast media injection, including the total number of injections and types of contrast media and the total number of extravasations observed. The following keywords were used in different combinations: “GBCA,” “iodine contrast agent,” “risk factor,” “extravasation,” and “gadolinium.”

2.2. Data extraction and quality assessment

Each of the 17 papers was reviewed by 2 radiology research fellows (AHB and ZF) who extracted the type of contrast media used, the total number of injections and extravasations for each contrast medium type, use of hand versus power injection, injection rate, catheter insertion by radiology staff versus using an existing IV catheter, catheter location and catheter size, inpatients versus outpatients and contrast agent temperature. Any discrepancies in the data extracted between the 2 observers were adjudicated by a third observer with 25 years of experience in contrast media research. No studies were excluded as a result of poor quality of methods or unsatisfactory results. As data in the present study were collected and synthesized from anonymous data of previous studies in which informed consent has already been obtained by the investigators, ethics approval was waived for this systematic review.

3. Results

A search of the PubMed (n=608) and Google Scholar (n=71) databases was conducted independently by authors for all published studies reporting contrast agent extravasation from January 1990 to April 2017. After removing duplicate papers (n=29), we screened all 650 papers; 612 papers were excluded because inclusion criteria were not matched. For the 38 remaining articles, 13 did not include the total number of injections, 4 were case reports, and 2 articles reported duplicate data. Finally, 17 papers^[3,15,17-18,21-23,25-35] met our criteria, including data from 1,104,872 (nonionic iodine, ionic iodine, or gadolinium) contrast media injections (Fig. 1).

These 17 papers (Table 1) reported 2191 contrast media extravasations in 1,104,872 injections including nonionic low osmolality (n=759,047 with 1979 extravasations=0.26%) or high osmolality ionic (n=8423 with 61 extravasations=0.72%) iodinated contrast media or GBCA (n=337,402 with 151 extravasations=0.045%) as shown in Table 2. We assessed risk of bias in the 17 final studies based on the A Cochrane Risk of Bias Assessment Tool: for Non-Randomized Studies of Interventions (Table 3).^[36]

However, a more controlled comparison with data from 3 studies reporting rates of extravasation for both nonionic, low osmolar (n=3843 with 32 extravasations=0.83%) and ionic, high osmolar (n=8423 with 61 extravasations=0.72%), suggests that higher osmolality may not be an important risk factor.^[3,26,27] However, local toxicity is directly proportional to osmolality; therefore, hyperosmolar solutions have a higher risk of causing tissue necrosis.^[25,26]

3.1. Gadolinium versus iodinated contrast agents

Two papers reported rates of extravasation for both low osmolar, nonionic iodinated contrast (n=409,864 with 632 extravasations=0.015%) and gadolinium (n=178,606 with 105 extravasations=0.006%) showing approximately 3-fold fewer extravasations with gadolinium compared with iodinated contrast.^[21,23] Other differences included an order of magnitude lower volume GBCA injected, lower injection rates, and more hand injections with GBCA.^[21,23] It is likely that the difference between GBCA and iodinated contrast extravasation rates is

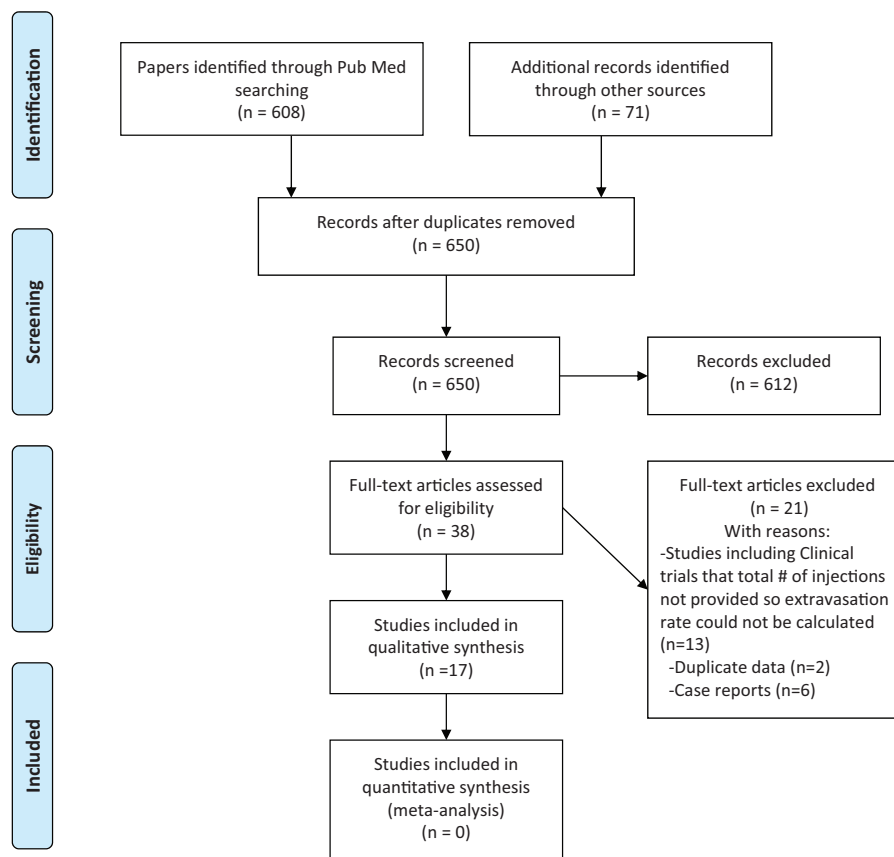


Figure 1. Flow chart shows papers selection criteria based on Preferred Reporting Items for Systematic Reviews guideline.

Table 1**Seventeen papers (listed in chronological order) reporting contrast extravasation data for 1,104,872 injections.**

| Authors | Year of publication | Total injections | Type of contrast studied | Population | No. of extravasations | Extravasation rate, % | Other findings |
|---------------------------------|---------------------|--------------------------------|--------------------------|------------------------------|-----------------------|--------------------------------|--|
| Miles et al ^[17] | 1990 | 5280 | Ionic and nonionic | Adult and children over 12 y | 6 | 0.10 | Use of power injection is safe |
| Sistrom et al ^[18] | 1991 | 20,950 | Nonionic | Adult and children | 28 | 0.13 | Higher rate of extravasation among patients injected by power injection |
| Cohan et al ^[25] | 1997 | 22,254 | Ionic and nonionic | Adult and children | 51 | 0.23 | Patients with extravasation received injection through smaller catheters |
| Federle et al ^[26] | 1998 | 5106 | Ionic and nonionic | Adult | 48 | 0.94 | Higher rate of extravasation among patients injected by power injection |
| Jacobs et al ^[27] | 1998 | 6660 | Ionic and nonionic | Adult and children | 40 | 0.60 | Higher rate of extravasation with higher rate of contrast media injection was not statistically significant |
| Birnbau et al ^[3] | 1999 | 500 | Ionic and nonionic | Adult | 4 | 0.80 | Extravasation Detection Accessory as a safe and accurate accessory for detection of extravasation |
| Cochran et al ^[23] | 2002 | 90,473 (57,739, 28,340*) | Nonionic, GBCA | Adult and children | 225 | Iodine = 0.34; GBCA = 0.053 | Patients undergoing CT (0.34%) are at higher risk of extravasation than MRI patients (0.053%) |
| Sinan et al ^[28] | 2005 | 3560 | Nonionic | Adult | 11 | 0.30 | Lower extravasation rate for manual versus power injection is not statistically significant |
| Wang et al ^[15] | 2007 | 69,657 | Nonionic | Adult and children | 475 | 0.70 | Extravasation of nonionic (low-osmolar) iodinated contrast medium results only rarely in moderate or severe adverse effects, and only when injecting large volumes |
| Wienbeck et al ^[30] | 2010 | 4457 | Nonionic | Adult | 52 | 1.2 | High flow rates with small caliber IV and location of IV catheter in the hand has higher extravasation rate |
| Prince et al ^[22] | 2011 | 158,796 | GBCA | Adult | 46 | 0.03 | GBCA has low extravasation rate |
| Kingston et al ^[31] | 2012 | 26,854 | Nonionic | Adult | 119 | 0.44 | Extravasation may occur with high or low injection rates and when small or large size cannulas are used |
| Davenport et al ^[32] | 2012 | 24,820 | Nonionic | Adult and children | 78 | 0.31 | Contrast warming (to 37°C) reduces extravasation rates for the viscous iopamidol 370 |
| Moreno et al ^[33] | 2013 | 118,970 | Nonionic | Adult | 330 | 0.28 | Volume of extravasation was less for smaller-gauge catheters in the hand with higher flow rates and for catheters newly placed in the radiology department |
| Niv et al ^[34] | 2014 | 37,788 | Nonionic | Adult and children | 83 | 0.48 | Females, older age, and catheter located outside antecubital fossa have higher rate of extravasation |
| Hardie et al ^[35] | 2014 | 10,750 | Nonionic | Adult | 82 | 0.76 | Less extravasation with antecubital catheter placement compared to deep brachial veins |
| Shaqdan et al ^[21] | 2015 | 502,391 (352,125, 150,266*) | Nonionic, GBCA | Adult and children | 451, 90 | 0.13, 0.06* | CT patients are at higher risk of extravasation than MRI patients. Females and inpatients were more likely to extravasate at both CT and MRI |
| Summary | 1990–2015 | 1,104,872 | | | | | High osmolar (all ionic) = 0.72 (range = 0.6–0.9); low osmolar (all nonionic) = 0.26 (range = 0.12–1.2); GBCA = 0.045 (range = 0.03–0.06) |

CT = computed tomography, GBCA = gadolinium-based contrast agents, IV = intravenous, MRI = magnetic resonance imaging.
* GBCA.

Table 2**Demographic data for each type of contrast media.**

| | No. of papers | Total no. of injections | No. of extravasations | Extravasation rate, % |
|---|---------------|-------------------------|-----------------------|-------------------------|
| High osmolality: ionic iodinated contrast | 14 | 759,047 | 1979 | 0.26 (range=0.12–1.2) |
| Low osmolality: nonionic iodinated contrast | 3 | 8423 | 61 | 0.72 (range=0.6–0.9) |
| Gadolinium-based contrast agent | 3 | 337,402 | 151 | 0.045 (range=0.03–0.06) |
| Summary | 17 | 1,104,872 | 2191 | 0.20 (range=0.03–1.2) |

explained by these confounding effects rather than by molecular differences in the contrast media.

3.2. Gender

Five papers reported rates of extravasation of iodinated contrast media (mostly nonionic, low osmolar) for male versus female patients. These include 276 extravasations in 194,306 male patient injections (0.14%) compared with 354 extravasations in 186,636 female patient injections (0.19%) (Table 4).

Although neither Jacobs et al^[27] nor Birnbaum et al^[3] found any gender effect, Wienbeck et al showed a predominance of women in the extravasation group ($P = .05$).^[30] This finding was confirmed by 2 more recent studies: Niv et al found the extravasation rate to be nearly twice as high in females (0.64%)

compared with male patients (0.33%) ($P = .005$)^[34] and Shaqdan et al also demonstrated that females were more prone to extravasations (0.15%) than male patients (0.11%) ($P = .0023$).^[21] This difference could be related to smaller size and deeper positioning of subcutaneous veins within thicker subcutaneous fat in female patients.^[37,38]

3.3. Age

Niv et al reported a difference between mean age of all patients being injected for contrast enhanced CT = 53.5 years (range 1–94) compared with the mean age of patients with extravasation = 61.2 years (range 24–93) ($P < .0001$).^[34] Wienbeck et al^[30] demonstrated significantly higher extravasation rates for patients older than 50 years ($P = .02$). Shaqdan et al showed that

Table 3**Risk of bias of 17 included studies in this meta-analysis based on (ACROBAT-NRSI)^[36].**

| Risk of bias assessment | Bias due to confounding | Bias in selection of patients into the study | Bias due to missing data | Bias in measurement of outcomes | Bias in selection of the reported result | Bias due to conflict of interest | Overall bias |
|---------------------------------|-------------------------|--|--------------------------|---------------------------------|--|----------------------------------|--------------|
| Miles et al ^[17] | Low | Low | Moderate | Moderate | Low | Low | Low/moderate |
| Sistrom et al ^[18] | Low | Low | Moderate | Moderate | Low | Low | Low/moderate |
| Cohan et al ^[25] | Low | Low | Moderate | Moderate | Low | Low | Low/moderate |
| Federle et al ^[26] | Low | Low | Moderate | Moderate | Low | Moderate | Low/moderate |
| Jacobs et al ^[27] | Low | Low | Moderate | Moderate | Low | Low | Low/moderate |
| Birnbaum et al ^[3] | Moderate | Moderate | Low | Low | Low | Moderate | Low/moderate |
| Cochran et al ^[23] | Low | Low | Moderate | Moderate | Moderate | Low | Low/moderate |
| Sinan et al ^[28] | Low | Moderate | Moderate | Low | Moderate | Low | Low/moderate |
| Wang et al ^[15] | Low | Low | Moderate | Moderate | Low | Low | Low/moderate |
| Wienbeck et al ^[30] | Low | Moderate | Low | Moderate | Low | Moderate | Low/moderate |
| Prince et al ^[22] | Low | Low | Moderate | Moderate | Low | Low | Low/moderate |
| Kingston et al | Low | Moderate | Moderate | Moderate | Low | Low | Low/moderate |
| Davenport et al ^[32] | Moderate | Low | Low | Moderate | Moderate | Low | Low/moderate |
| Moreno et al ^[33] | Low | Moderate | Moderate | Moderate | Low | Low | Low/moderate |
| Niv et al ^[34] | Low | Low | Moderate | Moderate | Low | Low | Low/moderate |
| Hardie et al ^[35] | Low | Moderate | Moderate | Moderate | Low | Low | Low/moderate |
| Shaqdan et al ^[21] | Low | Low | Moderate | Moderate | Low | Low | Low/moderate |

ACROBAT-NRSI = A Cochrane Risk of Bias Assessment Tool for Non-Randomized Studies of Interventions.

Table 4**Five papers reported the rates of extravasation of iodinated contrast media (mostly nonionic) for male versus female patients.**

| Studies | Male patients | No. of extravasations | Extravasation rate, % | Female patients | No. of extravasations | Extravasation rate, % | P value (if reported) |
|--------------------------------|---------------|-----------------------|-----------------------|-----------------|-----------------------|-----------------------|-----------------------|
| Shaqdan et al ^[21] | 179,105 | 197 | 0.1 | 173,020 | 254 | 0.15 | .0023 |
| Niv et al ^[27] | 8810 | 29 | 0.33 | 8390 | 54 | 0.64 | .005 |
| Wienbeck et al ^[30] | 2757 | 25 | 0.9 | 1700 | 27 | 1.6 | .05 |
| Birnbaum et al ^[3] | 257 | 2 | 0.78 | 243 | 2 | 0.82 | NS |
| Jacobs et al ^[27] | 3377 | 23 | 0.7 | 3283 | 17 | 0.5 | NS |
| Summary | 194,306 | 276 | 0.14 | 186,636 | 354 | 0.19 | .003 |

NS = nonsignificant.

Table 5**Catheter insertion on the floor versus in radiology department.**

| Studies | Total no. of injections | No. of injections by radiology staff | Extravasation rate | No. of injections by nonradiology staff | Extravasation rate | P value (if reported) |
|--------------------------------|-------------------------|--------------------------------------|--------------------|---|--------------------|-----------------------|
| Niv et al ^[27] | 37,788 | 12,169 | 42 (0.35%) | 5031 | 41 (81%) | <.0001 |
| Kingston et al ^[24] | 26,854 | 11,470 | 39 (0.34%) | 15,384 | 80 (0.58%) | NS |
| Sinan et al ^[22] | 3560 | 2191 | 5 (0.23%) | 1359 | 6 (0.44%) | NS |
| Summary | 68,202 | 25,830 | 86 (0.33%) | 21,774 | 127 (0.58%) | <.001 |

NS = nonsignificant.

extravasations increased in patients more than 60 years of age in both CT and MRI ($P=.001$). This finding is possibly explained by fragile veins in older patients.^[38,39] Another possible factor is that elderly patients might not be able to communicate quickly regarding pain at the injection site.^[21,35] Uncooperative, confused elderly patients may dislodge an initially functioning IV especially if they are surprised when the injection begins. These factors increase the likelihood of extravasation in elderly.^[21,37,38]

3.4. Cannula insertion by radiology staff versus using an existing IV

Three studies^[28,31,34] reported on the rate of extravasation during CT scanning with IV cannula insertions performed by nonradiology staff (0.58%) prior to patient arrival in the radiology department as compared with IV catheter insertions performed by radiology staff immediately prior to scanning (0.33%) ($P<.001$) (Table 5). A number of factors might account for this difference: the IV cannulas inserted by nonradiology staff may have been in place for more than 24h or inserted after multiple attempts, with no extravasation with drip infusions but leaks at the higher injection rates used for CT and MRI.^[40-44] Catheters could be dislodged during transportation of the patient to the CT scanner from the patient floor. An additional factor could be the cannula insertion site because the staff of the Department of Radiology preferred the upper forearm, while the nonradiology staff preferred smaller more peripheral veins in the dorsum of the hand which are more prone to extravasations.^[28]

3.5. Catheter location

Higher numbers of extravasation have been reported at the antecubital fossa compared with other sites, which reflects the fact that most injections occur at this site (Table 6).^[3,18,21,25,27] Comparative studies, however, show that the rate of extravasation during a contrast-enhanced CT examination was actually lower with antecubital IV catheter placement than that with deep

Table 6

Three papers^[27,30,35] reported the rates of extravasation of iodinated contrast media (mostly nonionic) for different sites of injection.

| Injection site | No. of injections | No. of extravasation | Extravasation rate, % | P |
|-------------------------|-------------------|----------------------|-----------------------|-------|
| Antecubital | 15,070 | 95 | 0.6 | .0002 |
| Other than Antecubital* | 3714 | 45 | 1.2 | |
| Hand | 1406 | 17 | 1.2 | |
| Wrist | 329 | 3 | 0.09 | |
| Forearm | 1950 | 25 | 1.3 | |
| Foot | 29 | 0 | 0 | |

* Including hand, wrist, forearm, upper arm, and foot.

brachial IV catheter placement.^[30] Wienbeck et al reported significant differences in the incidence of extravasations with catheter position and size. Extravasations occurred more frequently in IV catheters placed into hand veins compared with larger veins; for 20-gauge IV catheters, a significant difference between the dorsum of the hand and the antecubital fossa was noticed (1.8% vs. 0.8%; $P=.018$).^[30]

Based on the findings of Hardie et al, the rate of extravasation for antecubital IV, deep brachial IV and all other IV sites was 0.6%, 6.5%, and 0.9%, respectively. The relative risk of extravasation for antecubital IV, deep brachial IV, and all other IV sites was 0.4, 9.4, and 1.7, respectively.^[35] This finding is in line with results of another study that reported a significantly higher rate of extravasation injuries with injections into dorsum of the hand when compared with antecubital fossa injections.^[26]

3.6. Catheter size

Jacobs et al found no difference in extravasation rate for different catheter sizes,^[27] but an investigation by Wienbeck et al found that small diameter angio-catheters (e.g., 22-gauge) were associated with higher rates of contrast material extravasation (2.2%; $P<.05$), independent of the anatomic location.^[29] Their finding corroborated a previous report by Cohan et al which found that extravasations were significantly higher in patients receiving Contrast Media injection through small-bore catheters.^[25] These observations may be confounded by the use of smaller bore catheters in smaller more tenuous veins.^[21]

3.7. Power versus manual injection

The introduction of automated power injection enabled larger volumes of contrast media to be injected at higher flow rates than are possible with hand injection. It also allowed the injection to proceed without a person adjacent to the injection site watching for signs of extravasation.^[35,45] Initially, it was thought that high infusion rates or the use of power injectors would be associated with higher rates of subcutaneous contrast extravasation.^[25] This theory is supported by Sistrom et al who in 1991 reported an extravasation rate of 0.17% for CT studies of the chest, abdomen, and pelvis when IV contrast was administered by automatic contrast injectors, compared with an extravasation rate of 0.09% for CT scans of the head, orbits, and spine where a manual injection was used.^[18] Jacobs et al^[27] and Sinan et al,^[28] using more modern, pressure limited power injectors, also reported fewer extravasations with manual injection.

A recent survey by Shaqdan et al study suggests that females undergoing power injections are more likely to develop extravasation than females with manual injections but failed to find this trend in males. The findings indicate that power injection might be an extra risk factor for a patient who already has a risk factor, such as female gender or older age^[21] (Table 7).

Table 7

Three papers^[21,27,28] reported the rates of extravasation of iodinated contrast media between manual and power injection.

| Studies | Manual injection | No. of extravasations | Extravasation rate, % | Power injection | No. of extravasations | Extravasation rate, % | P value (if reported) |
|-------------------------------|------------------|-----------------------|-----------------------|-----------------|-----------------------|-----------------------|-----------------------|
| Shaqdan et al ^[21] | 105,528 | 51 | 0.05 | 44,649 | 39 | 0.09 | .0048 |
| Sinan et al ^[27] | 920 | 2 | 0.22 | 6631 | 9 | 0.34 | <.05 |
| Jacobs et al ^[28] | 29 | 0 | 0 | 6631 | 41 | 0.62 | — |
| Summary | 106,476 | 53 | 0.050 | 53,920 | 89 | 0.17 | <.01 |

It is also likely that extravasations occurring with manual injections are less serious because they are likely to be detected earlier while there is still time to stop the injection and minimize the extravasate volume.

3.8. Injection rate

Cohan et al reported a doubling of extravasation rates for CT injections (from 0.1% to 0.24%) which coincided with switching from 1.0 to 1.5 mL/s. The extravasation rate further increased to 0.4% when injection rates were further increased to 2 to 4 mL/s.^[16] Miles et al^[17] and Siström et al^[18] also observed more extravasations at higher injection rates. Jacobs et al^[28] and Wienbeck et al^[30] also observed the highest rate of extravasation at the highest injection rates, although this finding was not statistically significant.^[28,30] Shaqdan et al had the unexpected finding of the highest rates of extravasation in CT patients injected at <2 mL/s compared with higher rates. Shaqdan et al concluded that this unexpected finding reflects the use of lower injection rates in patients felt to be at higher risk of extravasation.^[21] Thus there is compelling data indicating that higher injection rates increase the risk of extravasation.

3.9. In-patients versus out-patients

Both Shaqdan et al and Hardie et al showed that inpatients had higher rates of extravasations (0.29%) than out-patients 0.05% for both MRI and CT ($P < .0001$) (Table 8).^[21,35] This observation of a nearly 6-fold difference reflects the risk factors of in-patients having the IV established on the patient's floor by nonradiology personnel; the IV may be several days old and may be dislodged in transport. Out-patients almost always have an IV inserted in the radiology department shortly before contrast injection. Also, inpatients are more likely to have had multiple IVs in the recent past, which may have damaged their best peripheral venous access options resulting in IV catheters in less optimal locations.

3.10. Contrast agent temperature

Only Davenport et al^[32] reported on the effect of contrast media temperature. Warming contrast media to 37°C did not

significantly affect extravasation rates for IV injections of iopamidol 300 (0.30 at 37°C compared with 0.23 at room temperature) but did reduce extravasation rates for the more viscous iopamidol 370 (0.27 at 37°C compared with 0.87 at room temperature).

3.11. Factors affecting extravasation volume

Large volumes of extravasation were associated with more serious adverse consequences.^[15] Moreno et al^[33] evaluated the factors associated with extravasation volume. Compared to prior studies that have demonstrated effect of patients' age and gender on extravasation rates,^[21,30,34,35] this study found that mean volume of extravasate did not differ based on patients' gender or age.^[33] In contrast with 2 prior single-institution studies by Federle et al^[26] and Jacobs et al^[27] (41 and 48 extravasation events) which found no relationship between contrast material administration rate and extravasate volume, Moreno et al^[33] reported that if an extravasation event occurred, the volume of extravasate was likely to be smaller for smaller-gauge catheters in the hand with higher flow rates, perhaps because of earlier detection of the extravasation event. However, smaller-size cannulas may limit injection rates, resulting in an overall decrease in arterial phase image enhancement/quality. These data also showed that if an extravasation event happened, the volume of extravasation was larger for existing catheters as compared with catheters newly placed in the radiology department.^[33]

3.12. An unusually severe extravasation event

In 1 patient, an automated blood pressure cuff was periodically inflating on the upper arm, superior to the site of IV injection of 150 mL low osmolar iodinated contrast by power injection. The patient developed a 30 cm² region of vesicular lesions "similar to ulceration caused by a second degree burn." Fortunately, the lesion resolved with topical therapy only with "no long-term sequelae." But this emphasizes the importance of making sure there is no external device, which obstructs flow of contrast media from the injection site to the right atrium.^[12]

Table 8

Two papers^[21,35] reported the rates of extravasation of iodinated contrast media in out-patients compare with in-patients.

| Studies | In-patients | No. of extravasations | Extravasation rate, % | Out-patients | No. of extravasations | Extravasation rate, % | P value (if reported) |
|-------------------------------|-------------|-----------------------|-----------------------|--------------|-----------------------|-----------------------|-----------------------|
| Shaqdan et al ^[21] | 20,079 | 32 | 0.16 | 130,187 | 58 | 0.045 | <.0001 |
| Hardie et al ^[35] | 2473 | 33 | 1.3 | 6987 | 13 | 0.19 | — |
| Summary | 22,552 | 65 | 0.29 | 137,174 | 71 | 0.05 | <.0001 |

4. Discussion

Contrast media extravasation is an infrequent occurrence. But contrast extravasations can cause local complications, especially with higher osmolar and ionic agents. An extravasation may also spoil the exam resulting in radiation exposure without diagnostic information. This systematic review of 17 papers reporting 2191 extravasations with 1,104,872 CT and MRI examinations demonstrates multiple factors that contribute to increased risk of contrast media extravasation. Female gender, older age, use of an existing cannula instead of starting a new IV line, a catheter site other than the antecubital fossa, and use of power injection with higher injection rates are all risk factors for contrast media extravasation. Assessment of catheter size as a risk factor is confounded by the frequent use of smaller catheters in patients with tenuous veins at higher risk of extravasation.

Extravasation was 6 times less likely with gadolinium than with iodine-based contrast agents overall but only 3 times less likely in studies reporting extravasation data for both GBCA and iodinated contrast. But this is more likely secondary to the lower contrast volumes, lower injection rates and greater use of manual injection for GBCA than any difference in the chemical properties of these contrast agents.

Since the papers included in our survey used a variety of methods to assess risk factors, a meta-analysis was not feasible despite a large number of injections (1,104,872). And most of the papers were retrospective reviews; they were dependent on the quality, accuracy, and comprehensiveness of the medical records and extravasation data forms. To the extent that records may have been missing or incomplete, the prevalence of extravasation may have been underestimated. In particular, small-volume contrast extravasation events might not have been recorded.

The relative importance of these factors is not possible to assess without a multivariate analysis, which was not possible with these data. Although these extravasations may contribute to diminished image quality and/or the need to repeat the scan with additional radiation exposure and inconvenience, only 1 paper in this review reported a complication requiring surgical intervention, a fasciotomy in 1 patient.^[15] This suggests that most extravasations are well tolerated and resolve without surgical intervention.

5. Conclusion

In conclusion, this systematic review demonstrates increased contrast media extravasations with iodine contrast agents compared with GBCA, older age, female gender, using an existing IV instead of placing a new IV, in-patient status, use of automated power injection, high injection rates, catheter location and failing to warm up the more viscous contrast media to body temperature. Extravasation is infrequent and rarely requires surgical intervention, but it still may spoil an imaging study resulting in radiation exposure without diagnostic information so attention to minimizing these risk factors may be prudent.

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