

Navigating the risks of contrast extravasation in CT scans: A 3-year study of 26,544 automated power injector cases

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Dear Editor,

We present findings from our large-scale retrospective study on contrast media extravasation (CME) in computed tomography (CT) examinations. Over 3 years, we analysed 26,544 adult CT examinations with intravenous contrast media administered via a power injector to determine CME incidence and evaluate associated risk factors.

CME is a recognised complication of contrast-enhanced CT, potentially leading to severe outcomes in rare cases. Most instances result in mild, self-limiting symptoms like swelling, erythema and pruritus. However, severe outcomes, including compartment syndrome, extensive skin ulceration and tissue necrosis have been documented, occasionally necessitating surgical intervention.¹

Our study revealed an overall CME incidence of 0.11% (28/26,544), consistent with previously reported ranges.² The majority were mild CME (89.3%), while 3 cases had moderate CME that presented with blistering, altered sensation and severe pain. None had severe CME. This low rate of approximately 1 in 915 patients underscores the relative safety of contrast-enhanced imaging procedures while highlighting the importance of identifying and mitigating risk factors.

Multivariate analysis identified several independent CME risk predictors: injection rate >3 mL/s (odds ratio [OR] 2.8, 95% confidence interval [CI] 1.9–4.1), age >50 years (OR 2.3, 95% CI 1.6–3.3), female sex (OR 1.9, 95% CI 1.3–2.7) and lower limb injection sites (OR 3.5, 95% CI 2.1–5.8).

Higher injection rates (>3 mL/s) were associated with increased CME risk (0.19%) compared to lower rates (≤3 mL/s, 0.06–0.07%; $P<0.001$). This aligns with previous research suggesting a positive relationship between higher injection rates and CME risk.³ However, the absolute risk remains low even at higher rates, with <0.2% incidence across all categories.

We observed that injection rates below 3 mL/s offered no significant advantage over injection rate at 3 mL/s in reducing CME risk (0.07% versus [vs] 0.06%, ($P>0.05$) (Table 1). This is in line with other studies that found no significant advantage in CME rates at lower injection speeds.^{4,5} Radiologists can confidently employ a 3 mL/s injection rate for routine CT examinations, achieving optimal image quality without elevating extravasation risk.

Age and sex emerged as significant factors. Patients older than 50 years showed higher CME incidence (0.13% vs 0.08%, $P=0.02$), as did female patients (0.15% vs 0.07%, $P=0.01$). Women had approximately 2.14 times higher CME risk than men. These findings are consistent with recent studies and may be attributed to vascular fragility and venous access challenges.⁶

CME incidence varied based on intravenous access site. Lower limb cannulation sites had higher CME rates than upper limb sites (0.25% vs 0.10%, $P=0.03$). Lower extremities present higher CME risks due to difficult visualisation, patient movement and reduced blood flow. Obesity and peripheral vascular disease can complicate femoral vein access. Foot veins, being smaller and more fragile, are susceptible to rupture. The limited soft tissue in the foot offers less absorption capacity for extravasated contrast. Upper extremity veins, particularly in the antecubital fossa, are preferred due to their larger size, better stability, lower venous pressure and easier monitoring—these characteristics reduce vein perforation and extravasation risk while allowing for more secure placement.

Overall, injection sites in the lower limbs and small distal veins are less optimal.⁷ No CME cases were reported in central venous access procedures, which agrees with existing literature and suggests that contrast injection via central venous catheters can be performed safely for CECT when using a strict protocol.⁸

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Table 1. Demographics, study variables and incidence of contrast media extravasation (CME) (n=26,544).

	Incidence of CME no. (%)
Injection rate (n)	
<3 mL/s (12,329)	9 (0.07)
3 mL/s (7701) ^a	5 (0.06)
>3–5 mL/s (6270)	12 (0.19)
Unspecific (244)	2 (0.01)
Age group (n)	
≤50 years (8532)	4 (0.05)
>50 years (17,984)	24 (0.13)
≤60 years (13,776)	11 (0.08)
>60 years (12,740)	17 (0.13)
Sex (n)	
Male (14,826)	10 (0.07)
Female (11,690)	18 (0.15)
Injection site (n)	
Wrist and hand (8956)	9 (0.10)
Cubital fossa (7768)	14 (0.18)
Forearm (1902)	3 (0.16)
Groin (29)	1 (3.45)
Foot (28)	1 (3.57)
Central venous line (251)	0 (0)
Unspecified (7610)	0 (0)
Cannula gauge (n)	
14G (2)	0 (0)
16G (92)	1 (1.09)
18G (1869)	7 (0.37)
20G (6086)	15 (0.25)
22G (1462)	4 (0.27)
CVP line, PICC (303)	0 (0)
Unspecified (16,730)	1 (0)

CVP: central venous catheter; PICC: peripherally inserted central catheter

^a Default injection rate for routine scans.

While our study suggests that gauge size may influence CME risk (Table 1), other clinical factors and usage frequency are also important considera-

tions. A comprehensive assessment of patient characteristics is essential, rather than strictly following the “larger gauge size is better” approach.

Our study highlighted the importance of preventive measures. Extravasation during pre-injection saline flush, followed by re-insertion of cannulas, successfully prevented CME in 26 examinations. This underscores the value of careful vascular access assessment and saline test injections before contrast media administration.

Qualitative analysis of procedural notes revealed factors commonly associated with CME cases: limited or difficult IV access (53.6%), multiple venipunctures on the same limb (17.9%) and small peripheral veins (35.7%). The overall low CME incidence (0.11%) may be attributed to a well-established protocol for checking cannulas before contrast injection.

These findings have important clinical implications. While higher injection rates may be necessary for optimal image quality, particularly in CT angiography, they should be used judiciously, especially in high-risk populations. Identifying risk factors such as advanced age, female sex and lower limb injection sites can guide clinicians in taking extra precautions with susceptible patients.

Patient education should address these different risk factors, emphasising the slightly elevated risk for certain groups while noting the low absolute risk. Enhanced monitoring protocols during and after contrast media procedures may benefit high-risk patients.

The study's limitations include its retrospective, single-centre nature, which potentially limits generalisability and applicability to different patient populations and contrast administration protocols. Reliance on electronic medical records may have led to underreporting of minor CME cases. Future research should focus on prospective, multicentre studies to validate these findings. Interventional studies testing the efficacy of preventive measures, such as pre-injection saline flush protocols or ultrasound-guided IV placement would be valuable. Investigating the long-term outcomes of CME patients could inform follow-up care protocols.

In conclusion, our study provides valuable insights into CME risk factors and preventive strategies in CT examinations. Identifying high-risk populations and implementing tailored preventive approaches can enhance contrast-enhanced imaging procedures' safety while maintaining optimal diagnostic quality. The findings underscore the need for standardised cannula assessment and contrast administration protocols, particularly in susceptible patients. While higher injection rates may be necessary

for diagnostic quality, appropriate precautionary measures should be taken to reduce CME risk in high-risk populations.

Ethics statement

Waiver for ethics approval was granted by the National Healthcare Group Domain Specific Review Board following retrospective nature of study and use of de-identified data (DSRB Reference number: 2016/01381).

Declaration

The authors declare they have no affiliations or financial involvement with any commercial organisation with a direct financial interest in the subject or materials discussed in the manuscript.

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