Radiology

The Risk of Inadvertent Injection of Foreign Bodies in Angiography: Self-Reflective Assessment of Iatrogenic Risk

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In this issue of *Radiology*, Nikoubashman and colleagues (1) explore the source of particle contamination associated with angiographic injections. The authors analyzed seven different conditions of saline-filled bags and containers with or without gauze or towel content at different time intervals. The authors used the Coulter principle to size and count particles suspended in electrolytes. Many particles were found in packed basins. In fact, cotton towels and woven gauze in packed basins resulted in an increase of particles from 1.5 particles/mL ± 0.4 [standard deviation] to 64.4 particles/mL ± 4.1 and 257.1 particles/mL ± 11.6, respectively ($P < .001$). Rinsing basins with saline reduced the number of particles to low levels ($P = .03$ to $P < .001$). To combat particle contamination, the authors recommend rinsing all basins before use, drawing saline and contrast material from separate bags during procedures, and avoiding cotton towels and woven gauze whenever possible.

Scrupulous procedural technique is an important cornerstone of procedural safety, and the content of this study contributes to our understanding of an important aspect of such a technique. Saline and contrast material aspiration from dedicated bags is performed in many interventional suites, especially for neurointerventional procedures. But it is certainly not a universal practice. The distinct benefits of such a setup have also not previously been proven. In most cases, the clinical relevance of inadvertent foreign body injections is uncertain but ought to be avoided as being medically unwarranted. A valuable key result from this study is the contamination risk associated with cotton towels and woven gauze. These supplies tend to be standard content of angiography trays, although the required use of these items for most angiographic procedures is doubtful. Standard assembly of angiography trays and assumption of an innocuous nature when using these supplies seems commonplace. These results offer an eye-opening paradigm challenge with regards to the latter perception. Although not evaluated in the context of this analysis, the exclusive use of nonadherent (Telfa; Cardinal Health) pads to wipe and handle guidewires seems to be a generally safer alternative. Rinsing of tray basins is easily performed in clinical practice and such recommendation is thus of particular clinical value.

Investigations regarding potential foreign body contamination of angiographic injections date back at least to the 1970s. In 1972, Schuberg et al (2) observed the occurrence of foreign-body microemboli in association with angiography and venous infusion. In 1980, Winding et al (3) published their results of sequelae of foreign bodies that contaminated flushing and contrast material solutions after selective renal artery injection in rabbits. "Frequent" regional renal infarcts were a result of these foreign body contaminated injections. Although performed in a smaller animal model, these latter results raise concern that embolization resulting from such contaminated injections may be of clinical consequence, at least when occurring in functional end arteries. An at least theoretical risk of iatrogenic infection deserves future consideration.

After the Schuberg and Winding publications, there was a long hiatus from published material in this area. Many readers may argue that this hiatus relates to the documented general safety of angiographic procedures. For instance, in the hands of experienced operators, the risk of permanent neurologic sequelae associated with neuroangiography is less than 1% (4). But stroke risk rates reaching 5.7% have also been cited in the literature (5). Lowering the procedure-related stroke risk always remains a desirable goal and the risk of stroke may dissuade some patients to undergo the procedure altogether.

Another explanation for a longer research pause in this area may be an "appeal to tradition" fallacy: Something routinely practiced and taught to trainees for decades is (naturally) considered safe. An environment where procedural volume dominates procedural outcome considerations may suppress critical and paradigm challenging directed thinking. This is often the case with current credentialing criteria and procedural volume-driven financial incentives (5). Therefore, it takes courage to engage in investigative efforts that challenge current and traditional practice pattern paradigms, and the authors ought to be applauded for doing so. Findings of such studies are often among some of the most surprising and clinically consequential. Many thematically different but conceptually related examples

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See also the article by Nikoubashman and Kraitem et al in this issue.

exist. For instance, the discovery of "gadolinium storage disease" has initiated the evaluation of potentially related symptoms. A critical review of the literature resulted in the questioning of the severity and existence of iodinated contrast nephrotoxicity and a smaller study regarding overnight vascular sheath dwell time in neuroangiography showed a surprisingly high frequency of sheath clot formation (6–8). All these examples are of considerable practical relevance. Perhaps more importantly, however, self-reflective research by physicians who also practice in these areas—as presented here—has the potential to improve patient safety and to strengthen trust in the physician-patient relationship.

There were study limitations related to the uncertain clinical relevance of the study findings. Longer-term clinical follow-up and embolic source determination in cerebral angiography (or other vascular territories) are also warranted, although the latter would be difficult to accomplish.

Along those lines, future research in this area may evolve around the clinical application of study findings; specifically, assessing the clinical prevalence of foreign body injections through techniques such as postmortem studies. Although the authors focused on cerebral angiography, effects on other vascular territories, such as the renal or pulmonary vascular beds in risk-stratified patient cohorts, would be of interest. Comprehensive comparative analysis with trays not containing cotton towels or woven gauze may also be meritorious, including the use of surrogate supplies and/or demonstration of the dispensability of these two items in the clinical routine. Infection risk potentially associated with iatrogenic embolization of foreign body material might also be a clinical concern meriting scientific exploration.

In summary, the presented study provides valuable insights into the risk of iatrogenic embolization of particular matter stemming from supplies that are routinely part of angiography trays. The authors also present practical and useful solutions to reduce such risk. Operators seem well-advised to follow these recommendations, while researchers interested in this area may pursue investigations that explore short- and longer-term clinical relevance.

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