Utility of dual-energy CT in differentiating contrast extravasation from intracranial hematoma

TO THE EDITOR: We read with great interest the article by Zamora and Lin5 (Zamora CA, Lin DD: Enhancing subdural effusions mimicking acute subdural hematomas following angiography and endovascular procedures: report of 2 cases. J Neurosurg 123:1184–1187, November 2015). The authors reported 2 interesting cases of iodine contrast extravasation into the subdural space mimicking acute subdural hematoma after intracranial neuroendovascular procedures. We applaud the authors for bringing attention to this important phenomenon and appreciate their literature review to help readers better understand the pathophysiology of contrast extravasation.

We have encountered similar cases and found that dual-energy CT (DECT) has significant diagnostic value in differentiating between contrast and blood in the subdural space.1 Dual-energy CT is a relatively new imaging technology that first became commercially available in 2006. It is based on the principle that materials have different attenuations at varying energy levels, which means that materials with similar Hounsfield units at one energy level will have different Hounsfield units at another energy level. Given this intrinsic property of materials, CT images obtained at 80 and 140 kV can be processed by computer algorithms, and each voxel can be separated into brain parenchyma, iodine, and hemorrhage components.1 Given these components for each voxel, computer software can then generate a set of images including a single-source image (equivalent to conventional CT), a virtual nonenhanced image, and an iodine overlay image. Hemorrhage would only appear hyperdense on a virtual nonenhanced image, while contrast extravasation would only appear hyperdense on an iodine overlay image (Table 1). Multiple recent studies have demonstrated that DECT can readily differentiate hematoma from contrast extravasation with high sensitivity, specificity, and positive predictive value.1,2,4

We recently encountered a case that illustrates this point nicely. Our patient presented with subarachnoid hemorrhage and had external ventricular drain placement for hydrocephalus. Subsequently, the patient underwent endovascular treatment of a left posterior communicating artery aneurysm, and postoperative CT demonstrated a

![Figure 1](image-url)

**FIG. 1.** A: Postoperative CT demonstrating a left-sided hyperdense subdural space concerning for subdural hematoma. B: Iodine overlay image from DECT demonstrating hyperdense signal suggesting contrast extravasation. C: Virtual nonenhanced image from DECT did not show hyperdense signal from the subdural collection, suggesting the absence of hematoma. D: Follow-up CT scan obtained the next day, demonstrating near-complete washout of the contrast material. Figure is available in color online only.

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left-sided hyperdense mass in the subdural space concerning for subdural hematoma (Fig. 1A). However, the subdural collection appeared hyperdense on an iodine overlay image (Fig. 1B) and was not hyperdense on a virtual nonenhanced image (Fig. 1C). Given these imaging characteristics on DECT, the diagnosis of contrast extravasation was made. Indeed, a follow-up CT scan the next day showed near-complete washout of the contrast material (Fig. 1D).

Dual-energy CT is an important tool in distinguishing intracranial hemorrhage from contrast extravasation, and it can help clinicians quickly reach the correct diagnosis and avoid potentially unnecessary surgical intervention.

Response

We thank Tan et al. for their insightful comments and for sharing a case of subdural contrast extravasation on head CT following an endovascular procedure that was very similar to ours. Dr. Tan and colleagues underscore the clinical utility and elegance of DECT (also called dual-source CT) for discriminating between 2 high-attenuating substances, blood and extravasated contrast material, whose presence has widely different clinical implications.

Like many medical centers, ours has several scanners with this capability, and dual-source acquisitions are routinely performed for CT angiography and other applications that require bone subtraction. However, dual-source imaging is generally not applied to routine head CT and is therefore not available in many cases (including the 2 cases in our report). We agree that this technique is promising for distinguishing blood from contrast material, as well as other applications, and is certainly a tool that should be taken advantage of when available. However, we also point out that if Hounsfield units within a collection markedly exceed the attenuation expected for blood, the presence of iodine can be confidently established and further imaging may not be needed for characterization. Lastly, the paucity of reports on contrast extravasation into the subdural space suggests that this event is very rare or underrecognized or both. In making a diagnosis of subdural hematoma, it is prudent to keep in mind the possibility of extravasated contrast medium from a recent examination.

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Cranioplasty complications and the timing of surgery

TO THE EDITOR: It is with great interest that we have read the article by Zanaty et al. (Zanaty M, Chalouhi N, Starke RM, et al: Complications following cranioplasty: incidence and predictors in 348 cases. J Neurosurg 123:182–188, July 2015). Cranioplasty is a relatively simple procedure from a technical standpoint, yet it could be linked with significant morbidity and mortality. Despite the fact that there is an increase in the number of patients undergoing cranioplasty, we still have a deficiency in data regarding several aspects of this procedure that may affect the outcomes.

One of these aspects is the timing of surgery. As the authors highlighted in their paper, there are contradictory data concerning this factor in the literature. However, we believe this factor needs to be analyzed according to patient subgroups and the characteristics of the inflammatory response after the injury. For example, we have noticed that early surgery seems to be associated with more bleeding complications in patients with massive middle cerebral artery (MCA) infarction. This could be attributed to a higher degree of fragility of cerebral parenchyma in this group of patients in comparison with other groups. The primary problem in this group of patients is the severely compromised blood supply. Perhaps this leads to a suboptimal inflammatory response; thus, it may be rational to expect a delayed recovery course associated with unusual tissue fragility.

Because of this increased tissue fragility, the cerebral parenchyma can be more susceptible to injury by manipulation (such as pushing the bone flap against the brain cortex or tissue during adjustment). The increased tissue fragility and the resultant greater vulnerability could amplify the risk of acute or delayed blood oozing and the