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# Catheter-directed computed tomography angiography: A pictorial essay

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## ABSTRACT

Catheter-directed computed tomography angiography (CDCTA) is an imaging technique where CT images are acquired after selective catheterization of a vessel. Images obtained in this fashion provide several advantages over conventional imaging techniques such as fluoroscopic angiography, digital subtraction angiography, cone-beam CT, and conventional CT angiography. At this point, there is still limited literature on the subject, with prior studies examining a small number of potential uses. The goal of this pictorial essay is to illustrate our single tertiary care center experience using CDCTA.

**Keywords:** Computed tomography angiography, Catheter-directed computed tomography angiography, Interventional radiology

## INTRODUCTION

Catheter-directed computed tomography angiography (CDCTA) is an imaging technique where CT angiographic images are acquired after selective vessel catheterization. Images obtained in this fashion confer several advantages over conventional imaging techniques, as it provides the regional high-density contrast seen with fluoroscopic angiography and digital subtraction angiography, along with the high spatial resolution and field of view of conventional CT angiography (CTA). As hybrid fluoroscopic/CTA suites are becoming more common, CDCTA may play a larger role in the future.

At present, limited literature exists on this subject, with prior studies only examining a small number of potential uses. CDCTA has been explored in reducing contrast burden in patients at risk for contrast-induced nephropathy in cases of peripheral vascular disease and abdominal aortic aneurysm treatment work-up.[1,2] These studies utilized decreased contrast over conventional CTA, but more importantly described comparable diagnostic image quality. Other studies have demonstrated utility in vessel mapping and targeting of hepatic tumors for radioembolization.[2,3]

Overall, CDCTA can be of benefit in numerous other clinical scenarios, and although it is likely used more commonly than the current literature would suggest, these cases have not been reported.

## MATERIAL AND METHODS

A single-center retrospective review of procedures was performed from March 1, 2019, to December 31, 2019, at our institute. Images were obtained using a Canon Infinix-i 4DCT

Aquilion PRIME/ONE VISION scanner (Canon Medical Systems, Tustin, CA, US). We identified a total of 20 cases during this period where CDCTA was used; five were selected for presentation. Omnipaque 300 contrast (GE Healthcare Ireland, Cork, Ireland) was diluted 70/30 for all angiographic examinations.

## DISCUSSION

The images below demonstrate how CDCTA, an underrepresented technique, is effective in vessel mapping by providing high contrast sensitivity and spatial resolution compared to other conventional imaging modalities.

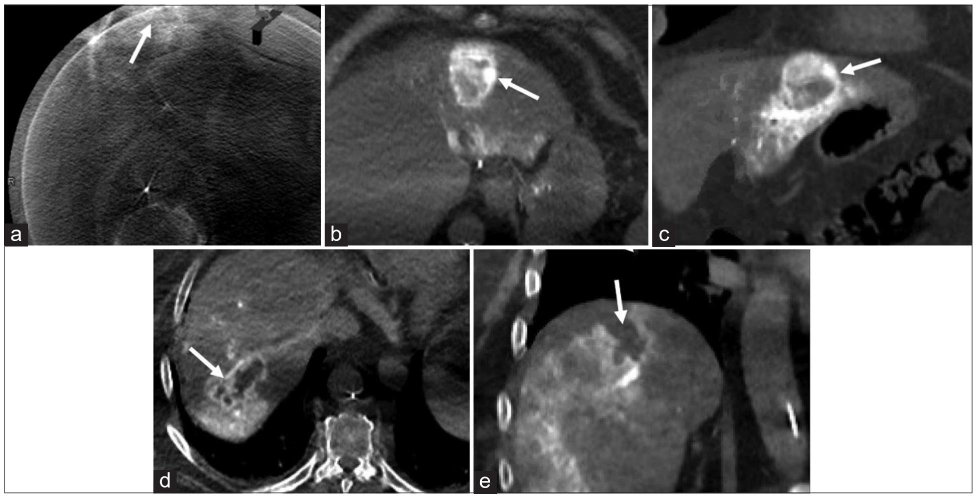


**Figure 1:** (a) 72-year-old male with HCC, and history of bilateral TACE and radiation segmentectomy presents with residual disease. Plan for vessel mapping prior to Y-90 radioembolization. Case above provides an example where CBCT from the left hepatic artery is unable to fully characterize the treatment region (arrow) secondary to an inadequate field of view as well as poor spatial resolution. (b) Left hepatic artery sub-selective CDCTA reveals an area of nodular enhancement (arrow) clearly separate from the background peri-treatment change, axial view. (c) Coronal view complimentary to Figure 1b. (d) In contrast, axial and coronal CDCTAs of another previously treated lesion from the right hepatic artery only show post-treatment changes without evidence of tumor recurrence (arrow). Increased contrast conspicuity and spatial resolution of CDCTA allowed for this delineation. (e) Coronal view complimentary to Figure 1d.

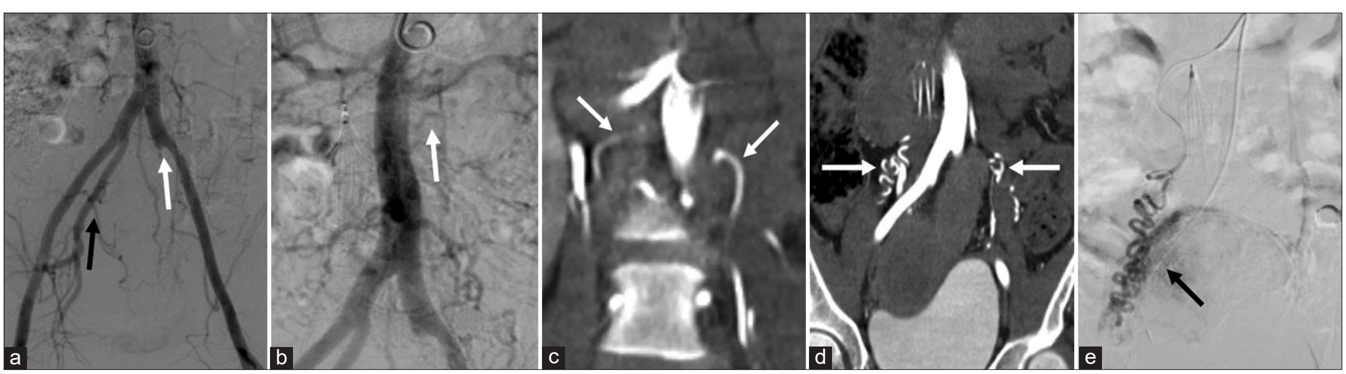


**Figure 2:** (a) 46-year-old female with ovarian fibroids and menorrhagia. Plan for uterine fibroid embolization (UFE). Mapping for UFE can be complicated by distorted pelvic anatomy (i.e. enlarged uterus) and the possibility of collateral uterine supply. Initial abdominal aortic DSA above demonstrates occlusion of the left internal iliac artery at its origin (white arrow), and no significant right uterine artery (black arrow). (b) The ovarian vessels were presumed to be the dominant blood supply; however, aortic fluoroscopic angiograpy only faintly revealed the left ovarian artery (arrow). (c) Aortic CDCTA revealed the origin of both ovarian vessels (white arrows). (d) Aortic CDCTA also confirmed a tortuous hypertrophied course into the pelvis to supply the uterus (white arrows). (e) After successful right ovarian artery cannulation, DSA revealed prominent uterine uptake (arrow).

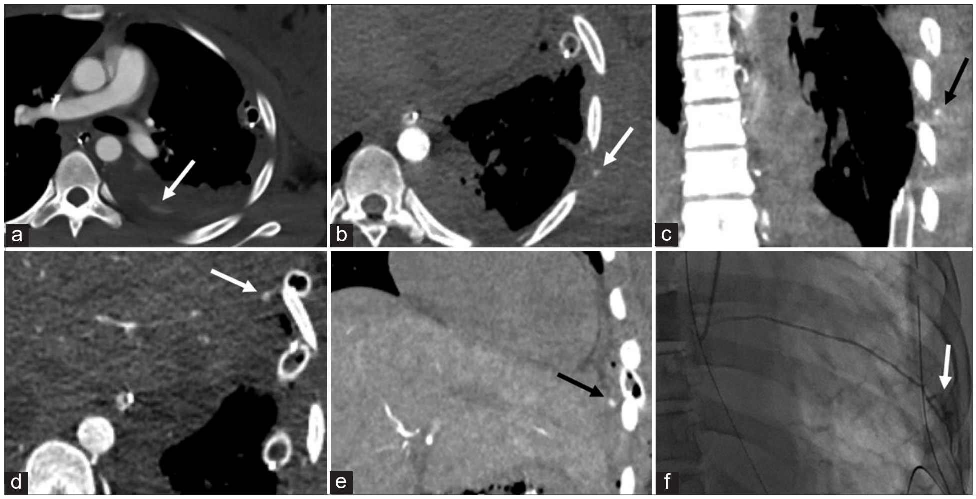


**Figure 3:** (a) 19-year-old female s/p MVC with rib fractures and bloody output from chest tube. Plan for angiogram with possible subsequent embolization. In cases of intercostal artery hemorrhage, identifying the involved thoracic level is important for quick cannulation and embolization. Conventional axial CTA did not demonstrate active arterial extravasation, with only non-localized pooling of contrast in the pleural space in the venous phase (arrow). (b) CDCTA via the aorta identified active extravasation in the $7^{th}$ intercostal artery (arrow), axial view. (c) Coronal view complimentary to Figure 3b. (d) CDCTA via the aorta also revealed active extravasation of the 8th intercostal artery (arrow), axial view. (e) Coronal view complimentary to Figure 3d. (f) Targeted cannulation and arteriogram confirmed the findings. Increased contrast conspicuity over conventional CTA allowed for visualization of the bleed (arrow).

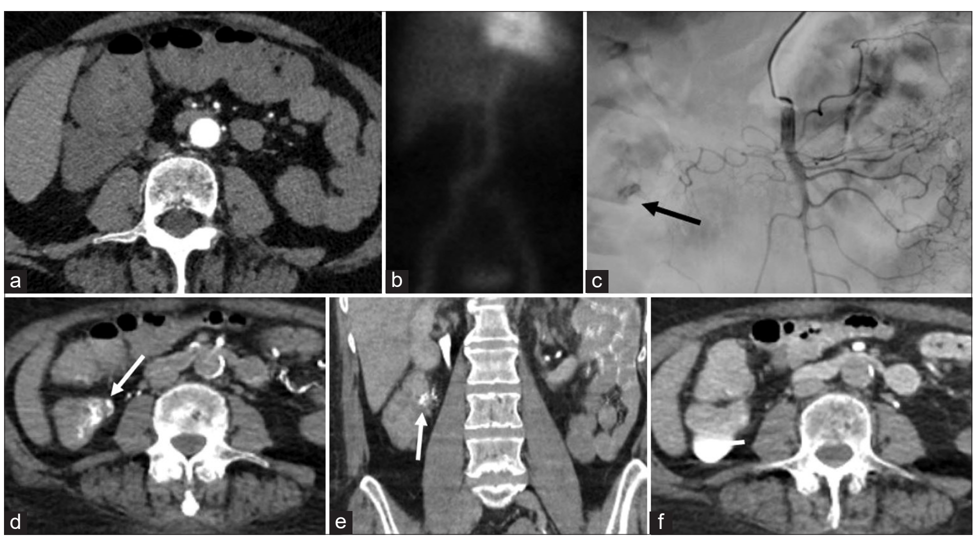


**Figure 4:** (a) 67-year-old female with history of colonic diverticulosis presents with lower GI bleeding, and decreased hemoglobin level. Detecting GI hemorrhage with conventional imaging methods is limited due to the intermittent nature of active arterial extravasation as well as the sensitivity of the exam. Axial conventional CTA demonstrated no extravasated contrast. (b) Tagged red blood cell nuclear machine failed to identify the bleed in this patient with clinically significant hemorrhage. (c) During a period of suspected ongoing hemorrhage, DSA via the SMA identified a region of possible extravasation from a right colic branch (arrow). (d) Sub-selective CDCTA demonstrated active extravasation from the suspected right colic branch (arrow), axial view. (e) Coronal view complimentary to Figure 4d. (f) Venous CDCT further confirmed the findings with pooling of extravasated blood.

**Figure 5:** (a) 65-year-old female with suspected infected portal venous clot. Plan for portal venogram and suction thrombectomy. Removal of a portal venous clot unmasked a portal venous-bowel fistula in a patient with a complex abdominal surgical history, including recent Whipple for pancreatic carcinoma. Initial trans-splenic portal venogram demonstrates scattered filling defects (black arrows). (b) Portal venous CDCT demonstrates the clot (arrow) as well as non-opacification of the right portal venous system (star) due to the chronic occlusive right portal vein thrombus. (c) After partial suction thrombectomy, a portal vein-bowel fistula was revealed on portal venogram (black arrows). (d) Portal venous CDCT more precisely described the fistula as involving the choledochojejunostomy loop used in the patient's Whipple (arrow), axial view. High resolution CDCT in a large field of view aided in surgical planning in the setting of prior abdominal surgeries. (e) Coronal view complimentary to Figure 5d.

CDCTA yields high radiographic contrast density at the tissue level and within small vessels, which promotes correct identification of targeted vessels for treatment. For example, correct recognition of the vessels involved in the Y-90 and UFE cases decreased the risk of non-target embolization and incomplete treatment [Figures 1a-e and 2a-e].

Furthermore, localization in conjunction with high contrast sensitivity is critical in cases of active extravasation. The cases of intercostal hemorrhage and mesenteric hemorrhage described above showcase the utility of CDCTA in correctly identifying and treating target vessels compared to other conventional modalities [Figures 3a-f and 4a-f]. Finally, as the case of portal venous thrombectomy shows, CDCTA provides high spatial resolution of the surrounding structures which enable the operator to see background context before treatment to reassess the plan and adjust treatment as necessary [Figure 5a-e].

The results of this study certainly advocate for the utilization of CDCTA whenever deemed viable as an alternative to traditional fluoroscopic methods. Our internal impression is that CDCTA has the potential to provide greater sensitivity in the detection of active arterial extravasation compared to fluoroscopic angiography and/or conventional CTA. However, a follow-up investigation will certainly be necessary to assess this hypothesis and holistically evaluate these imaging methods head to head in the context of pertinent radiological variables.

## CONCLUSION

CDCTA can serve as a novel and invaluable alternative to traditional imaging modalities in various clinical scenarios.

### Declaration of patient consent

Patients' consent not required as patients' identity is not disclosed or compromised.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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