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Case Study

New & Emerging Possibilities Using 4D CT in IR

The University of Chicago Medicine

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"You can do multiple sequential procedures in the same room without going back and forth between the CT and IR room…The procedures can be done sequentially without the patient ever getting off of the table…. Gives you a unique ability to handle some of the complications that you might encounter for CT guided procedures."

—Brian Funaki, M.D., FSIR, FCIRSE, FAHA

An internationally recognized expert in vascular and interventional radiology, Brian Funaki, MD, Chief of Vascular and Interventional Radiology at the University of Chicago Medicine, performs the full range of vascular and non-vascular interventions, including angioplasty, stenting, thrombolysis and embolization, as well as transplant-related procedures. He is a former member of the Executive Council of the Society of Interventional Radiology. An avid writer, he has authored over 200 publications, two books and 11 book chapters. Dr. Funaki is an associate editor of the Journal of Vascular and Interventional Radiology. He also served as editor-in-chief for Seminars in Interventional Radiology from 2004-2011 and is the co-editor in chief of Updates in Interventional Radiology.

"The Canon Medical 4D CT has transformed our ability to perform interventional oncology procedures. The ability to obtain diagnostic quality CTs quickly has allowed us to accurately confirm treatment areas, optimize dosimetry planning, and recognize sources of non-target embolization."

—Osmanuddin Ahmed, M.D.

Osmanuddin Ahmed, MD is a board-certified radiologist with extensive experience on diagnostic and interventional radiology at The University of Chicago, Section of Vascular and Interventional Radiology. He has been an editorial board member and social media editor of Journal of Vascular and Interventional Radiology since 2017. Dr. Ahmed has published numerous articles, is an invited reviewer of many high-impact journals and provides various lectures worldwide. He has been recognized as Top Reviewer of JVIR since 2016 and by the international Alpha Omega Alpha Honor Medical Society.

"The Canon Medical 4D CT system has transformed our workflow and increased our throughput by giving us the ability to treat a patient using two modalities in a single suite."

—Samuel E. Guajardo, RT (R) (VI)

Samuel E. Guajardo, RT (R) (VI) is an experienced and accomplished interventional radiology technologist with over fifteen years of experience. As a Senior IR Tech at the University of Chicago Medicine, Sam is responsible for training and teaching new technologist in interventional radiology. He actively develops teaching tools and training modules for new employees, fellows, residents, technologists and nurses on products and procedures in Interventional Radiology. He also participated in the development and implementation of Y90, trauma and research protocols.

Better patient care in one Interventional Lab/CT solution with Canon Medical's 4D CT

Canon Medical Systems' 4D CT is a powerful hybrid imaging system which has a fully operational ceiling mounted angiography system combined with an advanced dynamic volume CT scanner. This combination in one suite delivers an exceptional solution for complex image-guided interventional procedures. The 4D CT has a specially designed extendable table top that easily slides into position during imaging for either the angiography C-arm or the CT gantry. The uniqueness of the 4D CT is the ability of clinicians to prioritize the patient experience and streamline their workflow during interventional procedures in a single clinical setting. The combination of both systems within one integrated imaging suite enables physicians to eliminate patient transfer during intricate procedures and confirm the effectiveness of the procedure.

The Canon Medical 4D CT ceiling mounted C-arm has a high resolution flat panel detector with compact housing to enable unprecedented flexibility of positioning the C-arm 270 degrees around the patient. The CT system offers low contrast detectability and high contrast resolution for either volume or helical examinations to create thin slices with high precision 3D and MPR images.

The history of the University of Chicago Medicine dates back to 1927 and is a not-for-profit academic medical health system located on the campus of the University of Chicago in Hyde Park. The Department of Radiology, Vascular and Interventional Radiology team installed Canon Medical's 4D CT in April 2018. The physicians have learned the capabilities of the system and the various types of procedures performed continue to grow.

The procedures in this article are due to the efforts of the physicians and staff at the University of Chicago and is intended to highlight countless categories of procedures that are being performed.

University of Chicago 4D CT system

Renal Aneurysm Embolization

71 year old man with a past history of esophageal cancer had two renal aneurysms discovered incidentally on abdominal CT performed to evaluate tumor response. The smaller one was 1.8 cm and the larger one 3.6 cm in diameter. Initial DSA (digital subtraction angiography) series performed at 3 frames per second (fps) showed two aneurysms originating off of the Lt renal artery as well as a large cyst. The neck of the aneurysms were not delineated by DSA alone so a helical CT scan was performed with an intra-arterial injection of the Lt renal artery. The multiplanar views obtained from the CT aided in localizing the origin of the neck of both aneurysms. An additional CT scan was then performed using delayed scanning of 6 seconds to capture the left renal vein to confirm the aneurysms did not encroach on the vein. The larger one was treated using 2 long detachable packing coils to completely fill the aneurysm with preservation of all vessels. Post coiling both a DSA and a CT scan were done to check the effectiveness of the coils. The smaller aneurysm was not treated during this procedure.

Image 1: DSA Lt renal artery shows two aneurysm

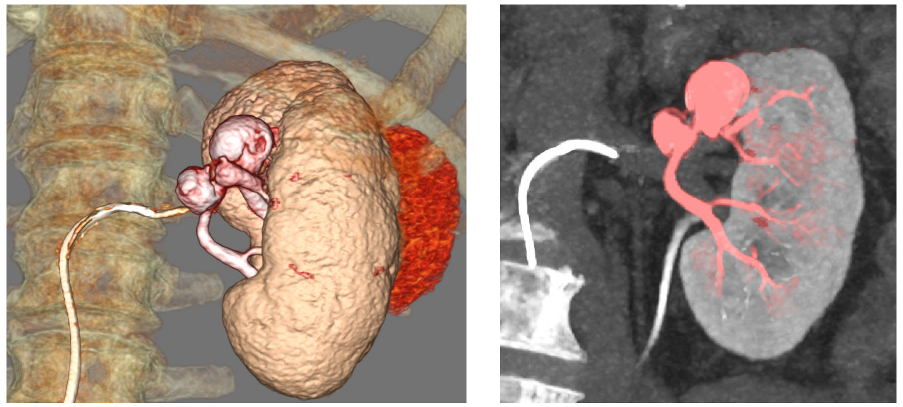


Image 2: 3D volume rendering and Coronal MPR oblique view depicts neck of aneurysm and renal cyst (red)

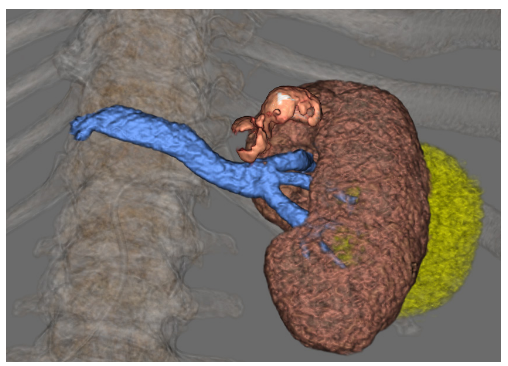


Image 3: CT late venous phase to check encroachment

Image 4: Fluoro record during first coil placement

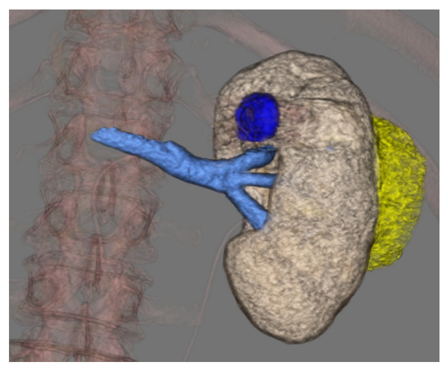


Image 5: DSA post 2nd coil of larger aneurysm. The darker blue represents the coils

Yttrium-90 Mapping

A 64 year old with a history of metastatic colon cancer in the liver, was brought to the 4D CT room for Y-90 mapping. A 5 French catheter was inserted into the patient's right femoral artery and advanced to the celiac artery. An intra-arterial injection DSA did not highlight the common hepatic artery. The common hepatic artery was found as a separate branch off of the aorta. A DSA through a 5 French catheter showed the vessels which were supplying the tumor in the late venous phase. A 2.4 French microcatheter was then advanced to the common hepatic artery and a DSA was done with an injection of 1 ml per second for a total of 11 ml. To highlight the tumor, a tri-phasic CT scan was done with an intra-arterial injection through the 2.4 French microcatheter to identify a significant lesion in the upper right lobe of the liver. Contrast injection of 0.5 ml per second for a total of 6 ml was used with a 2 second scan delay for the arterial phase, a 6 second scan delay for the early venous phase, and then a 10 second scan delay for the late venous phase.

Image 1: DSA of celiac origin

Image 2: DSA of common hepatic origin

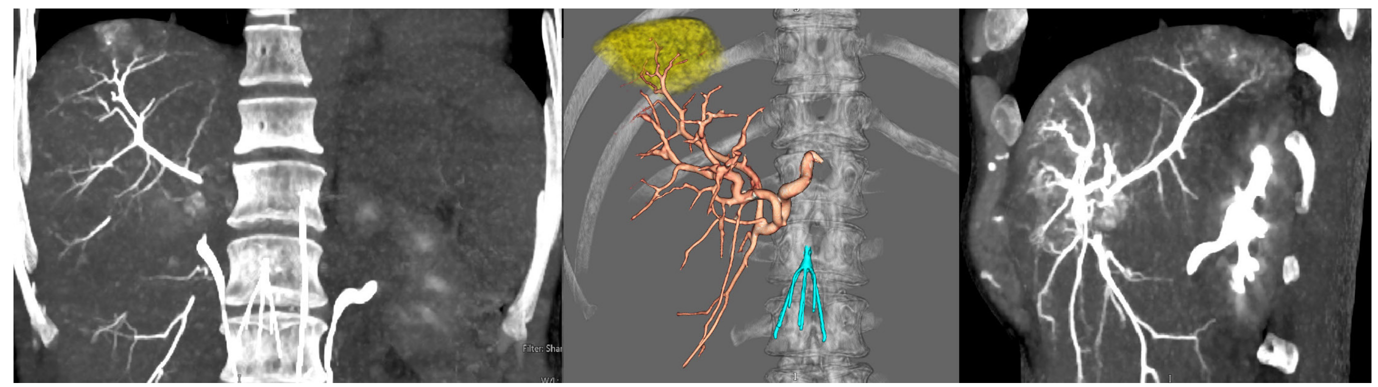


Image 3: Helical CT of common hepatic showing Coronal, 3D VR and Sagittal views

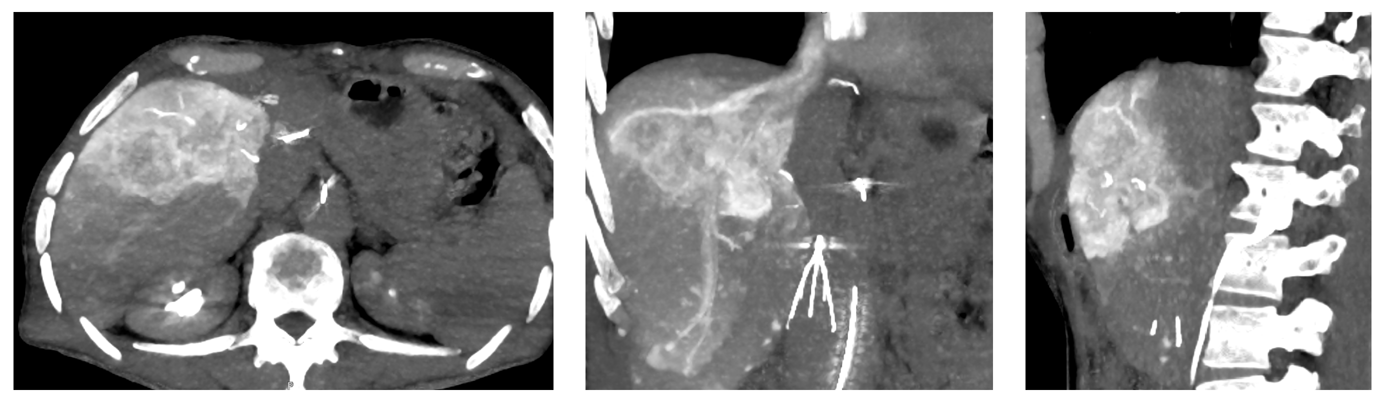


Image 4: Helical CT with injection through 2.4 French microcatheter placed in the common hepatic artery. Venous phase of axial, coronal, and sagittal MPR highlights contrast washout of the tumor area.

Arterial Bleed Embolization

A 23 year old man that came into the emergency room after a straddle injury and high flow priapism which developed post injury. Patient was brought to the 4D CT room and CT scan identified an arterial cavernous fistula from the right internal Pudendal artery. The communication was embolized using two microcoils and his condition resolved over the subsequent week.

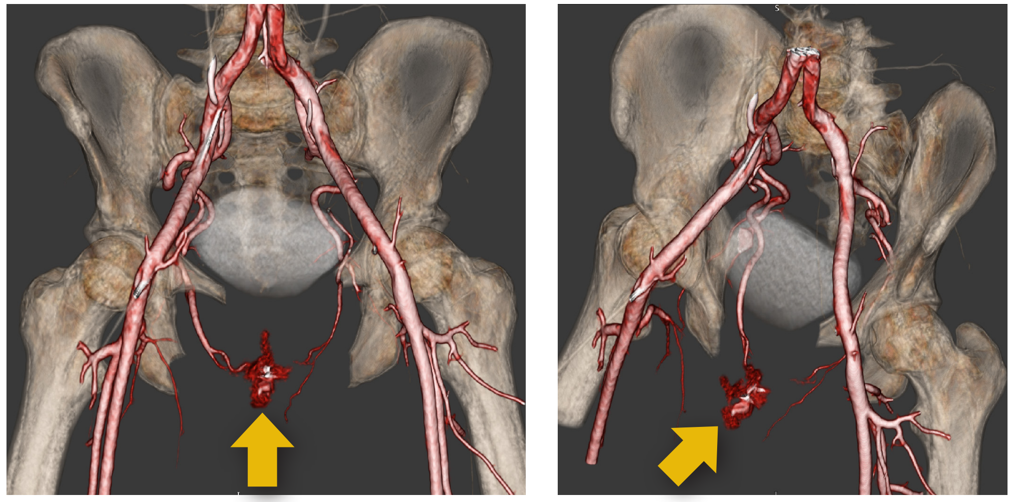


Image 1: CT of Aortic bifurcation. 3D Volume rendered AP and Oblique views

Image 2: DSA of right pudendal artery

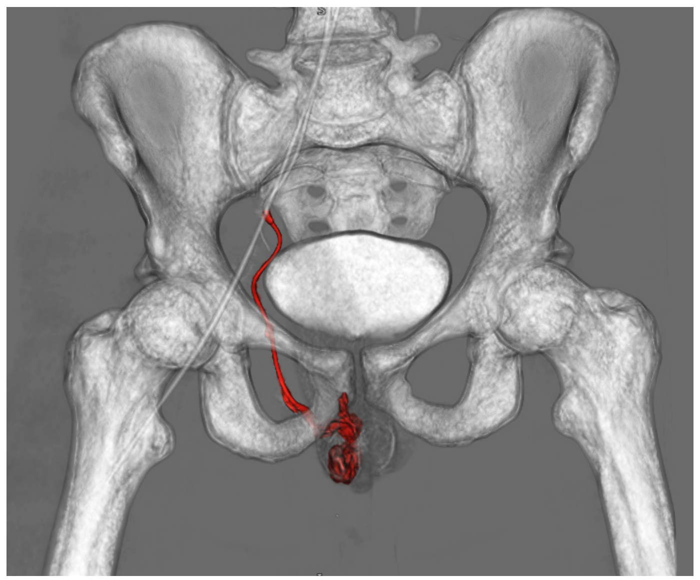


Image 3: CT of super selection of internal pudendal artery.

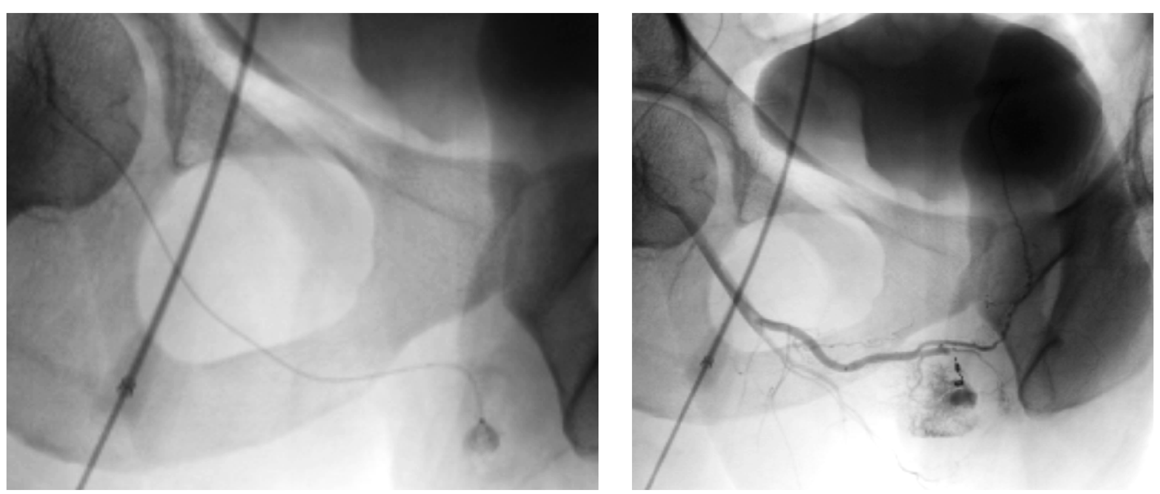


Image 4: Image on left shows microcatheter in position. Image on right shows coil placement

Pelvic Mass Cryoablation With Biopsy

A 55 year old brought into the 4D CT room for possible cryoablation in the pelvis. The helical CT scan of the pelvis was done and a large mass was seen. A biopsy was necessary to specify what category of pathology. Once the biopsy needle was advanced to the mass, a CT scan was done with an intra venous injection to ensure that the needle had missed the arteries in the pelvis. A cryoablation of the mass was then performed. Three cryoprobes were inserted into the area mass. CT provided the necessary information during this procedure without the need for fluoroscopy. The patient was able to have both procedures in the same room, on the same day without being transferred from one room to another.

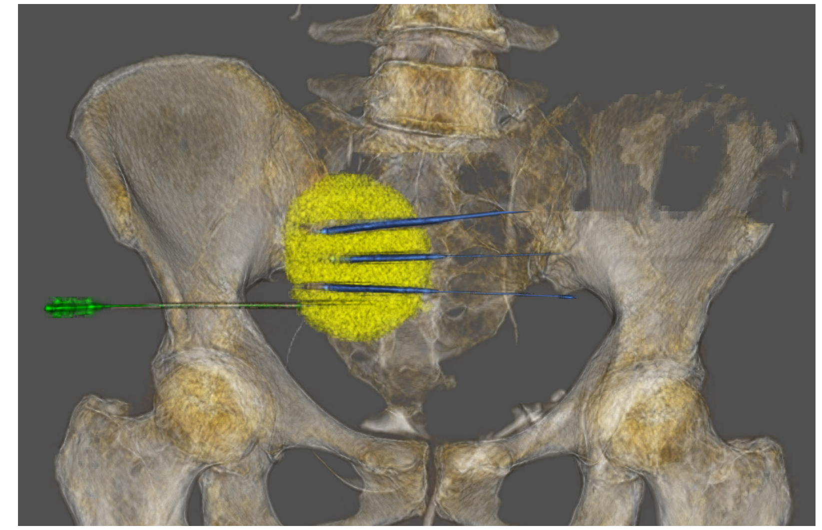


Image 1: Depicting CT-guided positioning of the cryoprobes with ice ball development.

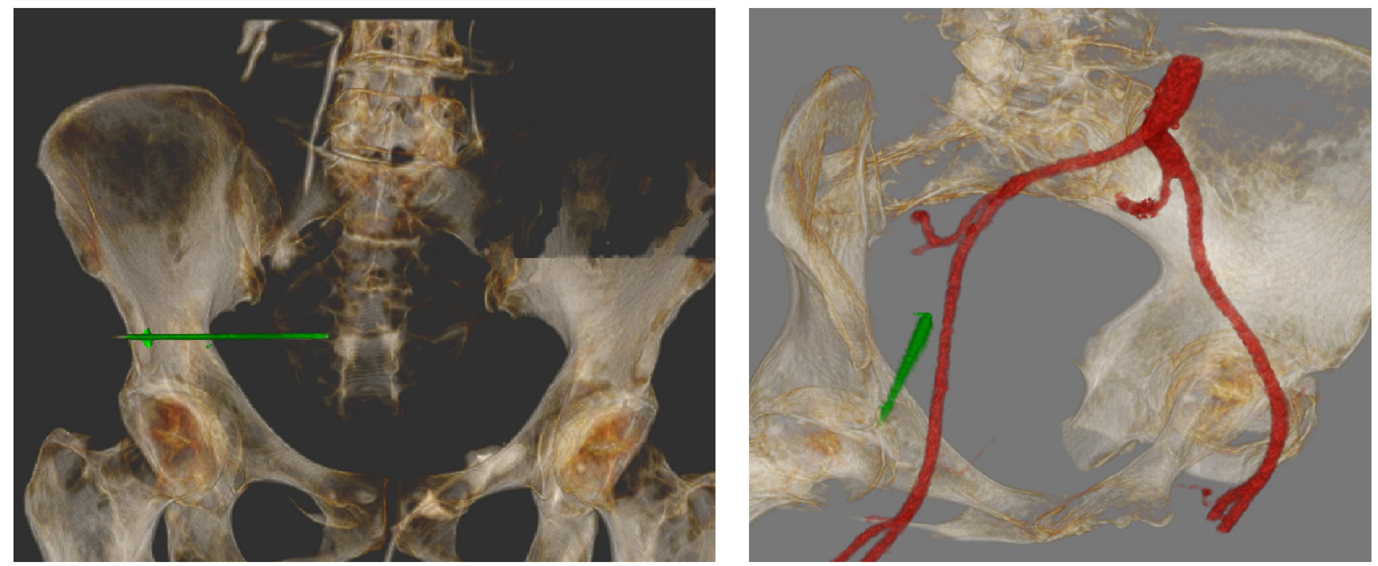


Image 2: Image on left shows the biopsy needle insertion. Image on right is the CT with IV contrast injection to check the needle pathway

Image 3: CT scan shows axial, sagittal, and coronal MPR views of the probes for cryoablation

Type 2 Endoleak Repair

A 72 year old who had undergone an endovascular aortic aneurysm repair (EVAR). Physician suspected an endoleak outside lumen of the patient's endoluminal stent graft. The procedure was done in the 4D CT room in anticipation of the need to perform CT scanning for localization of the area of the leak. A 5 French catheter was inserted into the right femoral artery and a DSA of the aorta was obtained. A helical CT scan was then performed and 3D volume rendered image was used along with the MPR views to try to visualize the endoleak. The patient was found to have a Type 2 endoleak demonstrated by a dynamic CTA. The sac was accessed in retrograde fashion from the SMA into ascending left colic and then the inferior mesenteric artery. The sac and IMA ostium was embolized using microcoils.

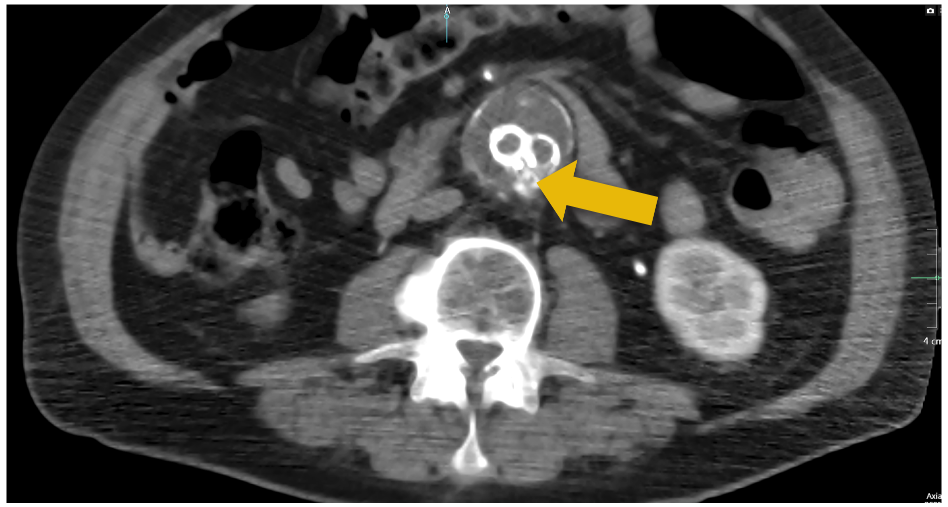


Image 1: CT scan helped to confirm area of endoleak.

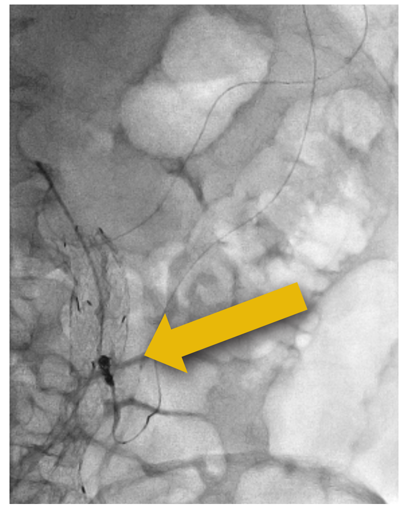


Image 3: Coil placement through microcatheter to repair the endoleak

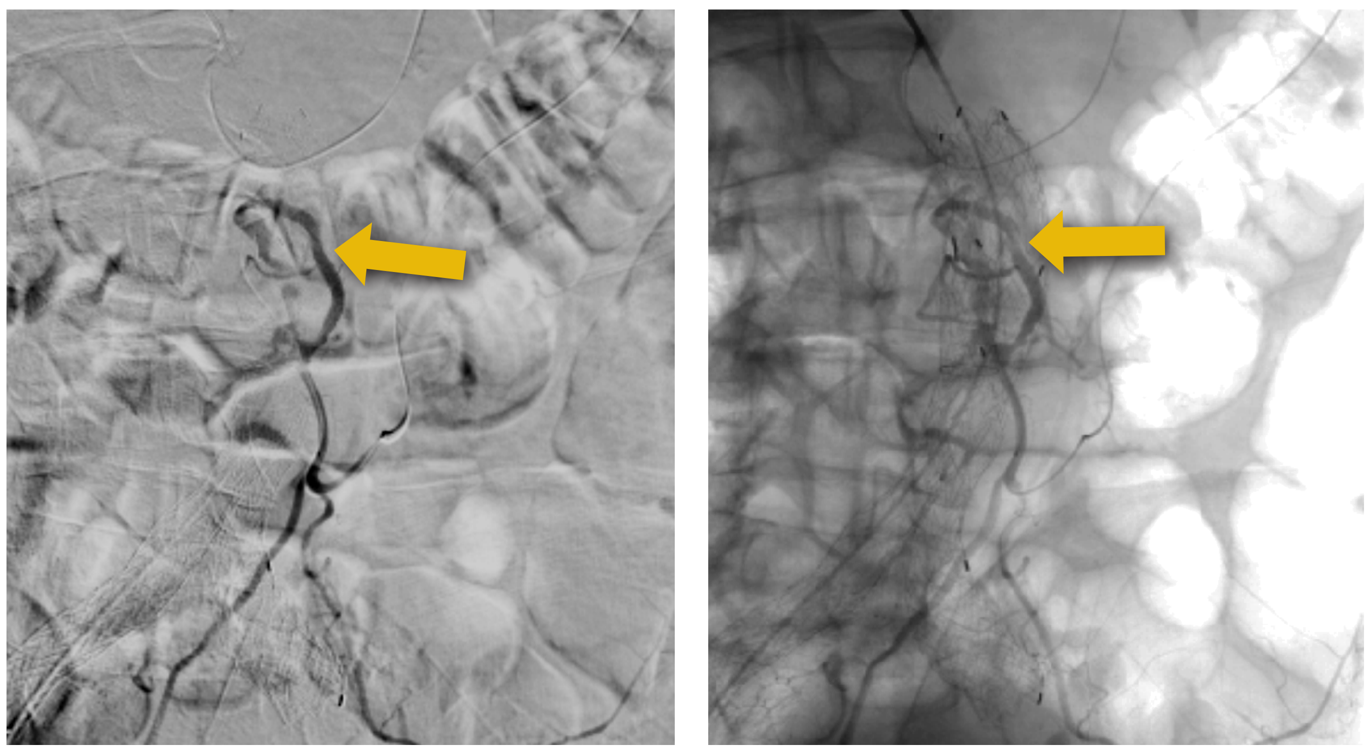


Image 2: Image on the left is a DSA through the microcatheter. Image on the right is DSA with land-marking. Leak was not distinguishable due to patient motion and bowel gas.

Procedural Parameters*1

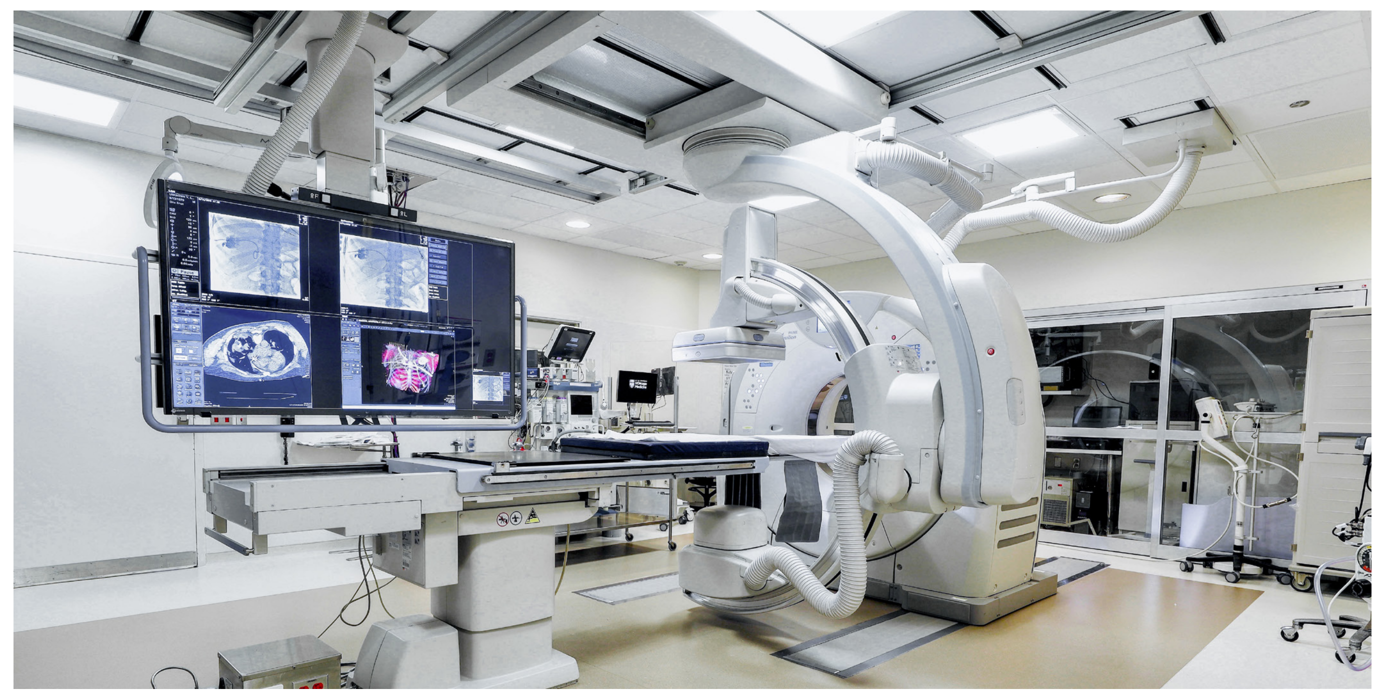
Due to the amount of procedures the University of Chicago has performed and the number of staff that need to be trained, Sam Guajardo has collected information for intra-arterial injections during CT scanning that are used consistently. The following parameters are used for intra-arterial injections acquired with CT imaging:

Vessel	Cath Fr	Cath Position	ml/s & total ml	Scan Delay	Scan Condition	Image Recon
SMA	5 Fr, end hole (EH)	Proximal	3 ml/s for 24 ml total	Arterial Phase Delay: 2 sec Venous Phase Delay: 6 sec Late Venous Phase Delay: 10 sec	Helical scan 120kV, MA modulation (MAM) Pitch 0.813 Rotation 0.5 sec	3x3 for all 5x5 for SEMAR*2 AIDR 3D*3 enhanced
Celiac	5 Fr, EH	Proximal	3 ml/s for 24 ml total			
Common Hepatic	Micro 2.4 Fr, EH	Mid	1 ml/s for 11 ml total			
Proper Hepatic	Micro 2.4 Fr, EH	Mid	1 ml/s for 11 ml total			
Lt / Rt Hepatic	Micro 2.4 Fr, EH	Mid	0.5 ml/s for 6 ml total			
Lt / Rt Gastric	Micro 2.4 Fr, EH	Proximal	0.5 ml/s for 6 ml total			
Phrenic	Micro 2.4 Fr, EH	Proximal	0.3 ml/s for 4 ml total			

*1 *The above chart is provided by the University of Chicago as a reference to the presented literature. Canon Medical is not endorsing or promoting the use of contrast agents outside of the drug insert.*
*2 *Single Energy Metal Artifact Reduction (SEMAR).*
*3 *Adaptive Iterative Dose Reduction 3D (AIDR 3D).*

Conclusion

The Canon Medical 4D CT efficiently integrates CT and IR imaging into one seamless solution. The use of real CT imaging available on demand helps reduce motion and breathing artifacts due to short acquisitions times and provide enhanced soft tissue visualization. The 4D CT seamlessly integrates our flexible interventional system with the advanced Aquilion CT imaging suite into one versatile solution. With the ability to see, diagnose, plan, treat and verify in the same room, the 4D CT helps you prioritize safety, speed and efficiency during complex interventions. Physicians are envisioning more and more ways to use the 4D CT system, enabling them to optimize the treatment of their patients and provide a comfortable environment during interventional procedures.



University of Chicago 4D CT PRIME system *(Photo Credit: Mark Hohn)*