TOSHIBA
MEDICAL

Clinical Applications

ImagingRite

Neuro Intervention

ImagingRite, a comprehensive suite of imaging tools offered with Infinix™-i angiographic systems, was designed to assist clinicians in optimizing their workflow and image quality (IQ) during interventional procedures. ImagingRite helps clinicians in the visualization and assessment of cerebrovascular disease including the evaluation of blood vessels supplying the brain, the blood flow within the interconnecting Circle of Willis, and feeding or draining vessels to abnormal cerebral pathology. Precise information assists clinicians in determining the appropriate intervention for treatment and for post intervention confirmation of procedural success. ImagingRite supports clinicians in addressing their challenges with a multitude of methods including 3D imaging, spatial and temporal processing, dose management tools, visualization techniques, and advanced acquisition protocols. Whether clinicians are performing a carotid angioplasty, a cerebral thrombolysis, an aneurysm coiling, or a stent procedure, Toshiba Medical's ImagingRite advanced applications give clinicians the tools they want to obtain the images they need.

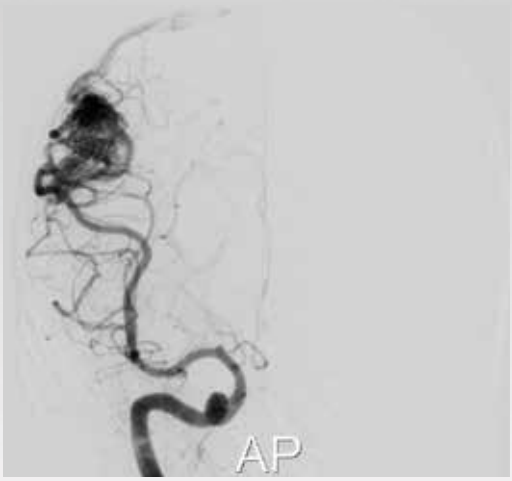
Advanced Imaging Applications

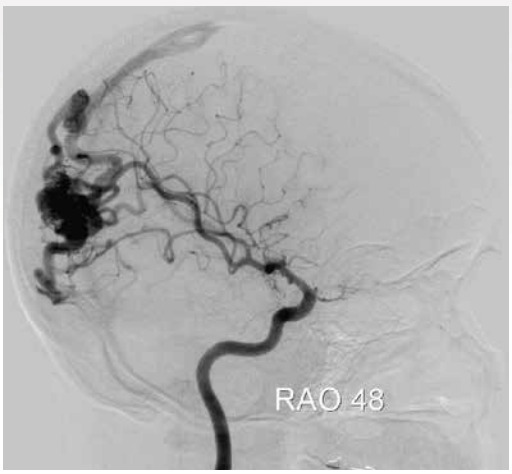
A suite of tools, allows you to plan, see and guide. Combined with Vital's Vitrea™ software, you have state-of-the-art software to help guide you through the intervention, including:

- Rotational Digital Subtraction Angiography (R- DSA)
- 3D Digital Angiography (3D DA)
- 3D Digital Subtraction Angiography (3D DSA)
- 3D Roadmap (3DRM)
- Multi-Modality Fusion (MMF) with CT, MRI, or angiographic images
- Low Contrast Imaging (LCI) – Cone Beam CT
- Needle Guidance

R-DSA

Infinix™-i ImagingRite standard features include R-DSA with all systems. R-DSA provides the ability to perform an entire





R-DSA views obtained from one acquisition showing feeding vessels of an arteriovenous malformation

rotational spin with boney anatomy and surgical hardware subtracted from the image for enhanced visualization of the blood vessels at several angles throughout the acquisition with one injection of contrast media.

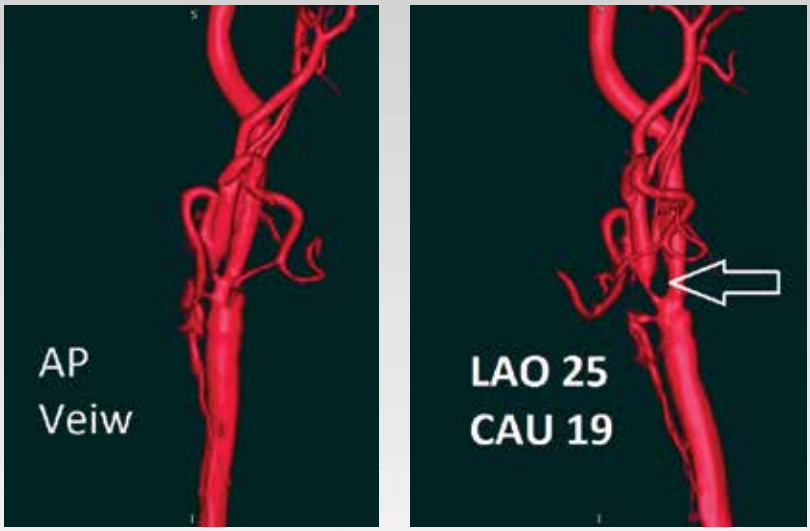
3D DA

C-arm rotation with high acquisition rates can be used to generate reconstructed volumes of vascular anatomy with one injection of contrast. The 3D vessel can be rotated in any direction to provide clinicians with additional views of vascular anatomy to aid them in their diagnosis and treatment during an interventional procedure. Multiple views obtained by a 3D rotational image enable clinicians to visualize vascular anatomy such as areas of stenosis, a take-off of an abnormal vessel, a feeder vessel to a vascular malformation, as well as various other pathologies. Clinicians can use these additional views to aid them during device manipulation.

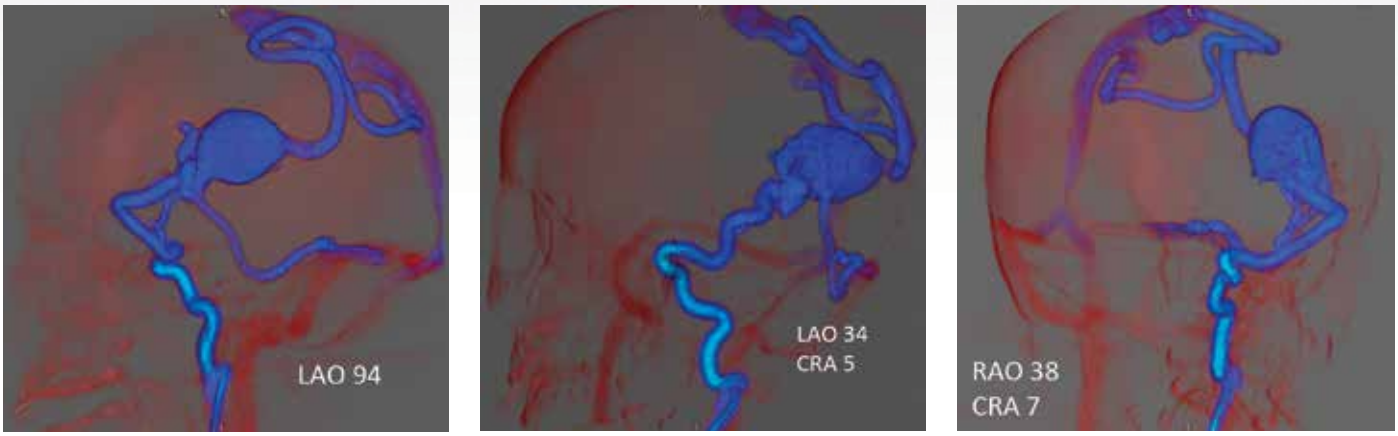
3D DSA

The C-arm rotates around the patient twice for 3D DSA acquisition protocols. The first spin is acquired without contrast, and the second spin with the injection of contrast. The data acquired from the two spins are automatically subtracted, removing bones throughout the entire rotation. As a result, the 3D DSA reconstructed volumes depict only the contrast filled vascular anatomy. The 3D data can be reconstructed with various processing techniques specifically tailored to depict bones, tissue, devices, and vascular anatomy.

3D DA of aorta showing bovine arch



3D DA views of common carotid shows stenosis



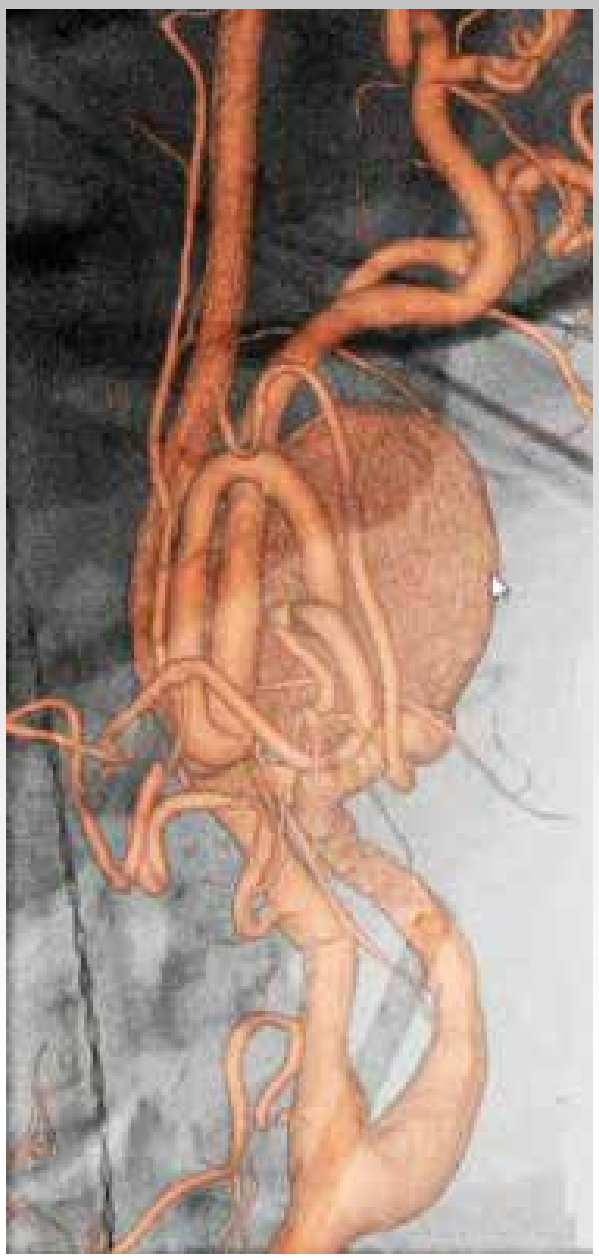
3D DSA of intracranial arteriovenous malformation, views from various angles.

Volume Navigation (3DRM)

Real-time volume navigation 3DRM with the Infinix-i system links every movement of the C-arm and table position with the 3D fused volume and fluoroscopic display. Regardless of changes in table position, Source-Image-Distance (SID), Field-of-View (FOV) or C-arm angulation, the 3D overlay remains consistently aligned with the fluoroscopic image provided.

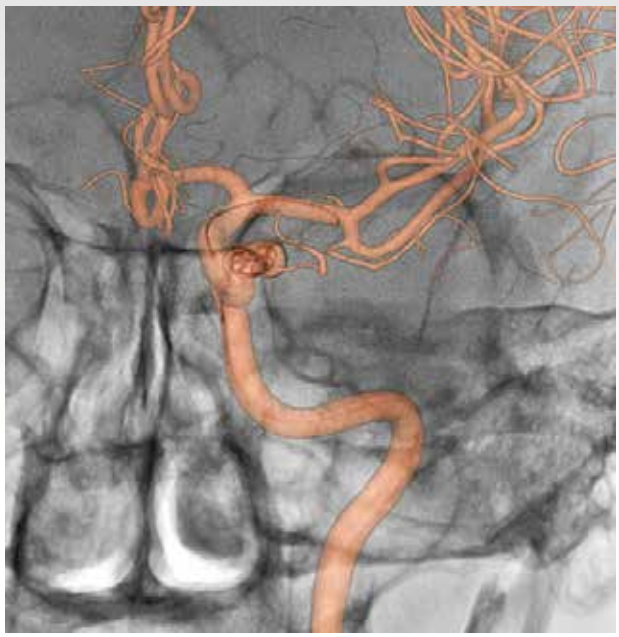
MMF

Using Vitrea software analysis tools, a 3D enhanced image previously acquired by CT, MRI or an angiographic system can be superimposed and displayed with live fluoroscopy.



3DRM of carotid aneurysm

3DRM showing coil placement



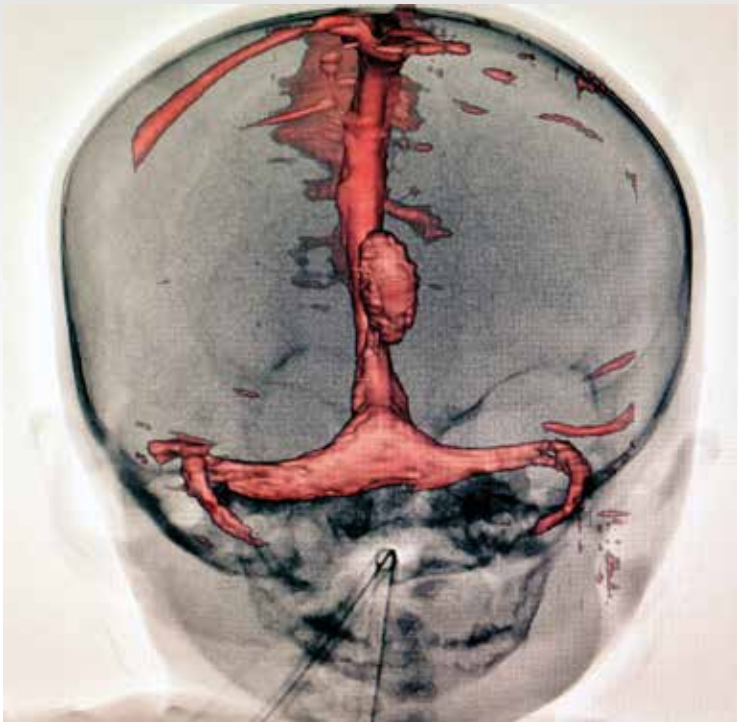
3DRM showing path of coil

Examples of CT Fusion:

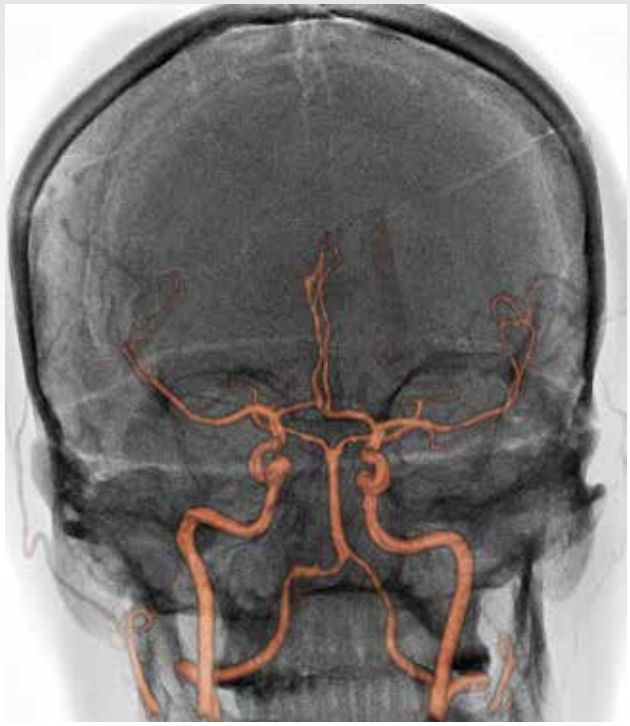
CT fusion of aortic arch

CT fusion abdominal aorta

Examples of MRI Fusion:



MRI fusion: Vein of Galen aneurysm



MR fusion: Circle of Willis

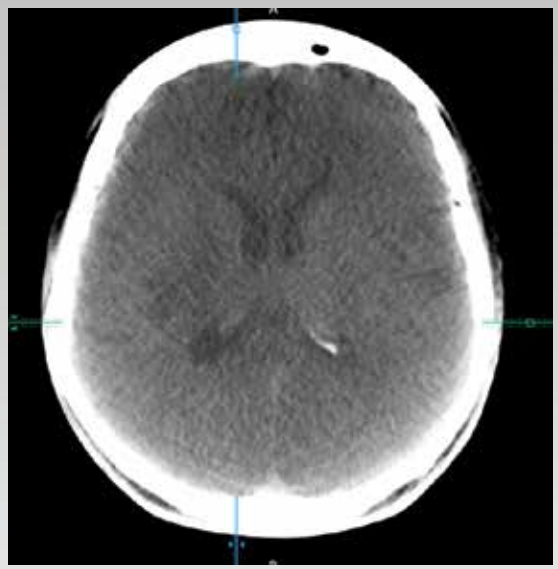
LCI or Cone beam CT

Cone-beam CT scans are derived from C-arm rotational acquisitions. The 3D reconstructed volumes can be transferred to viewing workstations. Volume Rendering (VR), Maximum Intensity Projection (MIP), Multi-Planar Reformations (MPR), axial, sagittal, and coronal views, may be used to visualize the target anatomy/pathology during interventional procedures, such as intervention for stroke.

ImagingRite includes several processing capabilities that can be used with LCI:

- *Metal Artifact Reduction (MAR)**
  MAR reduces metal artifacts present in images.
- Su*b Arachnoid Hemorrhage (SAH) De-Noising*
  SAH applies appropriate noise reduction filtering that is suitable for visualizing subarachnoid hemorrhage.

Neuro LCI shows cerebral bleed

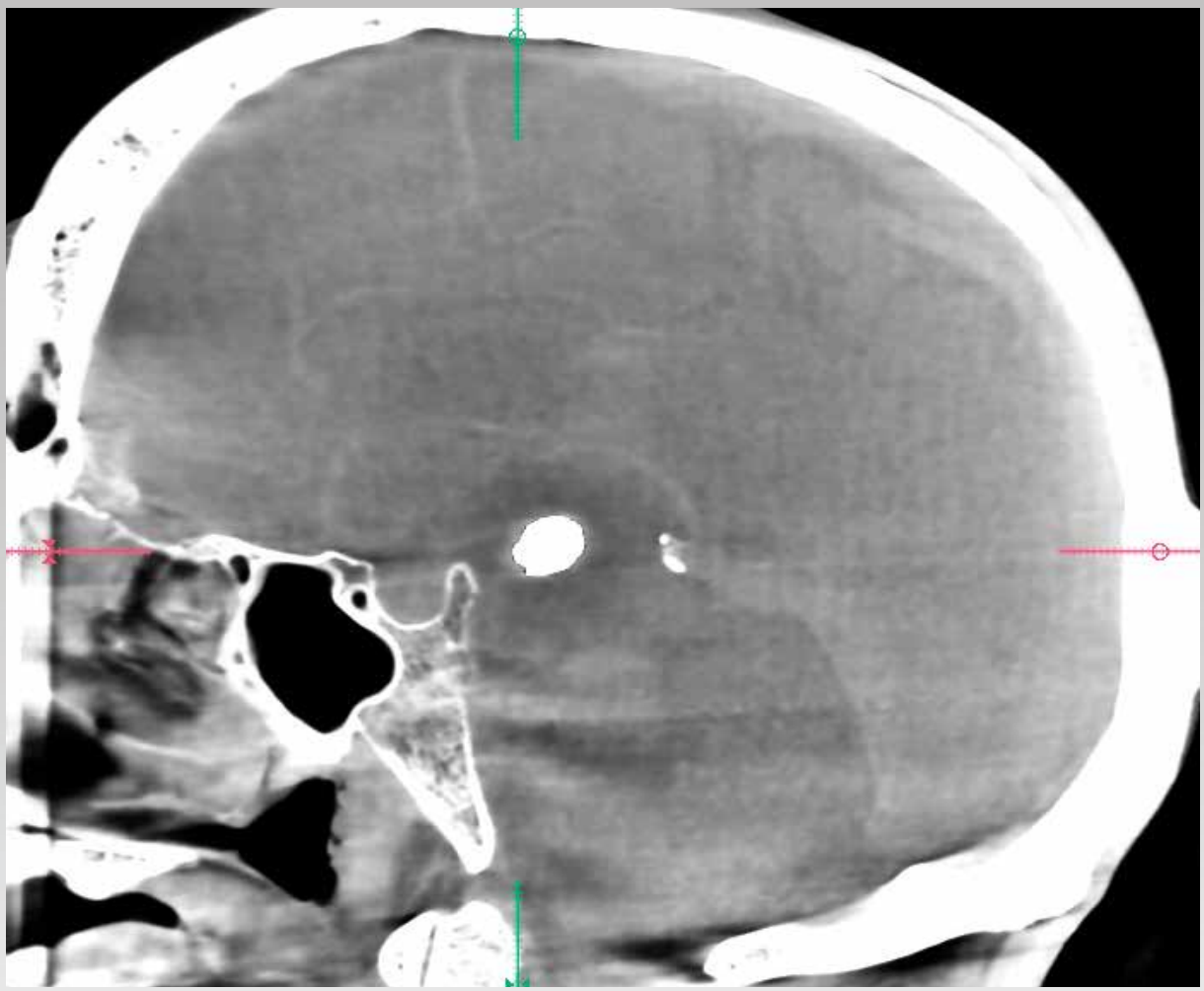


Neuro LCI

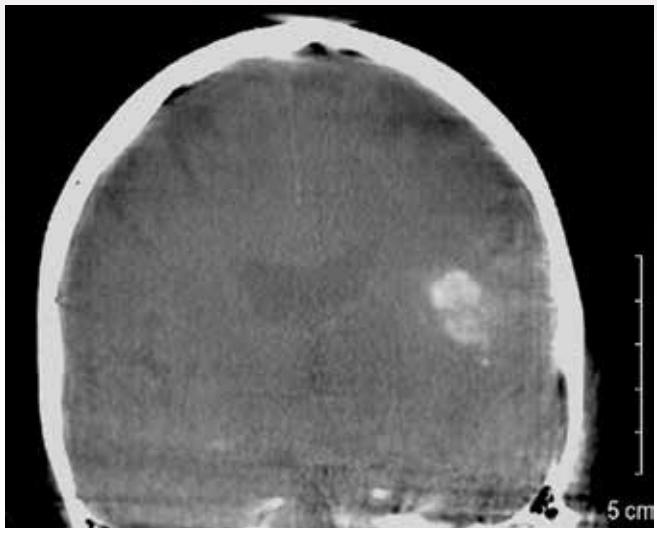
LCI for neuro coils without MAR

LCI for neuro coils with MAR

*MAR software is not intended for standalone use or diagnosis.



LCI with MAR for Neuro coils

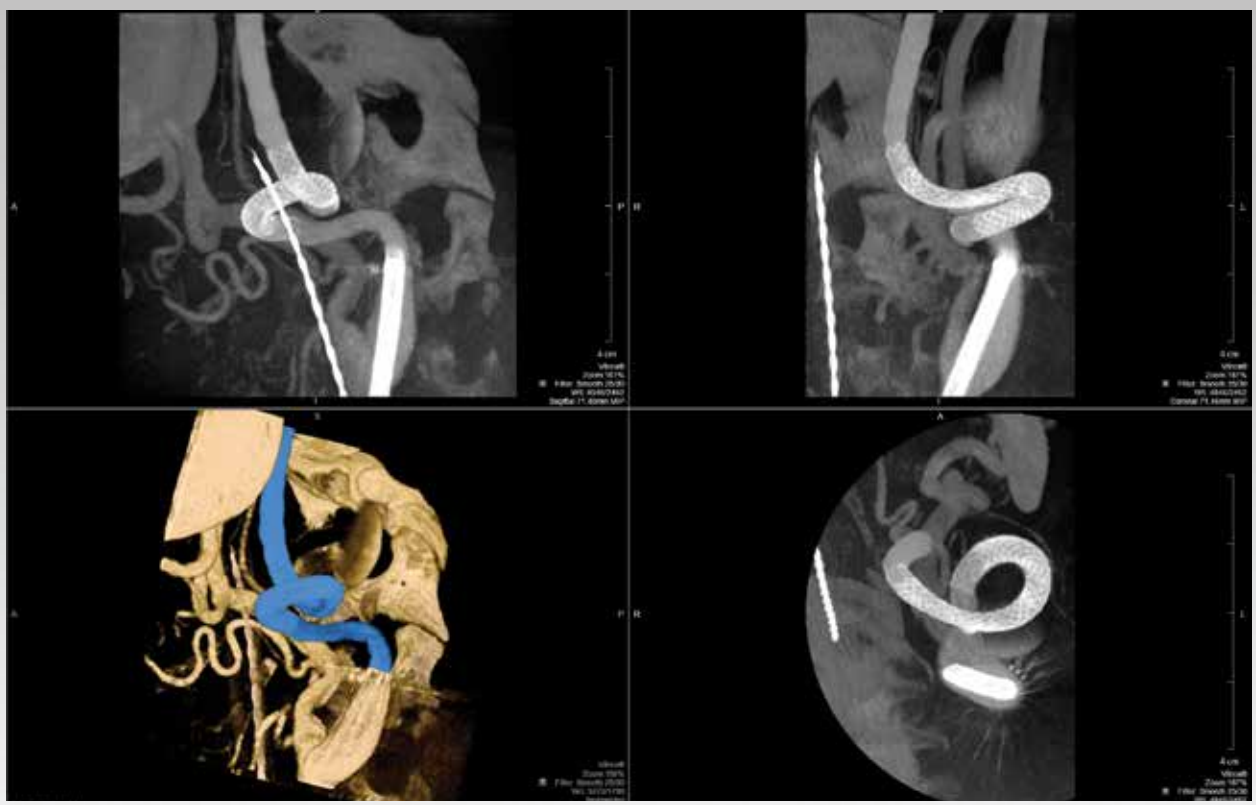


SAH processing for bleed

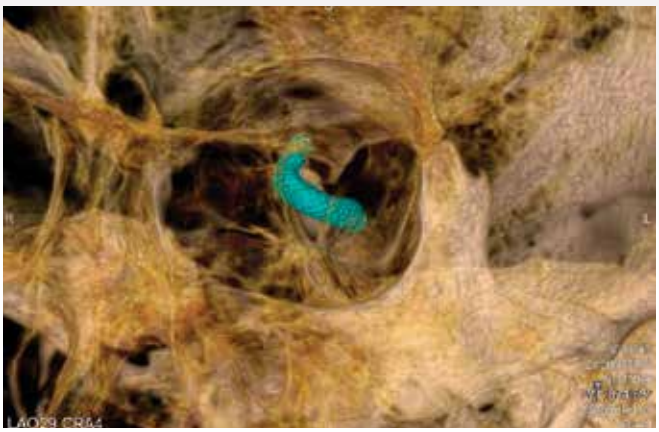
- *Stent Imaging Filter*
  A filter that is suitable for visualizing intracranial stents.
- *Device Fusion*
  Device fusion allows superimposition of a differently post-processed device within the blood vessel to aid clinicians during interventional procedures.

Needle Guidance

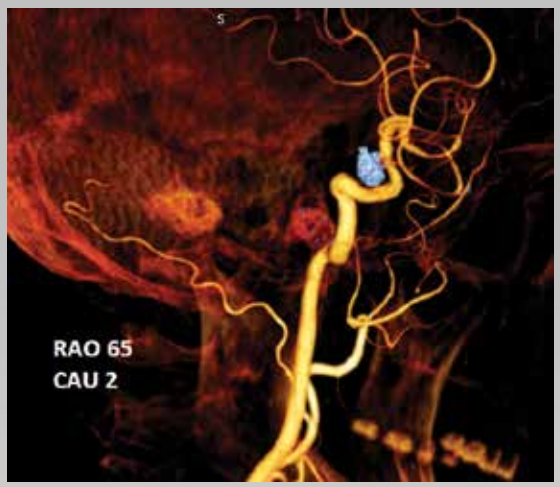
Needle guidance supports real-time navigation of needle insertion during percutaneous procedures; such as biopsy or RF ablation. Needle guidance software identifies the optimum point of needle entry and distance to the targeted anatomy. Acquired LCI or 3D DA images are superimposed over the live fluoroscopic image to provide visualization of anatomical structures during the procedure.

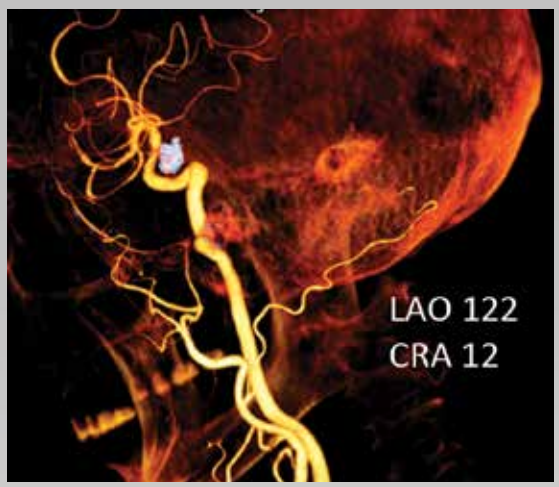


Stent LCI for neuro imaging

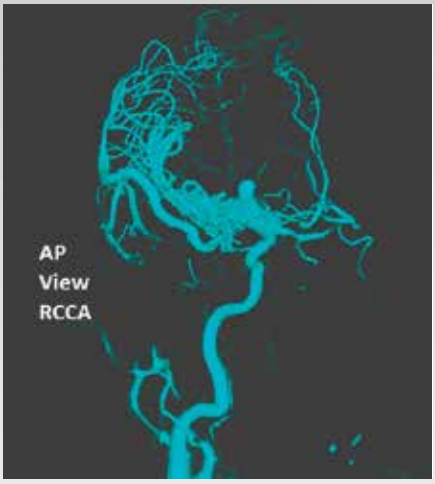


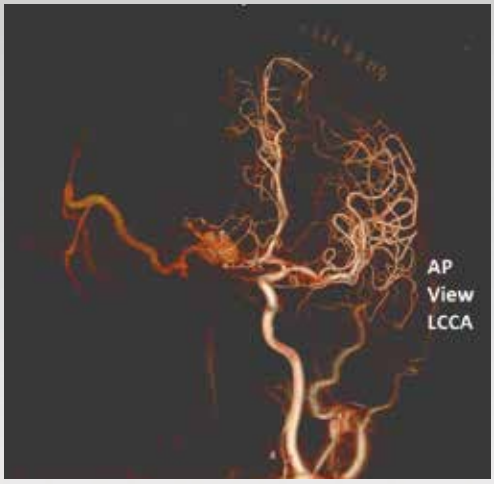
Stent LCI through cavernous sinus

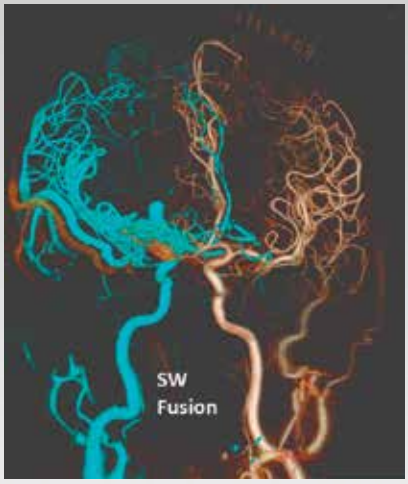




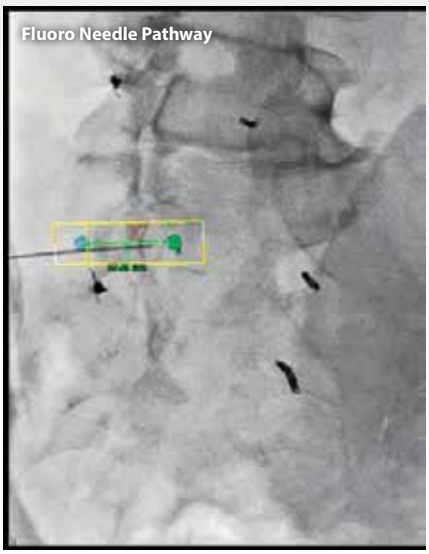
Device fusion shows coil placement in different views







Vital software fusion of multiple vessels injected to view communicating vessels of AVM



Needle guidance during spinal AVM embolization

Vital Post-Processing Tools

Vitrea software enables the visualization and analysis of 2D, 3D and 4D images of anatomy and physiological functions using CT (computed tomography) and MR (magnetic resonance), PET, ultrasound and XA scan data, giving medical specialists time-saving, Web-accessible tools for greater productivity.

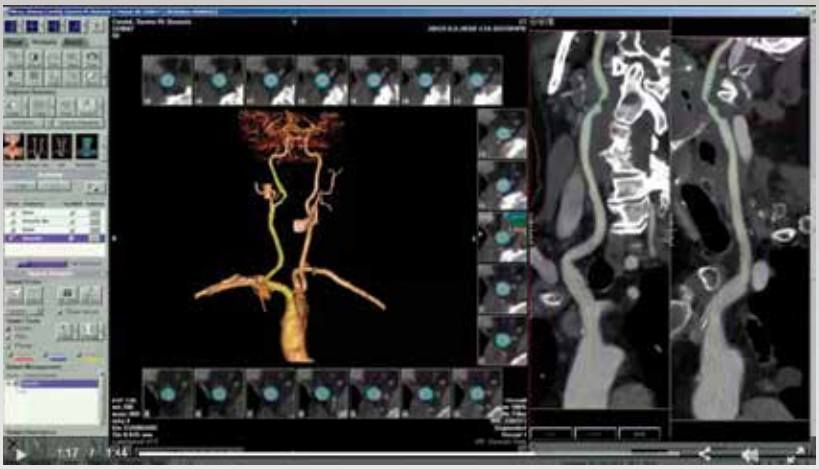
Vessel structures are visualized in 3D or curved reformats to evaluate tortuosity and perform measurements. Various software features assist with planning of aneurysm coiling and/or embolization.

Vital post-processing tools include CTA Vascular Analysis, CTA Carotid, and CTA Circle of Willis.

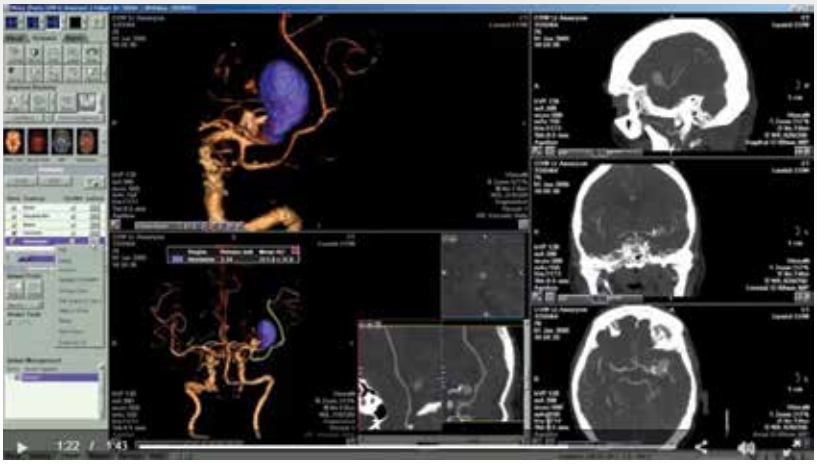
*Parametric imaging (PI)**

PI assists with the visualization of hemodynamic properties in interventional procedures. Time-density curve parameters are calculated for each pixel of a 2D DSA image and each pixel is color coded based on the respective calculated values. Pre- and post-procedural PI maps can help in the visualization of blood flow before and after treatment. The images show PI maps of time-to-peak values with red to blue color maps representing fast to slow flow.

- *Color Coded Circulation (CCC)*
  CCC creates a movie by shifting color scale gradually so that it is easy to understand vascular flow dynamics.

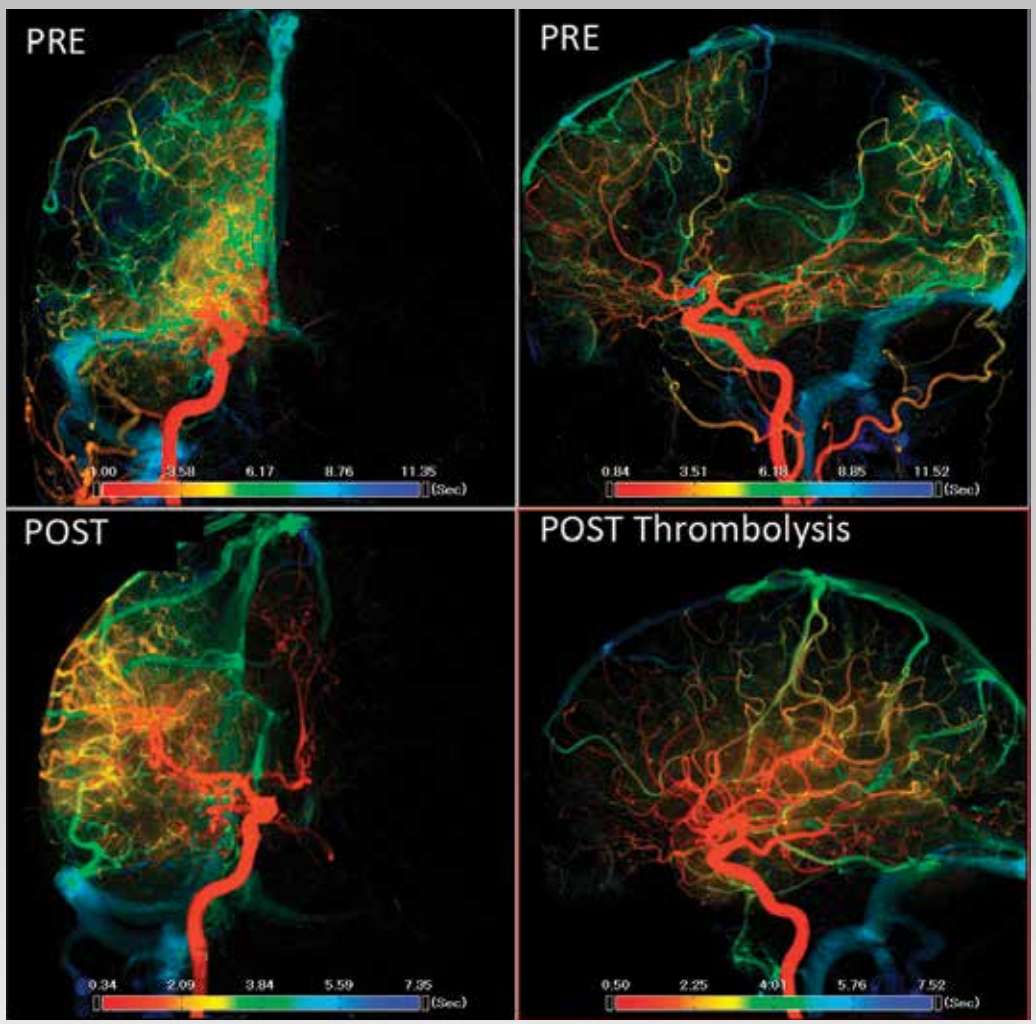


CT Carotid software

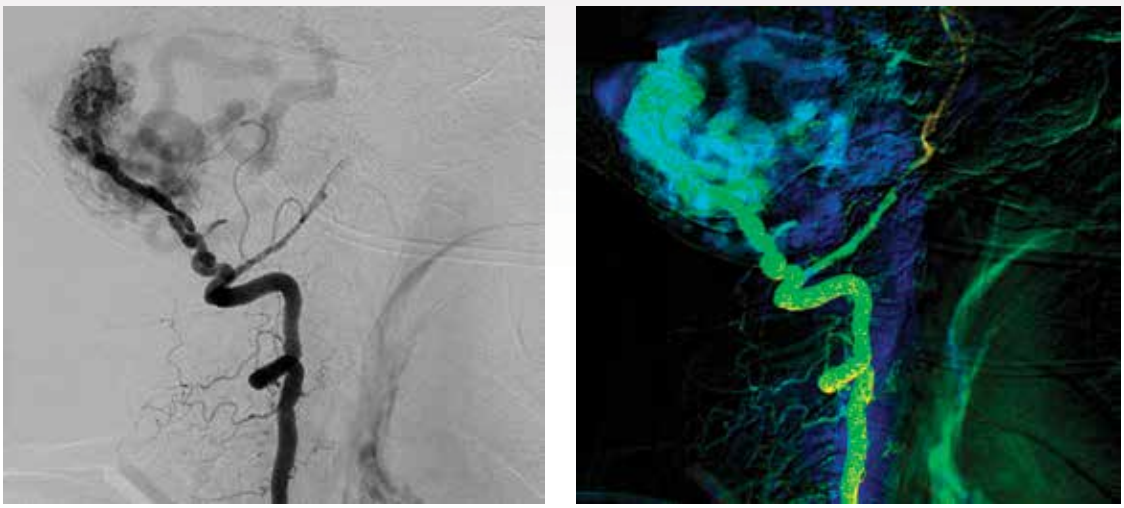


CTA Circle of Willis software

*Parametric Imaging Software is not intended for stand-alone use or diagnosis



PI of carotid artery. Pre thrombolysis images show an area without color representing the area without blood supply due to thrombus in the vessel. Post thrombolysis images show the return of the blood flow to the thrombosed region and the colors represent parameters reflective of the restored blood flow velocity.



The change in color depicts the slower flow into the malformation.

Conventional Imaging in Neuro Intervention

Digital Subtraction Angiography (DSA)

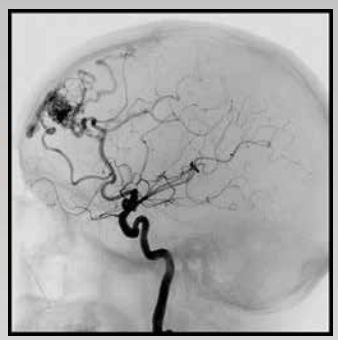
Standard neuro angiographic imaging requires simultaneous AP and lateral or biplane image acquisition. DSA uses an automatic subtraction technique that removes boney detail so that only the contrast enhanced blood vessels are seen. Boney structures can be brought back into the subtracted image to help in establishing visual landmarks with the Landmark (LM) feature. The degree (LM %) of the appearance of the bone in the image is operator dependent.

Auto Pixel Shift for Digital Subtraction

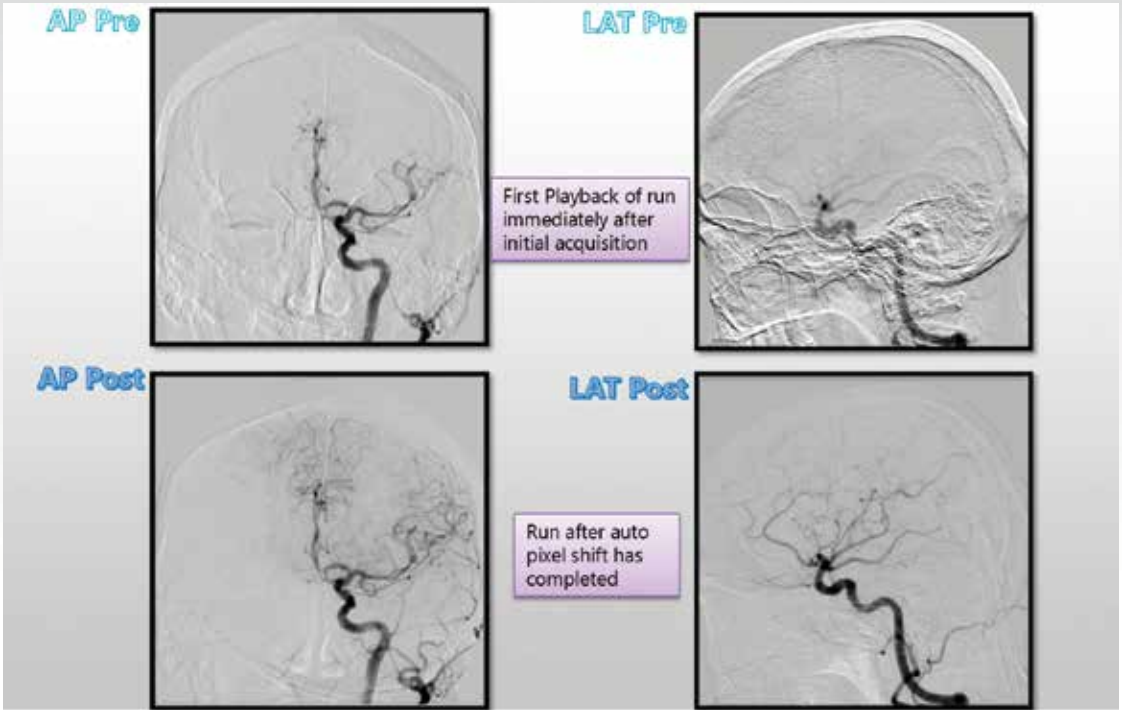
New image quality improvement algorithm provides automatic pixel shift which is applied automatically post acquisition and continues in the background even if image playback if disrupted.

DA – Non subtracted

DSA – Bones are subtracted



DSA – allows LM % to bring the Boney structures back in



Auto Pixel Shift

DoseRite™

The Infinix-i systems also feature comprehensive dose management tools, called DoseRite, including our exclusive Spot Fluoroscopy, Live Digital Zoom, Advanced Image Processing (AIP) with Super Noise Reduction Filter (SNRF), Variable dose modes and rates, Fluoro record and store, Virtual ROI (region of interest), and Dose Tracking System (DTS), helping clinicians to manage dose and maintain safety for patients and staff.

AIP/SNRF

AIP uses SNRF technology to lower dose dramatically by analyzing and processing each image frame in real time during fluoroscopy. AIP enhances visibility by increasing image contrast, enhancing small object detail and reducing halation from lung fields. SNRF reduces total noise power by up to 90 percent while maintaining sharp spatial and temporal resolution.[1] In concert, these unique technologies combine to provide image quality improvements greater than 200 percent.[2] This has resulted in demonstrated reduction to both patient and staff radiation dose levels by more than 50 percent with utilization of lower frame rates and more fluoroscopy as compared to higher dose digital "cine" acquisitions.[3]

Spot Fluoroscopy

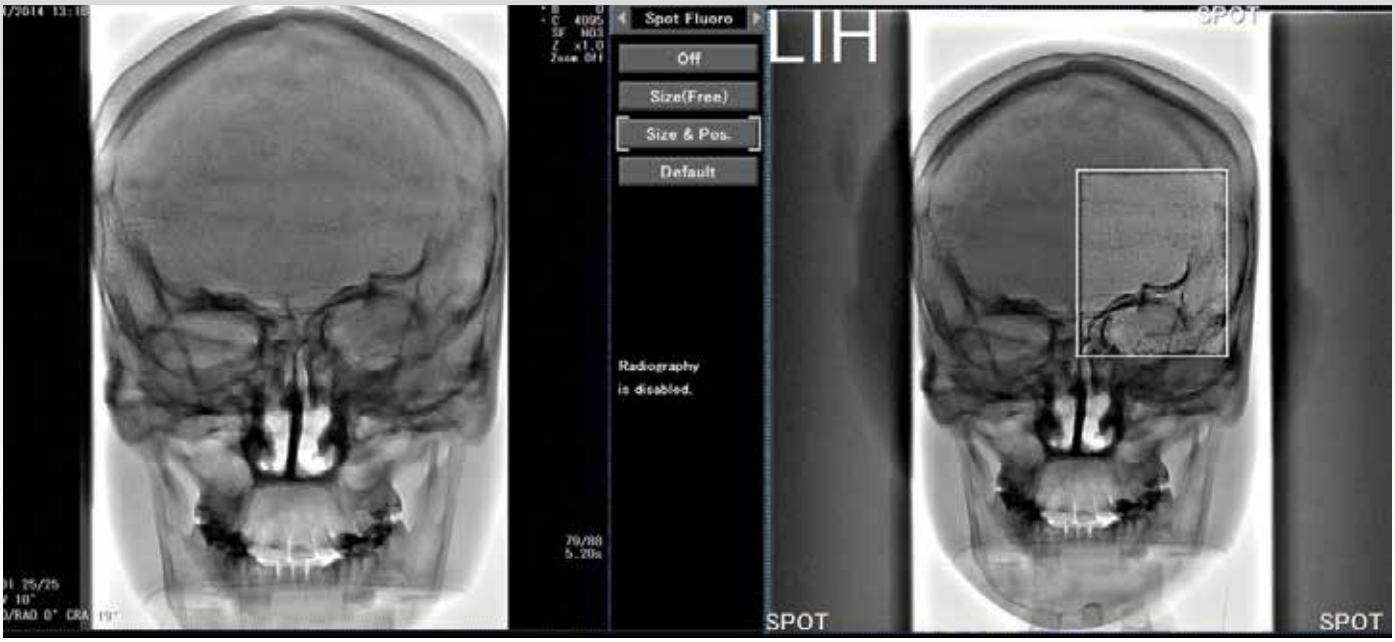
Spot Fluoroscopy provides asymmetric collimation anywhere within the field of view resulting in lower dose than conventional collimation. The ROIs can be precisely sized and positioned almost anywhere vs. centering them using conventional collimation, providing the clinician with the exact view desired. Clinicians can observe a smaller region of anatomy while viewing the Last Image Hold (LIH) surrounding the area.

Spot ROI

Spot ROI is intended to reduce the exposure dose while accommodating peripheral region visualization. By performing fluoroscopy through a filter with a square opening at the center, the fluoroscopic dose outside the ROI can be reduced with respect to the fluoroscopic dose inside the ROI.

Fluoroscopy with collimation

SPOT Fluoroscopy



Spot Fluoroscopy can be easily sized and positioned anywhere in the FOV and provides anatomical landmarks visible in the LIH.

1. Nishiki, M, Shiraishi, K, Sakaguchi, T, Nambu, K (2008). Method for reducing noise in X-ray images by averaging pixels based on the normalized difference with the relevant pixel. Radiol Phys Technol, 1, 2:188-95.
2. Nagesh, S, Kuhls-Gilcrist, A, Ionita, C, Bednarek, D, Rudin S (2015). Improved visualization of neurovascular interventional treatment devices by processing of images. Accepted for publication. IEEE MIC.
3. Sawdy, J et al (2011). Use of a dose-dependent follow-up protocol and mechanisms to reduce patients and staff radiation exposure in congenital and structure interventions. Cath and Card Interv, 78, 136-142.

Live Digital Zoom

Live Digital Zoom enhances image visualization by increasing image display size in real time during both fluoroscopy and digital acquisitions, offering potential dose savings compared to traditional FOV magnifications. A range of zoom modes from 1.2 to 2.4 times can be applied to any of the system magnification modes.

Dose Rates

The Infinix-i makes possible industry-leading dose rates. No other system comes close to providing as much flexibility with nine variable frame rates (1, 2, 3, 5, 7.5, 10, 15, 20, 30) and four programmed fluoroscopy modes (low, middle, normal, high), which are standard on every Infinix-i system.

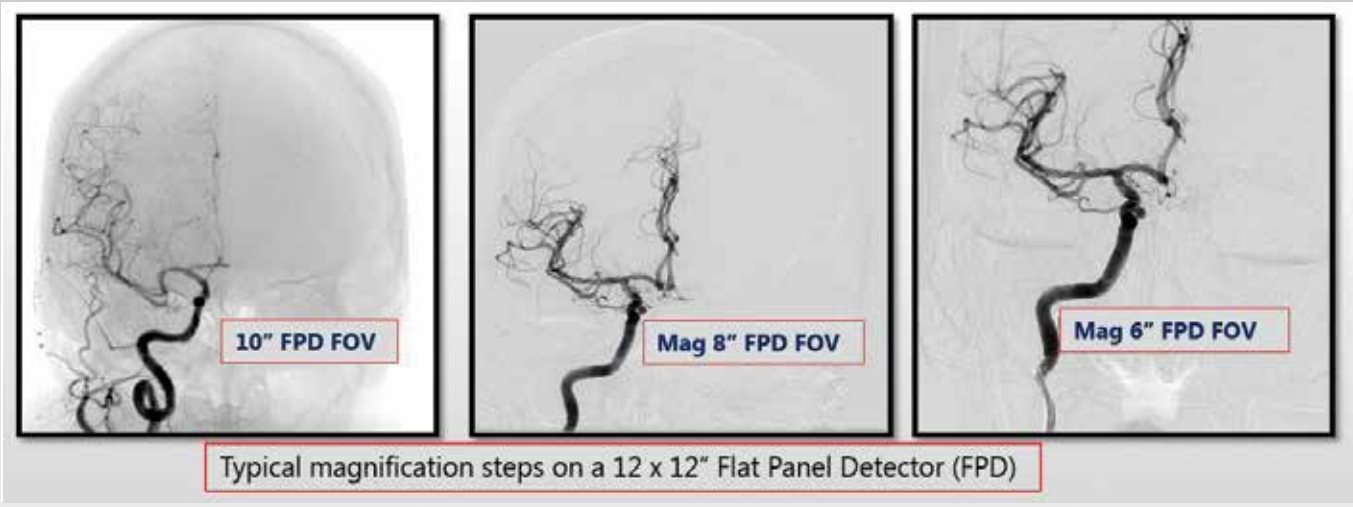
Different combinations of pulse rates, dose levels and system parameters are available to enable clinicians to optimize dose rates and image quality for various study protocols

Fluoro Record

Fluoro record and fluoro store is incorporated into the standard practice and can be used to replace digital acquisition (DA) for interventions as well as groin shots resulting in significant dose reduction.

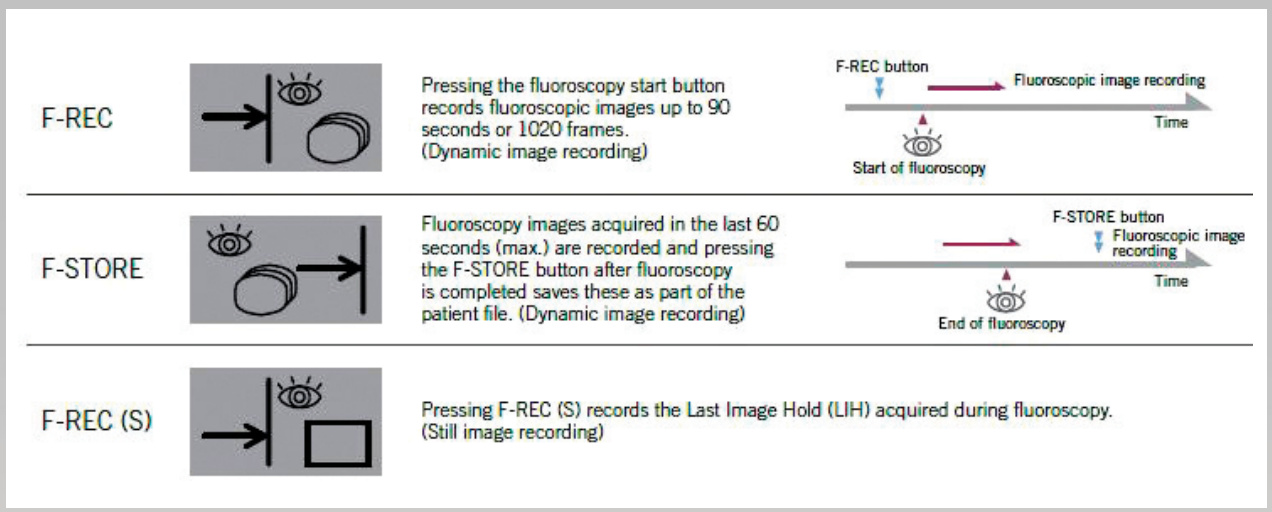
DTS

DTS provides real-time patient skin dose estimates in an easy to interpret color representation of radiation exposure to the patient. Real-time feedback of radiation exposure enables the clinician to make adjustments during the procedure.

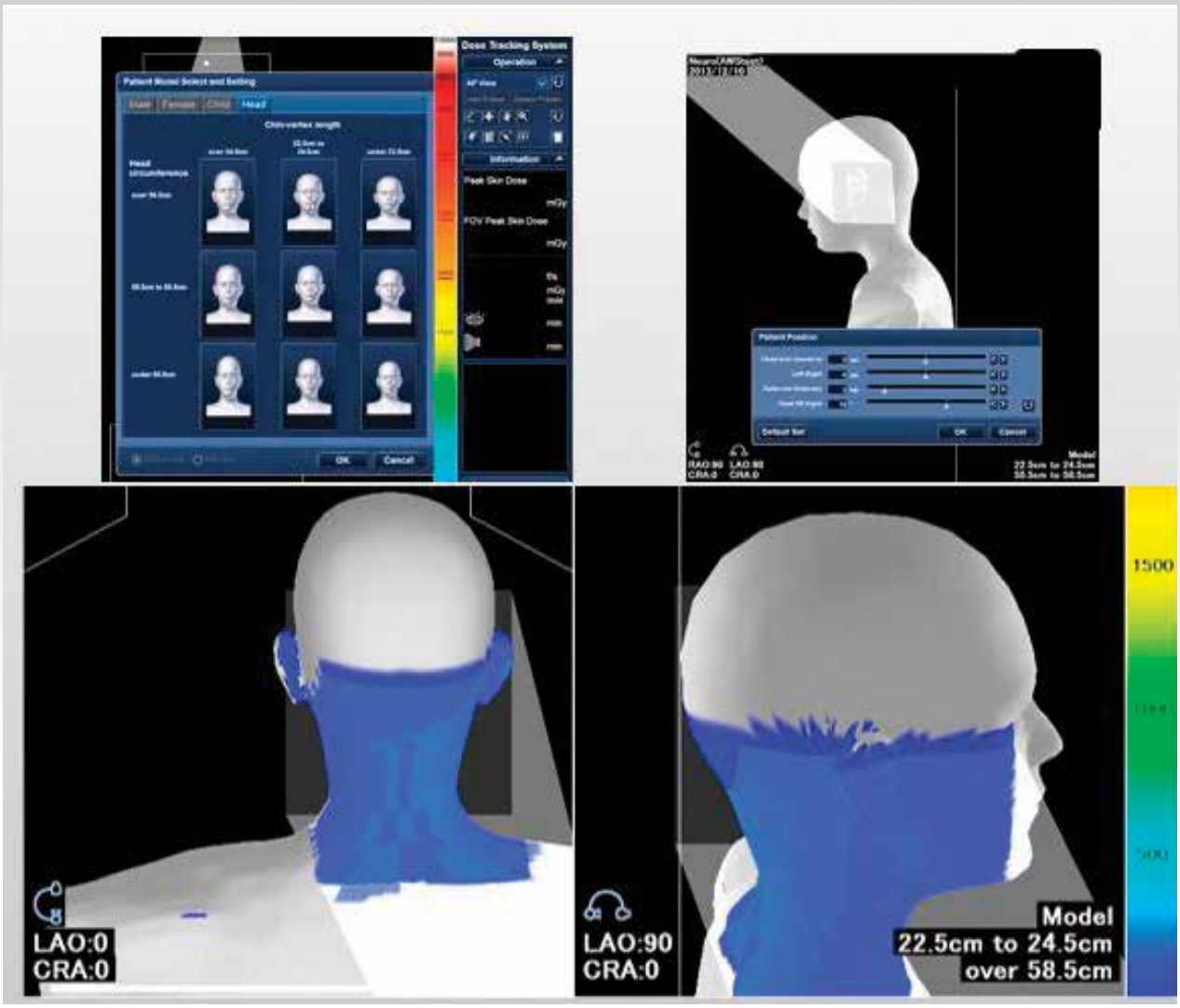


Typical magnification steps on a 12 x 12" Flat Panel Detector (FPD)

Applying the 1.2 zoom mode to the 12" FOV of the carotid artery, increases the display size by approximately 20%, the increase in display size is equivalent to one magnification mode.



Example of available fluoro records with Infinix-i



DTS provides an estimation of peak skin dose available on cardiovascular/neurovascular procedures

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