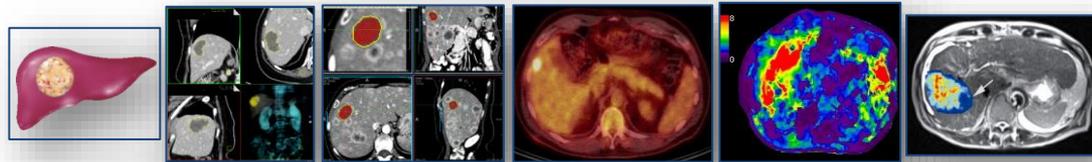


# Diagnostic Imaging Technology: State of the Art

Vahid Yaghmai, MD, MS, FSAR  
Department of Radiological Sciences  
University of California, Irvine



# Careers in Medical Imaging

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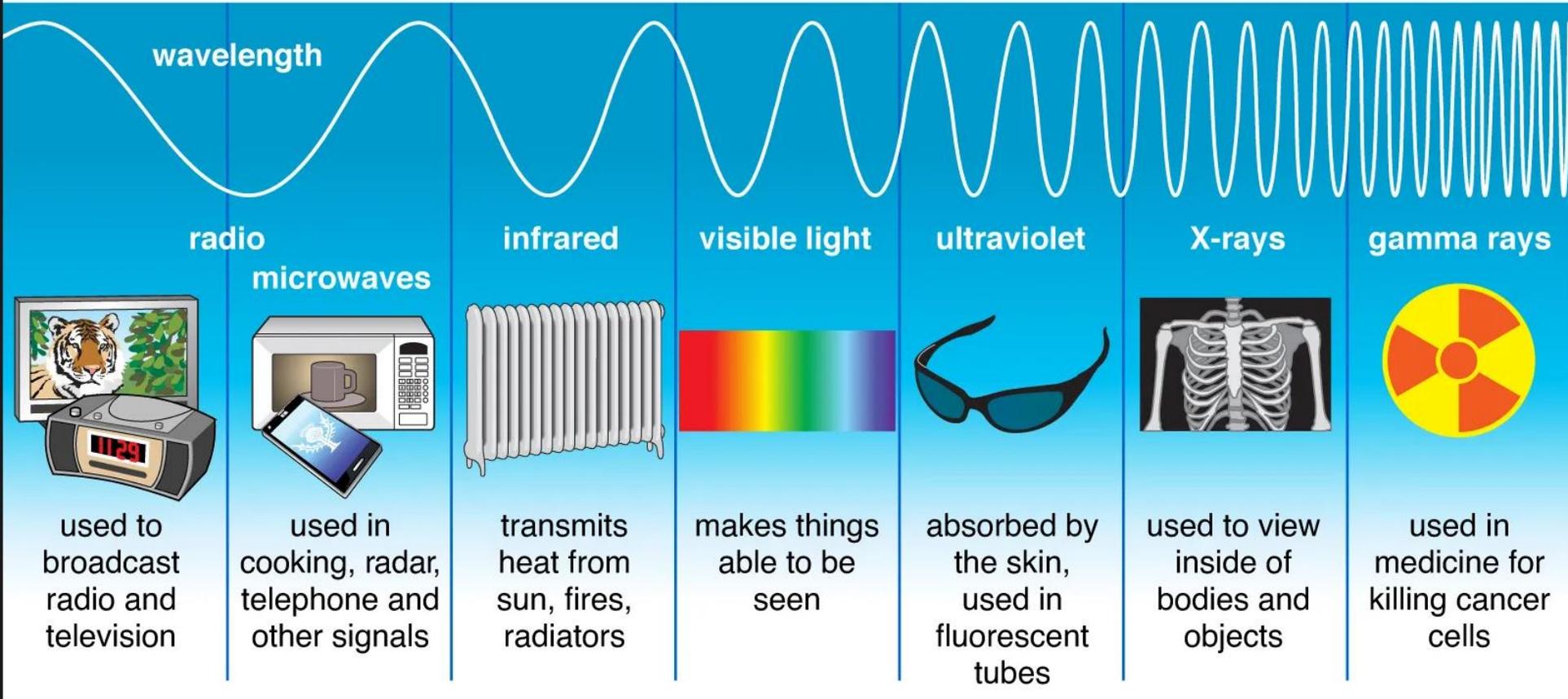
- Medical Imaging Research (PhD or MD)
- Technologists (AA)
- Physician Assistant (BA/BS/MS)
- Radiology Assistant (BA/BS)
- Radiologist (MD/DO + residency + fellowship)

# Radiologists

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# Types of Electromagnetic Radiation



# Different Imaging Modalities: Examples

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- **Ultrasound** uses sound waves
- **CT** uses X-rays
- **MRI** uses magnets and strong radio waves (e.g., images protons)
- **SPECT-CT** (Single-photon emission computed tomography): Uses radiotracers/gamma emitters (e.g., to image bones)
- **PET-CT** Uses radiotracers/gamma emitters (e.g., radioactive glucose)

# Spectral, Conventional and SPECT CT: Irvine

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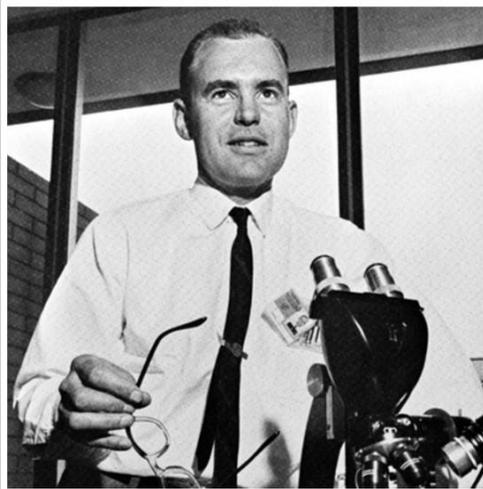
# Notable Advances in Medical Imaging

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- **Speed**- faster images acquisition with more detail
- **Safety**- Lower radiation dose or imaging that does not use radiation
- **Data management**: More data (Artificial Intelligence)
- **Image-guided therapies**

# 1965: "MOORE'S LAW" PREDICTS THE FUTURE OF INTEGRATED CIRCUITS

FAIRCHILD'S DIRECTOR OF R & D PREDICTS THE RATE OF INCREASE OF TRANSISTOR DENSITY ON AN INTEGRATED CIRCUIT AND ESTABLISHES A YARDSTICK FOR TECHNOLOGY PROGRESS.



Q Gordon Moore at Fairchild R & D in 1962

Credit: Fairchild Camera & Instrument Corporation



Gordon Moore, Fairchild Semiconductor's Director of R&D, wrote an internal paper in which he drew a line through five points representing the number of components per integrated circuit for minimum cost per component developed between 1959 and 1964. "The Future of Integrated Electronics" attempted to predict "the development of integrated electronics for perhaps the next ten years." Extrapolating the trend to 1975 he projected that the number of components per chip would reach 65,000; a doubling every 12 months. Edited for publication as a magazine article, "Cramming more components onto integrated circuits" was published in Electronics on April 19, 1965.

**UCI Health**

# Moore's Law

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The number of transistors on a microchip doubles every two years

We can expect the speed and capability of our computers to increase every couple of years

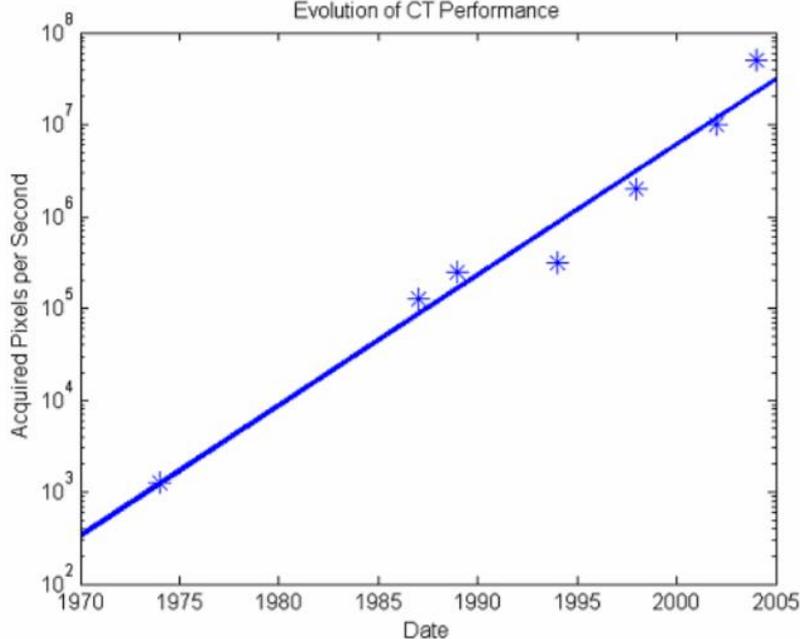
# Rapid Advance in CT Speed

**Abstract**

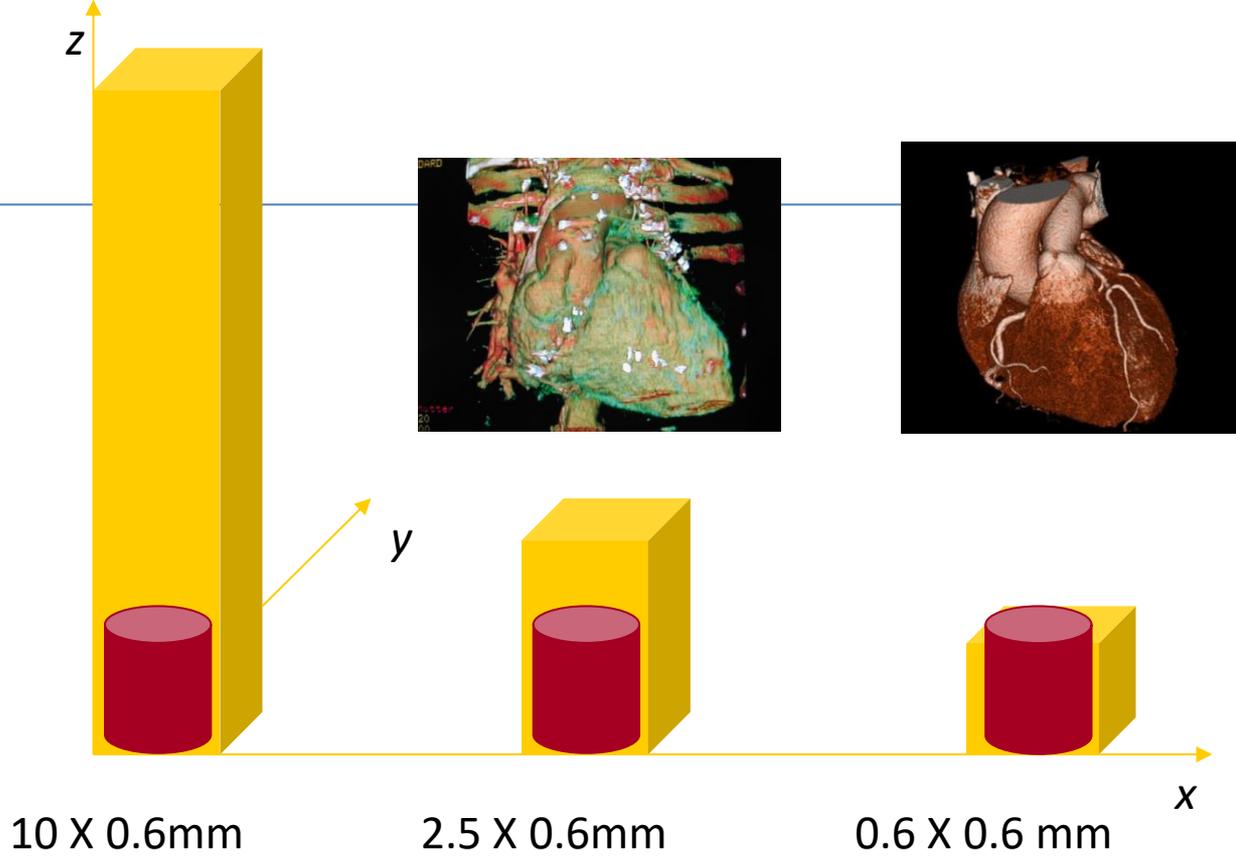
Computed Tomography (CT) is the first digital medical imaging modality and revolutionized diagnosis with cross-sectional images in the 1970's. The evolution of CT acquisition has followed its own form of "Moore's Law", with most metrics doubling every 25 months for the past three decades, improving by more than a factor of 50,000 over that time. This has been enabled

by technology which is considered to double every 18 months. How was this progress accomplished? Increased computer power played a role, but for a multidisciplinary approach was required in the fields of electro-mechanical engineering, x-ray source technology, x-ray detectors, analog and digital electronics, and algorithm development, as well as innovative system integration designs.

Evolution of CT Performance

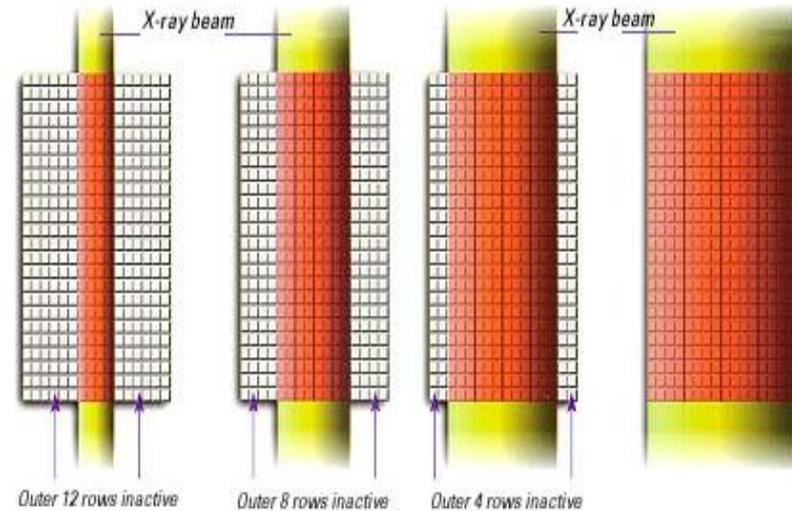


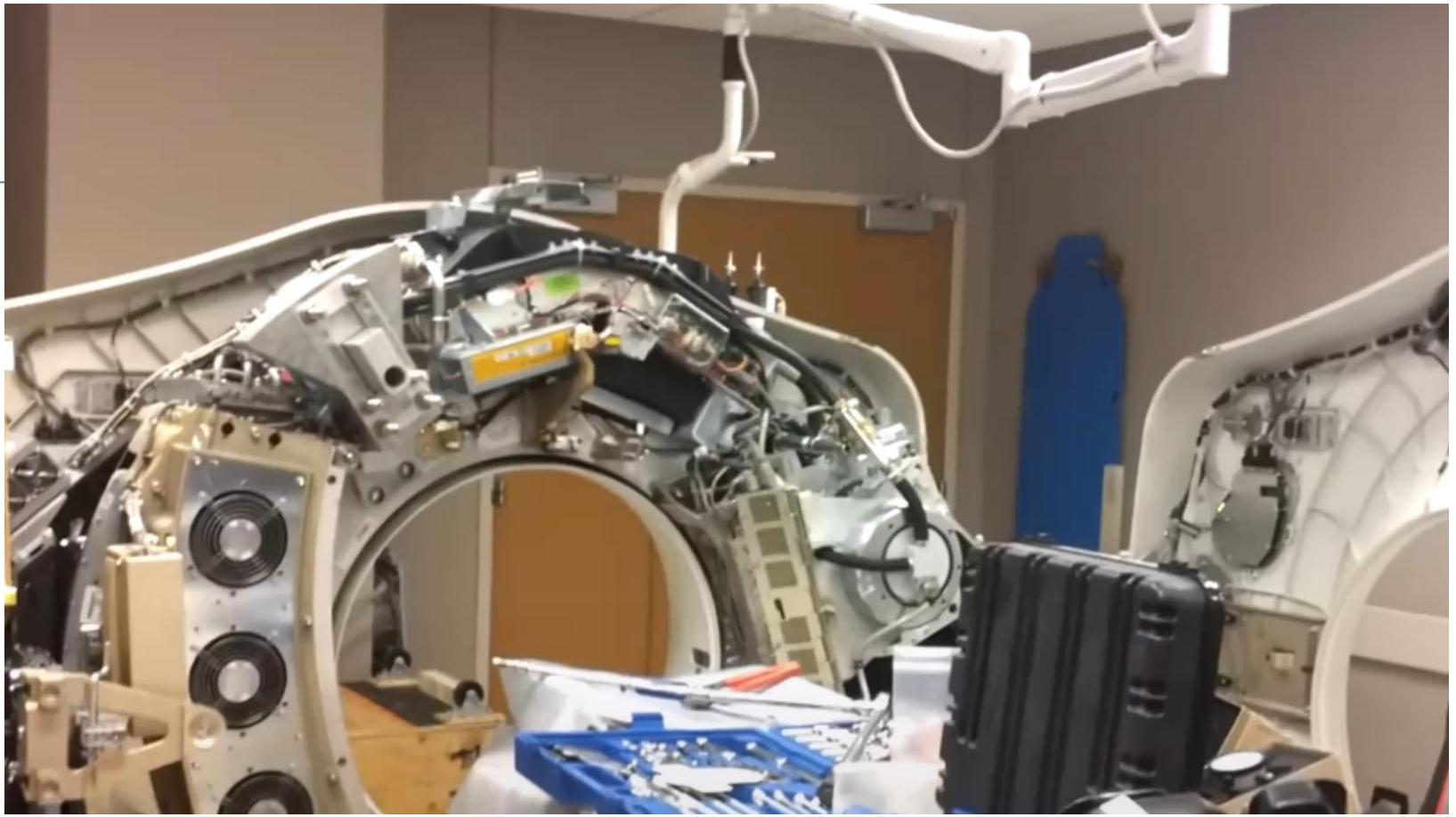
**Figure 2.** Plot of the metric for pixels acquired per second versus date reveals that performance doubling has doubled every



**ANISOTROPIC**  $\longrightarrow$  **ISOTROPIC**

# CT Scanner Technology



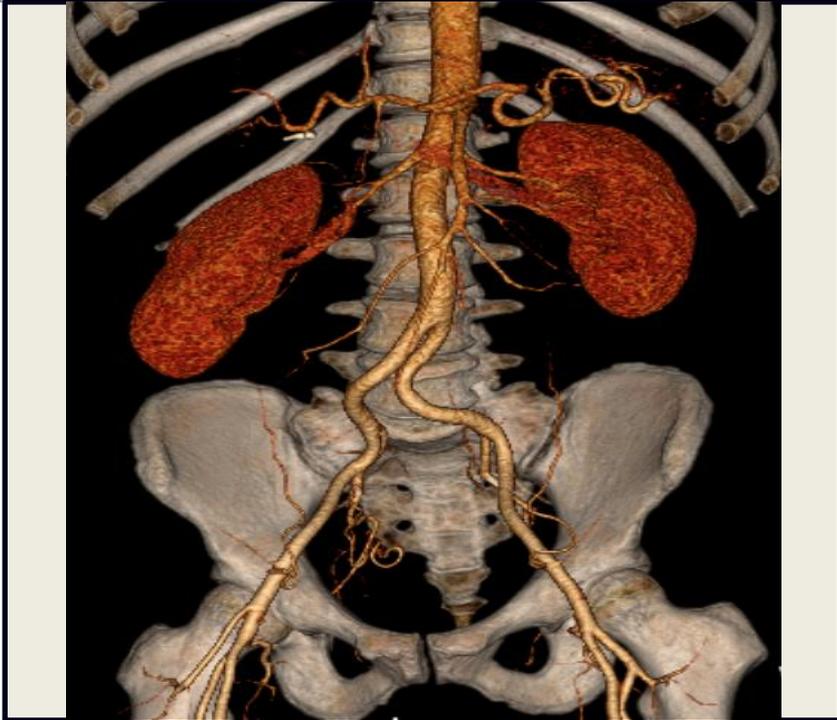


<https://www.youtube.com/watch?v=cjtHNxf01tQ>

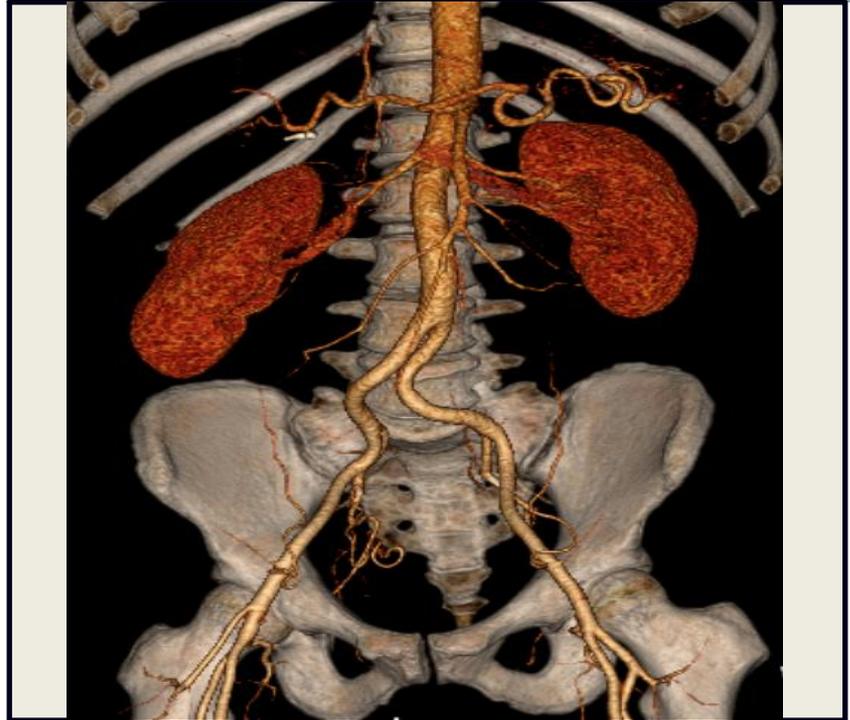
**UCI Health**

# Ultra-fast CT Angiography

Conventional CTA



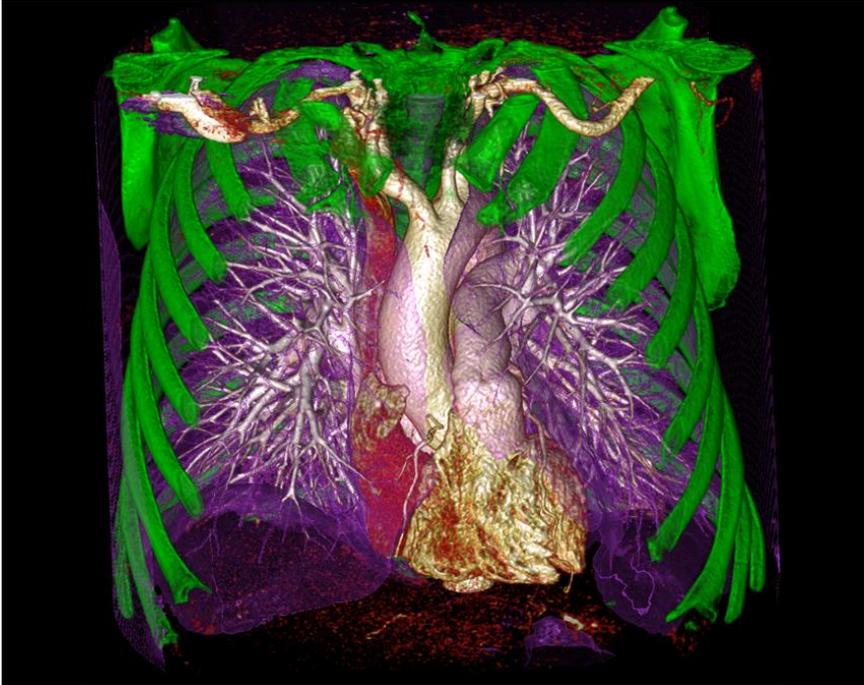
3<sup>rd</sup> Generation High-pitch DSCTA



# Ultra-fast CT Angiography

## Turbo Flash Spiral Mode

Conventional Technology



Turbo Flash

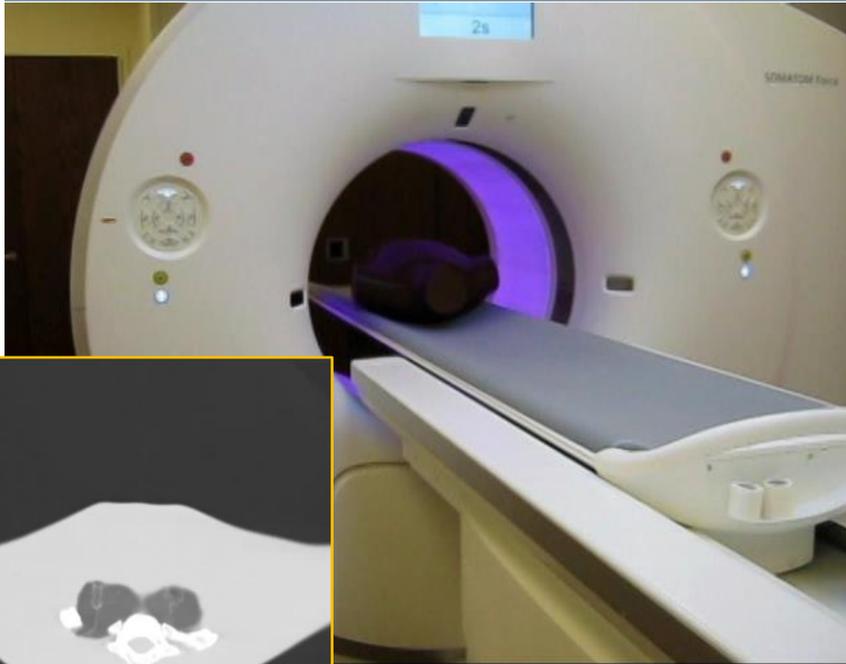


1: Sommer WH et al. Saving dose in triple-rule-out computed tomography examination using a high-pitch dual spiral technique. *Invest Radiol.* 2010 Feb;45(2):64-71

*Slide courtesy of Siemens*

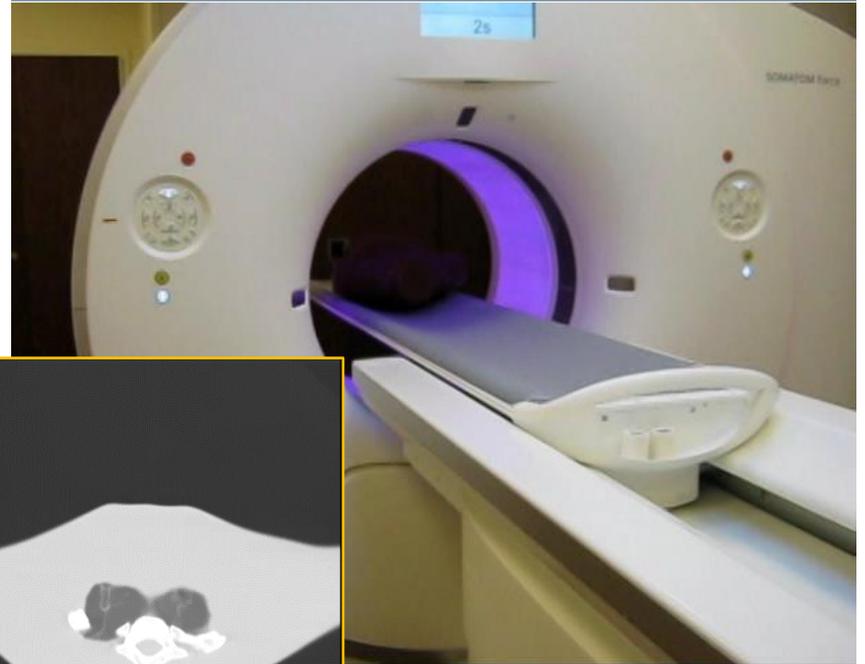
# Ultra-fast CT Angiography

Conventional CTA



Pitch: 0.9  
Duration: 6 s

Turbo Flash CTA



Pitch: 3.2  
Duration: 0.8 s

# Speed and Growth of Imaging Data

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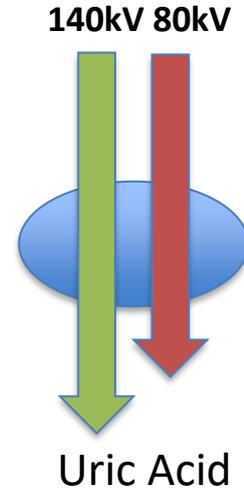
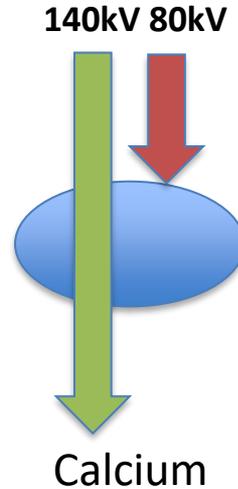
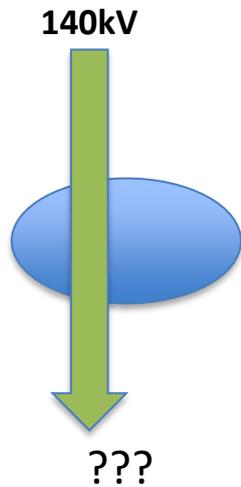
Imaging data growth has created challenges and opportunities

CT scans that generated 40 images in 1990's now generate 10,000 images in 1/60<sup>th</sup> of time

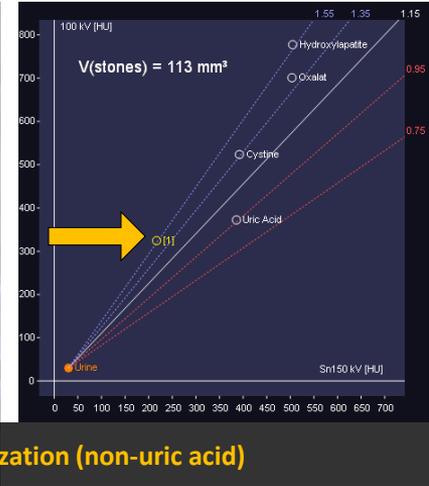
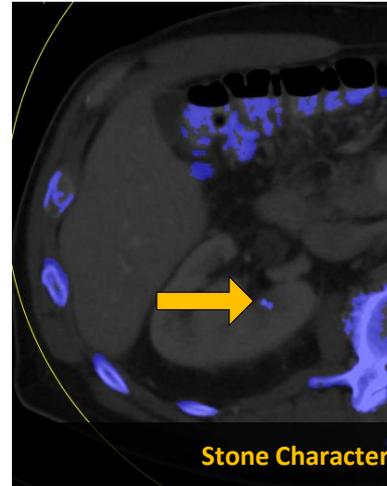
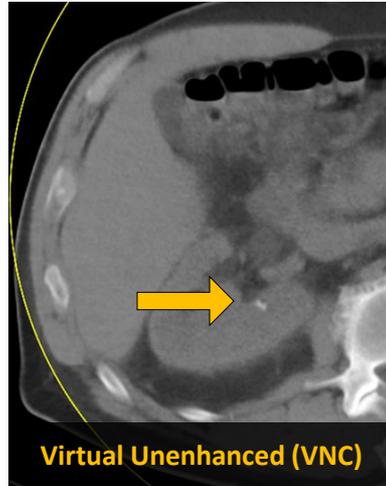
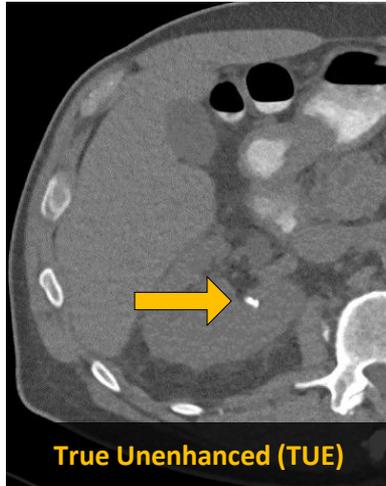
# Spectral CT

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Can distinguish calcium, iodine, water and fat



# Kidney Stone Characterization



# Fracture

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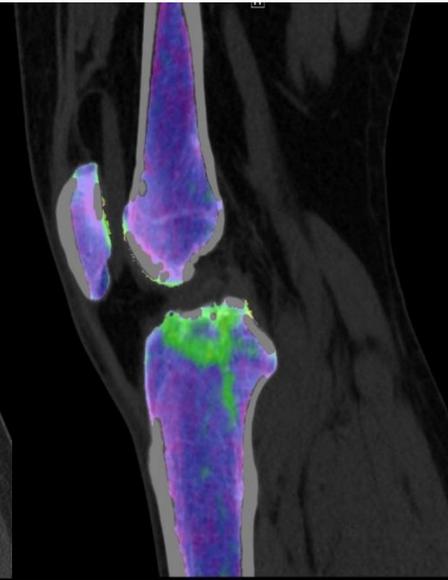
Mixed Image



Dual energy scan



Mixed Image



Dual energy scan

# Photon Counting CT at UCI Radiology - Irvine First in Southern California

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# PCCT

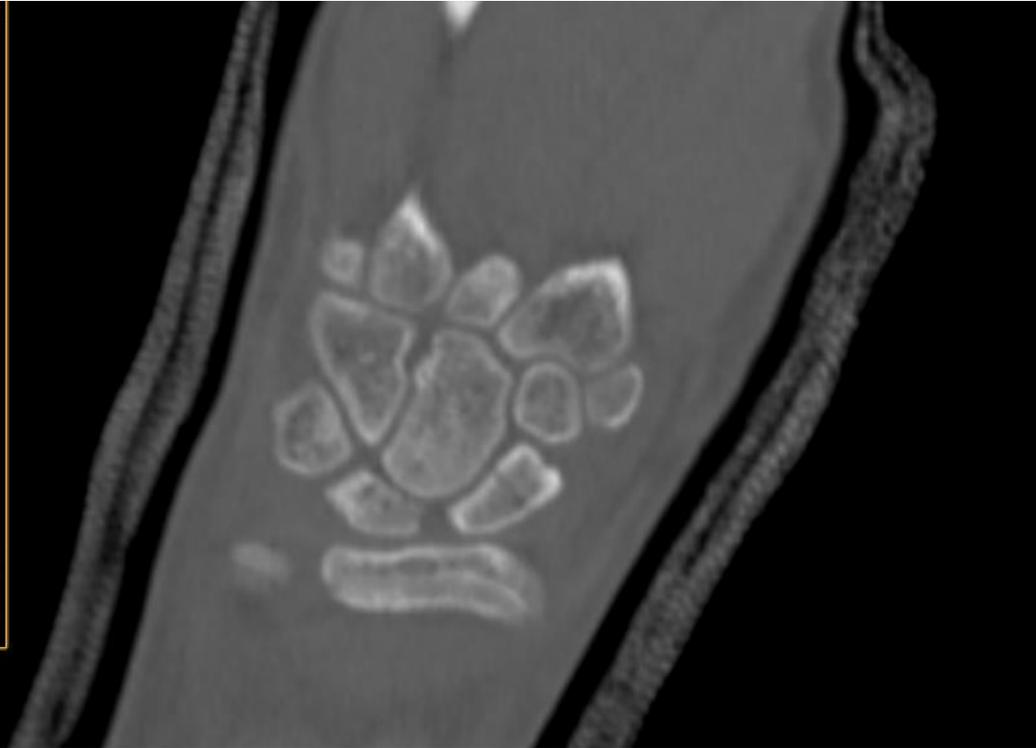
GE MEDICAL SYSTEMS  
Revolution Apex

## Dose Report

Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy*cm)	Phantom cm
<b>Scout</b>					
1	Scout	S790.25-S422.94	0.05	1.98	Body 32
1	Scout	S790.25-S422.94	0.05	1.98	Body 32
<b>UPPER EXT</b>					
2	Helical	S660.595-S433.095	11.33	304.15	Body 32
<b>Total Exam DLP:</b>				<b>308.11</b>	

1/1

Dose Report:  
Series 999 IMA 1  
(not calibrated)



# PCCT

Siemens Healthineers  
NAEOTOM Alpha

Ward:  
Physician:  
Operator:

Total mAs: 499

Total DLP: 57

Scan	IQ Level	kV	eff. mAs	CTDIvol* mGy	DLP mGycm	SSDE mGy	Dw cm
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Patient Position HFP

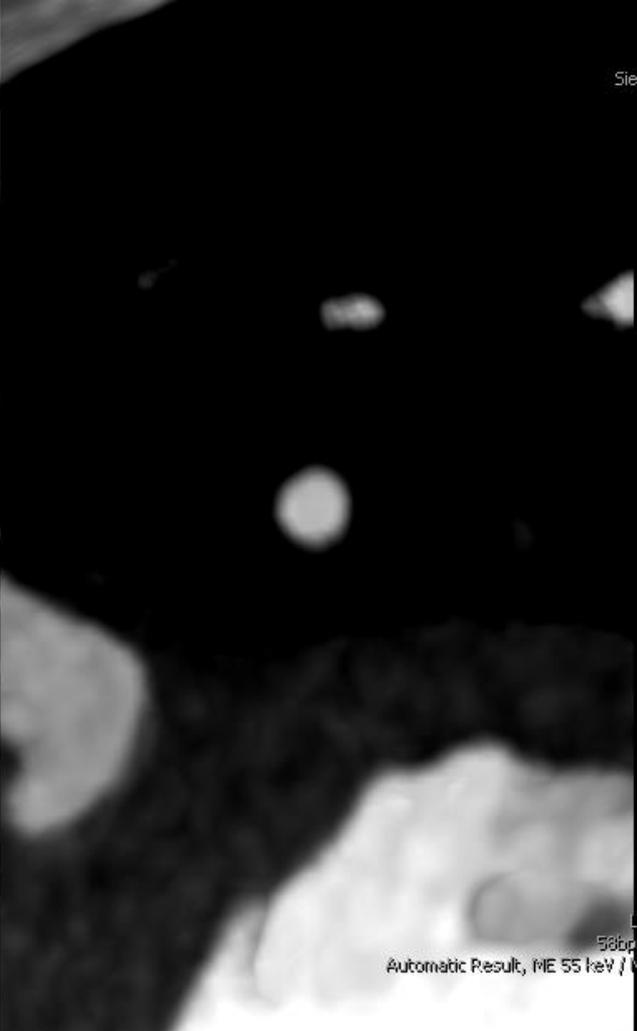
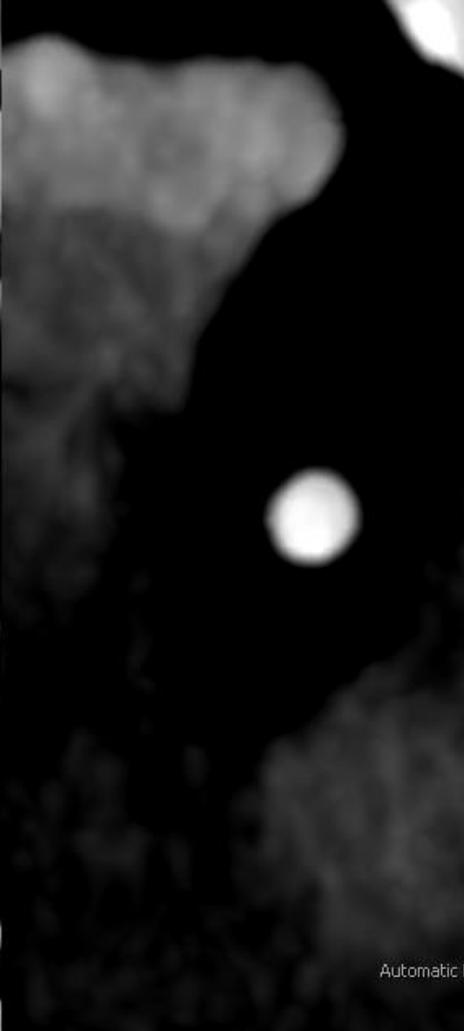
Topogram LAT	101	Sn140	55 mA	0.06 L	1.84		
Topogram PA	201	Sn100	55 mA	0.01 L	0.42		
UPPER EXT	301	75	120	45	3.57 L	54.7	9.60 9.02

Patient Protocol:  
Series 501 IMA 1

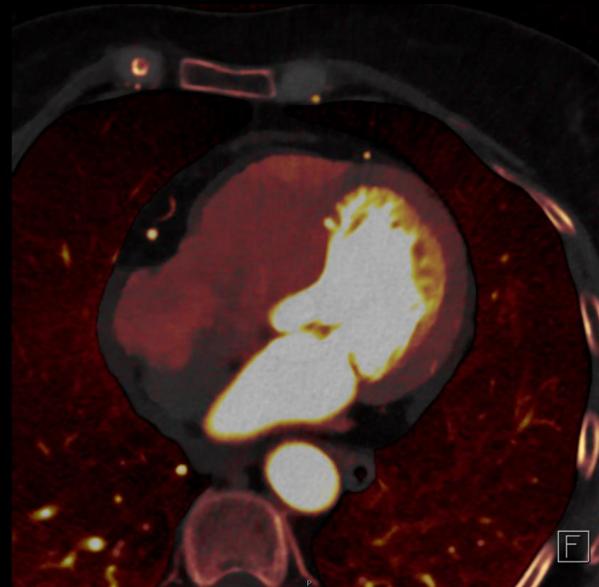
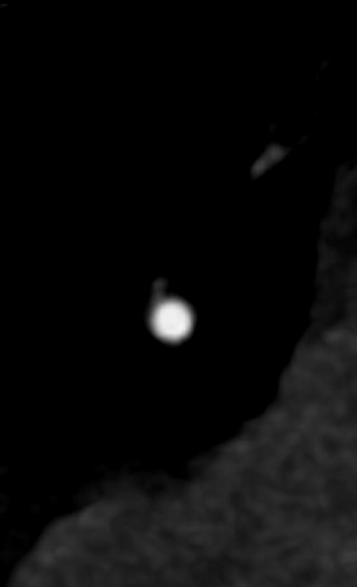
(not calibrated)

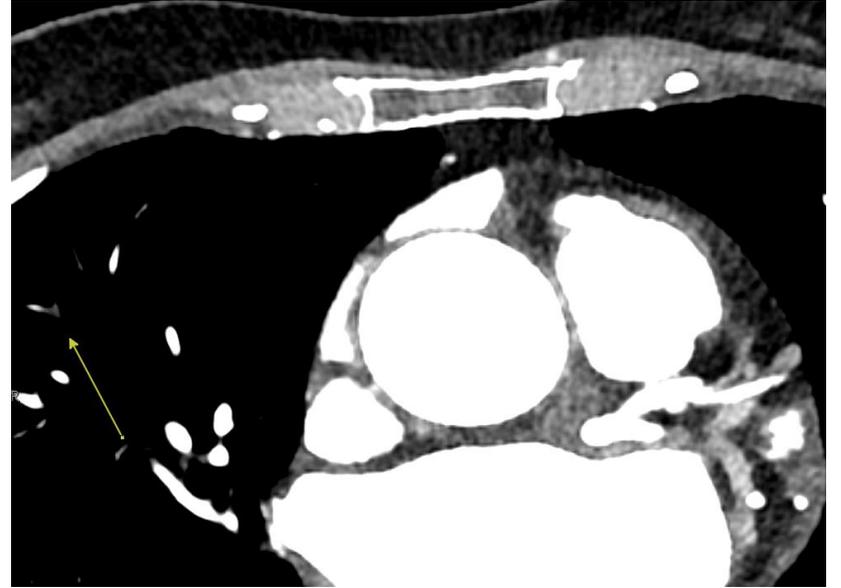
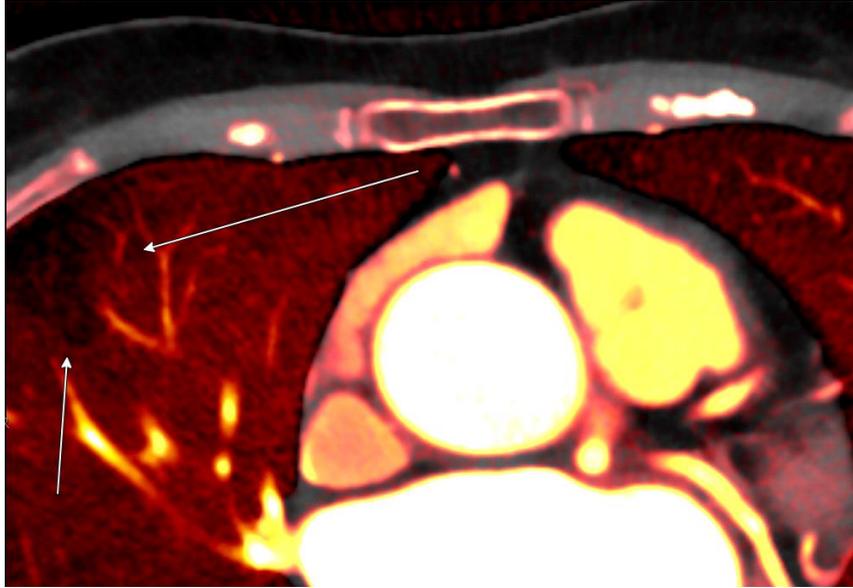
\*: L = 32cm; S = 16cm

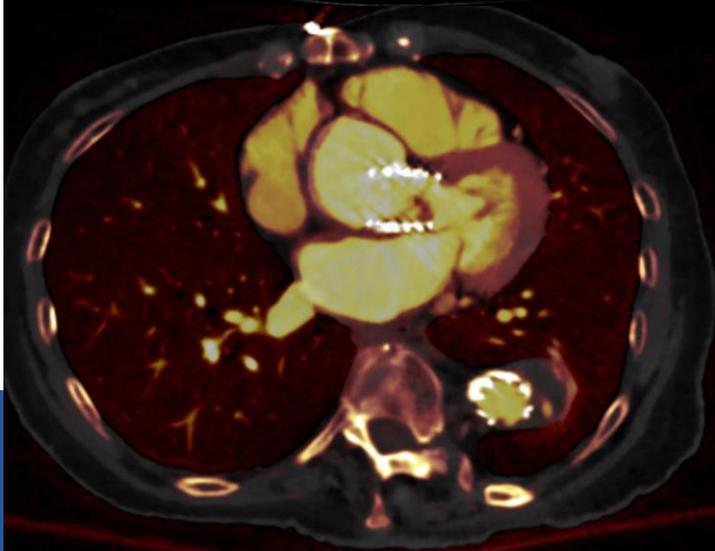
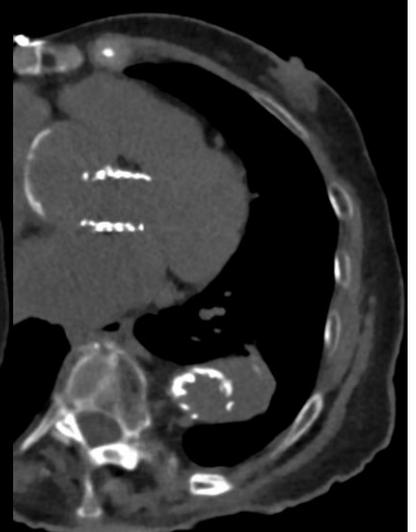




# PCCT with Spectral Imaging







Spectral CT FLASH mode

**UCI Health**

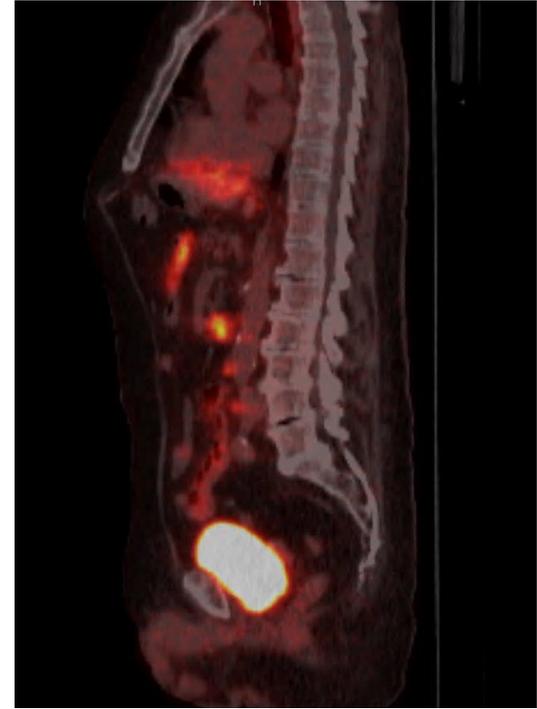
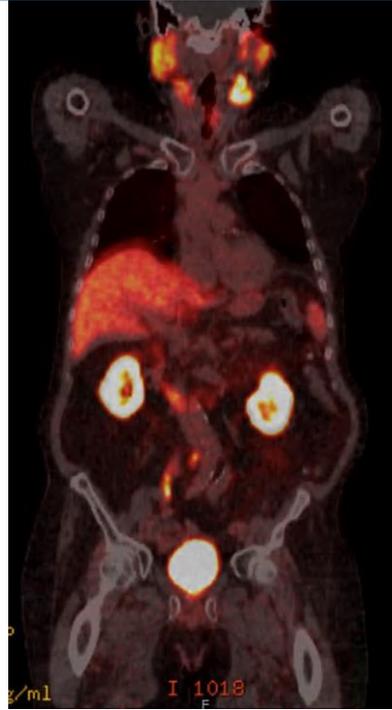
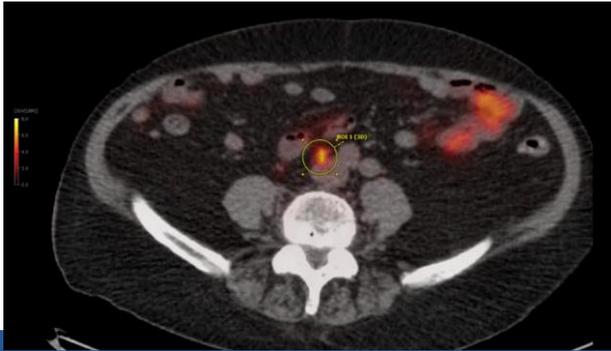
# Molecular Imaging and Theranostics

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- Faster SPECT/CT and PET/CT with higher image quality
- Precision therapy



# Ga-PSMA PET/CT for Prostate Cancer

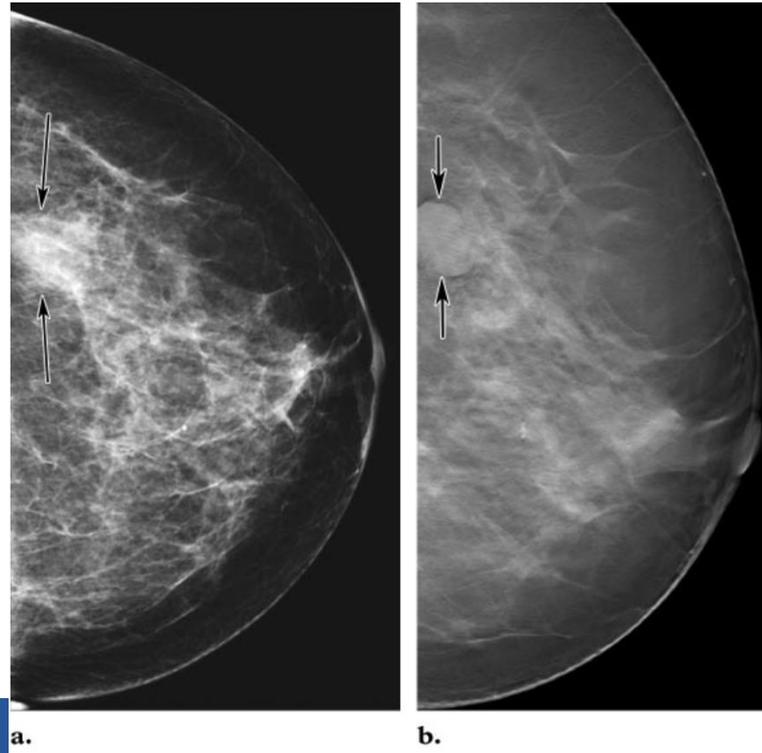


# Breast Imaging

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# 3D Breast Imaging: X-ray

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# Automated Breast Ultrasound Screening for Dense Breasts

Sung Hun Kim, MD<sup>1</sup>, Hak Hee Kim, MD<sup>2</sup>, Woo Kyung Moon, MD<sup>3</sup>

<sup>1</sup>Department of Radiology, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea; <sup>2</sup>Department of Radiology, Asan Medical Center, University of Ulsan College of Medicine, Seoul, Korea; <sup>3</sup>Department of Radiology, Seoul National University Hospital, Seoul National University College of Medicine, Seoul, Korea

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Mammography is the primary screening method for breast cancers. However, the sensitivity of mammographic screening is lower for dense breasts, which are an independent risk factor for breast cancers. Automated breast ultrasound (ABUS) is used as an adjunct to mammography for screening breast cancers in asymptomatic women with dense breasts. It is an effective screening modality with diagnostic accuracy comparable to that of handheld ultrasound (HHUS). Radiologists should be familiar with the unique display mode, imaging features, and artifacts in ABUS, which differ from those in HHUS. The purpose of this study was to provide a comprehensive review of the clinical significance of dense breasts and ABUS screening, describe the unique features of ABUS, and introduce the method of use and interpretation of ABUS.

# Safety in Medical Imaging

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CT Radiation Dose



**120 kV + FBP**  
**BMI: 25.9**  
**CTDIvol: 14.2 mGy**  
**Image Noise: 17.9**



**Auto-kV (100) + IR**  
**BMI: 25.3**  
**CTDIvol: 10.5 mGy**  
**Image Noise: 14.2**

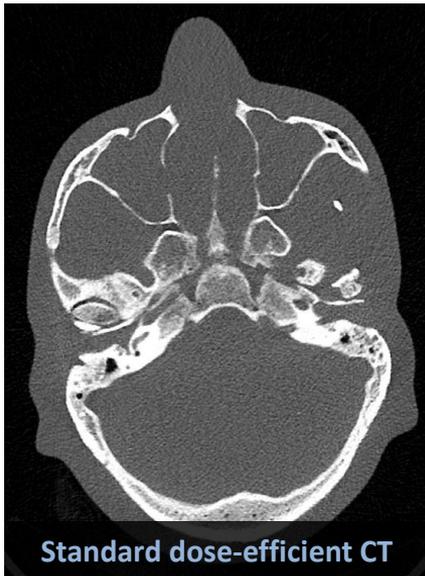
# Ultra Low Radiation Dose CT



Standard High Dose CT

kV: 120; mA: 100

ED: 0.629 mSv



Standard dose-efficient CT

kV: 70; mA: 100

ED: 0.049 mSv



Standard Low Dose CT

kV: 70; mA: 10

ED: 0.012 mSv



Spectral Shaped Low Dose CT

kV: Sn100; mA: 25

ED: 0.009 mSv

# MRI Technology

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# Current State-of-the-art MRI

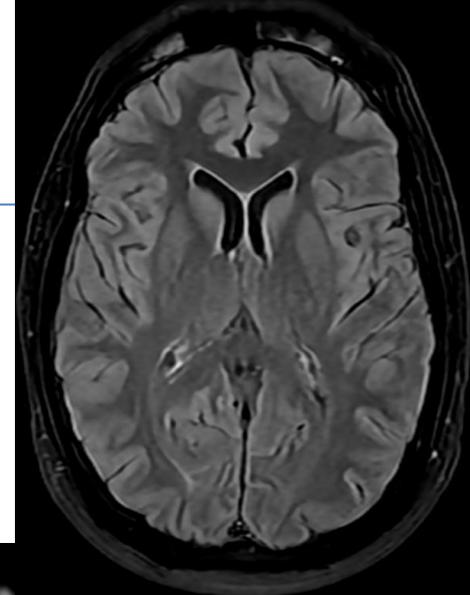
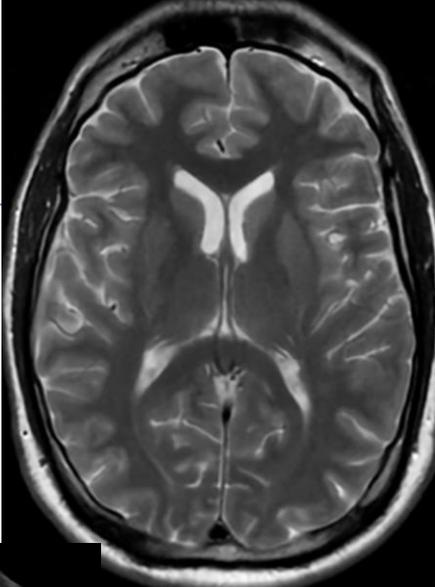
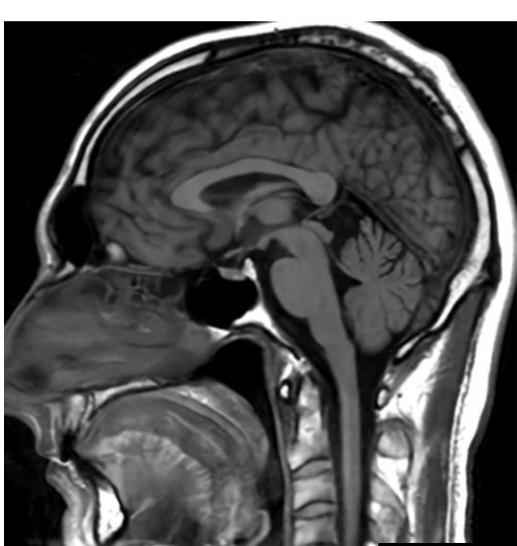
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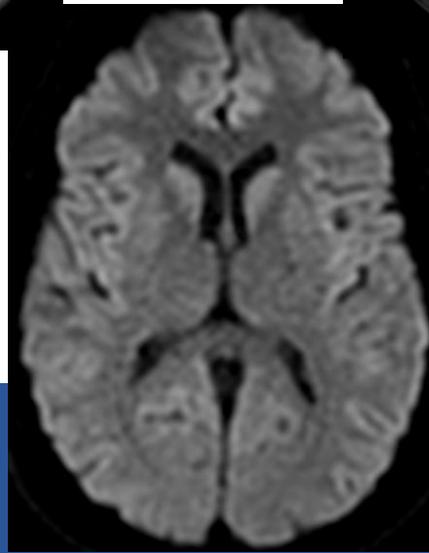
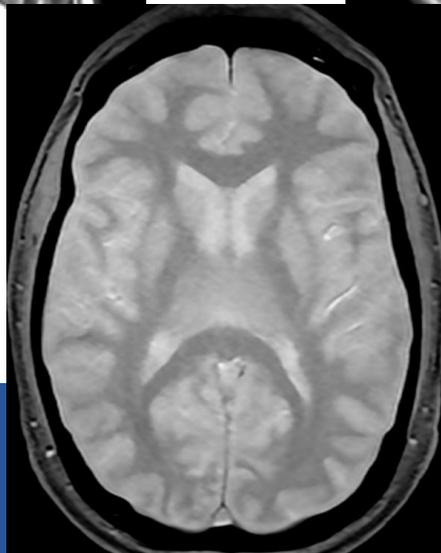
# Speed and Growth of Imaging Data

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MRI can be performed 50% faster with much higher resolution



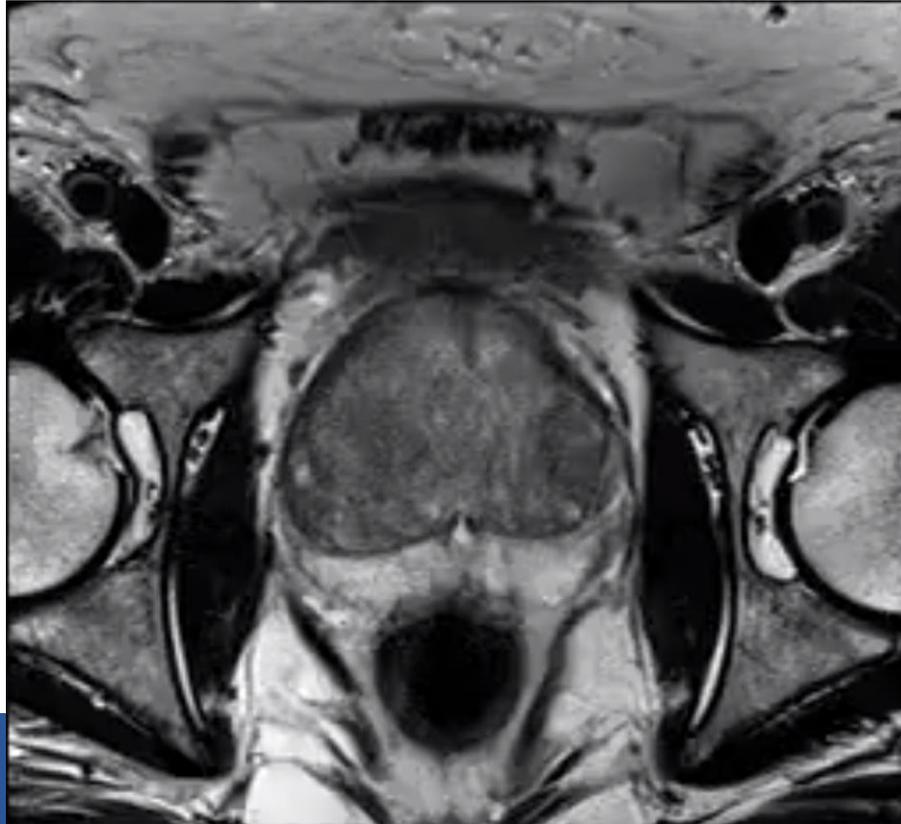
5 min exam  
time



**CI Health**

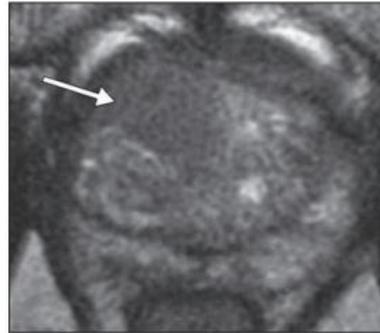
# Prostate MR

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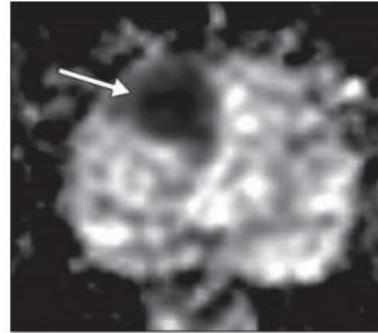


# Prostate MR

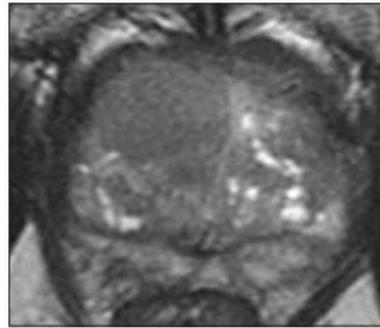
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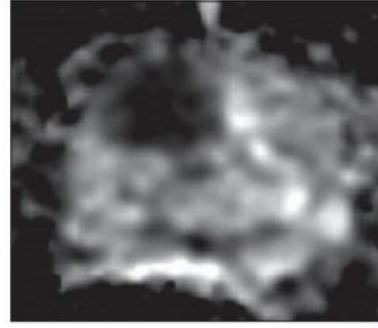
A



B



C



D

AJR 2017; 208:131–139

# Portable MRI at UCI





CI Technologists transporting the MRI to a patient

## The top 10 Health Imaging stories of 2020

*Matt O'Connor* | December 21, 2020 | *Practice Management*



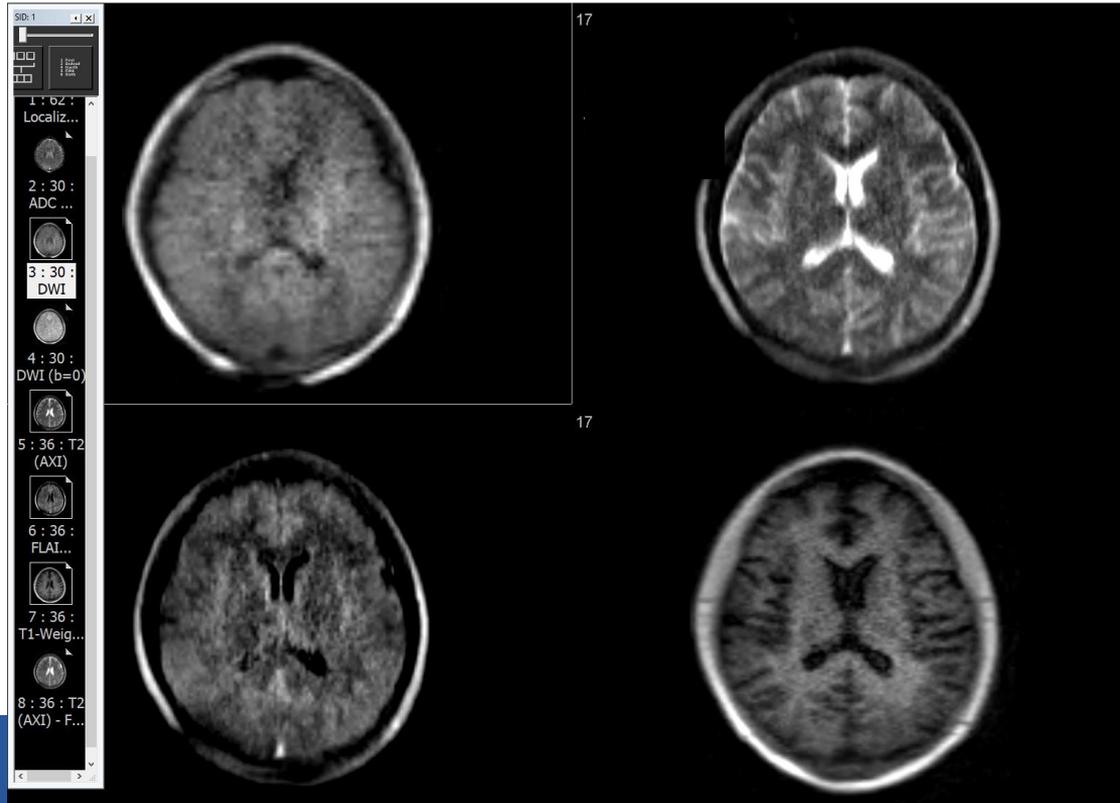
### 3. FDA clears 'world's first' portable, low-cost MRI following positive clinical research

Research

JAMA Neurology | **Original Investigation**

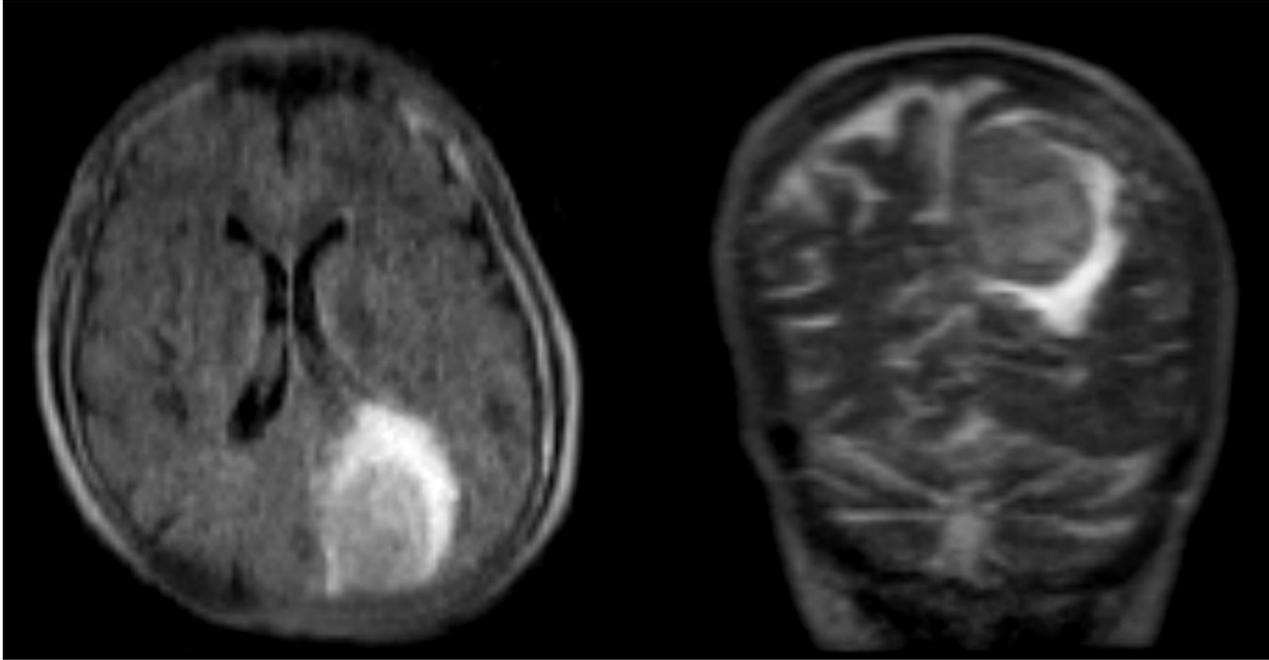
### Assessment of Brain Injury Using Portable, Low-Field Magnetic Resonance Imaging at the Bedside of Critically Ill Patients

# Normal Portable MRI of Brain



# Portable MRI Brain Tumor

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# Benefit of Increased Computing Power

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More meaningful data

Artificial intelligence

# Tumor Necrosis Quantification

## Threshold for Enhancement in Treated Hepatocellular Carcinoma on MDCT: Effect on Necrosis Quantification

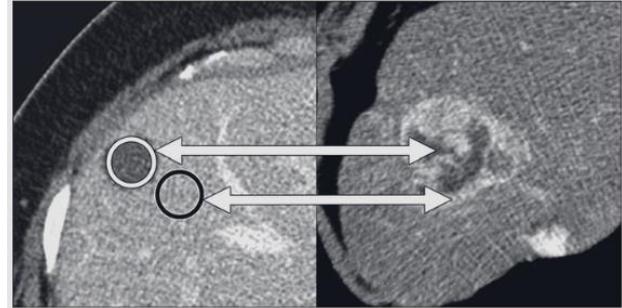
Atilla Arslanoglu<sup>1</sup>  
Hamid Chalian  
Faezeh Sodagari  
Adeel R. Seyal  
Hüseyin Gürkan Töre  
Riad Salem  
Vahid Yaghmai

**OBJECTIVE.** The objective of our study was to determine whether the conventionally used enhancement threshold of 10 HU for assessing tumor viability in treated hepatocellular carcinoma (HCC) lesions is valid.

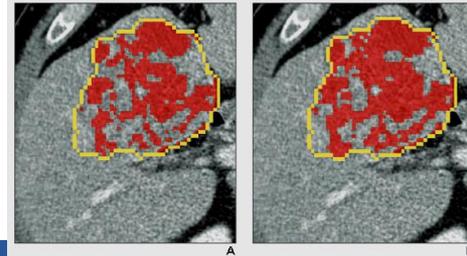
**MATERIALS AND METHODS.** To distinguish pseudoenhancement from enhancement in a tumor, we used an *in vivo* model: The attenuation of 54 hepatic cysts during the unenhanced and portal venous phases of MDCT, similar to what may be observed in HCC with central necrosis, was used to determine the threshold for pseudoenhancement. To validate this model, we compared the attenuation value of liver parenchyma in this cohort with that of 22 HCCs during the late arterial phase of enhancement. We tested the effect of this pseudoenhancement on quantifying necrosis in HCC compared with the conventionally used threshold of 10 HU.

**RESULTS.** Values of enhancing HCC tissue on arterial phase MDCT (mean, 121.3 HU) were comparable with normal liver parenchyma on venous phase MDCT (117.3 HU) ( $p = 0.27$ ). The threshold of 17.1 HU was the best threshold for the detection of pseudoenhancement in cysts (99% accuracy, 100% sensitivity, and 98% specificity). When this threshold was used instead of the conventional threshold of 10 HU, the mean necrosis proportion of treated HCC increased from 34.0% to 42.6% and the mean viable tumor proportion decreased from 66.0% to 57.4%. The quantification of viable HCC tissue based on 10 HU and the quantification of viable HCC tissue based on 17.1 HU were found to be significantly different ( $p < 0.0001$ ).

**CONCLUSION.** The threshold of 17.1 HU may be the appropriate cutoff for nonenhancement in a necrotic HCC. Use of this threshold may potentially affect how response to therapy is quantified and categorized.



**Fig 1.**—MDCT images of 58-year-old woman from cohort A with simple liver cyst (*left image*) and of 51-year-old man from cohort B with hepatocellular carcinoma (HCC) (*right image*). Cohort A (cyst imaged at portal venous phase) is used as model for cohort B (necrosis in treated HCC imaged at late arterial phase). Attenuation values of liver parenchyma on portal venous phase (mean, 117.4 HU) in cohort A were comparable with enhancing tumor tissue (mean, 121.4 HU) of HCC on arterial phase in cohort B (*lower double arrow*). We assumed if mean attenuation values are comparable for cohorts, then necrosis and cysts have comparable pseudoenhancement (*upper double arrow*). White circle denotes simple liver cyst, and black circle denotes liver parenchyma.



**Fig 5.**—MDCT quantification of necrotic portion of hepatocellular carcinoma (HCC) using conventional threshold of 10 HU and using proposed threshold of 17.1 HU in 45-year-old man with HCC who presented for response assessment 1 month after undergoing 90° radioablation.  
**A and B.** MDCT images show tumor segmented by software (yellow) using threshold of 10 HU (**A**) and using threshold of 17.1 HU (**B**). Total tumor volume was calculated by multiplying number of voxels by voxel volume. When conventional threshold of 10 HU was used for enhancement, 82.2 cm<sup>3</sup> (53.1%) of total tumor volume was identified as necrotic tissue (*red area*, **A**). Necrotic tissue volume increased to 93.0 cm<sup>3</sup> (64%) when threshold of 17.1 HU from this study was used (*red area*, **B**). Note that region of necrosis based on threshold of 17.1 HU (*red area*, **B**) is larger than region of necrosis based on threshold of 10 HU (*red area*, **A**).

UCI Health

# Artificial Intelligence for Diagnosis

## Deep neural network improves fracture detection by clinicians

Robert Lindsey<sup>ab,1</sup>, Aaron Daluiski<sup>bc</sup>, Sumit Chopra<sup>a</sup>, Alexander Lachapelle<sup>ad</sup>, Michael Mozer<sup>ab</sup>, Serge Sicular<sup>ae</sup>, Douglas Hanel<sup>bf</sup>, Michael Gardner<sup>g</sup>, Anurag Gupta<sup>ab</sup>, Robert Hotchkiss<sup>ac</sup>, and Hollis Potter<sup>ah</sup>

<sup>a</sup>Imagen Technologies, New York, NY 10012; <sup>b</sup>Department of Computer Science, University of Colorado, Boulder, CO 80309; <sup>c</sup>Department of Orthopaedic Surgery, Hospital for Special Surgery, New York, NY 10021; <sup>d</sup>Faculty of Medicine, McGill University, Montreal, QC, Canada, H3A 2R4; <sup>e</sup>Department of Radiology, Mount Sinai Health System, New York, NY 10029; <sup>f</sup>Department of Orthopaedics and Sports Medicine, Harborview Medical Center, University of Washington, Seattle, WA 98104; <sup>g</sup>Department of Orthopaedic Surgery, Stanford University School of Medicine, Stanford, CA 94305; <sup>h</sup>Department of Emergency Medicine, Northwell Health, New Hyde Park, NY 11040; and <sup>i</sup>Department of Radiology and Imaging, Hospital for Special Surgery, New York, NY 10021

Edited by Terrence J. Sejnowski, Salk Institute for Biological Studies, La Jolla, CA, and approved September 14, 2018 (received for review April 25, 2018)

Suspected fractures are among the most common reasons for patients to visit emergency departments (EDs), and X-ray imaging is the primary diagnostic tool used by clinicians to assess patients for fractures. Missing a fracture in a radiograph often has severe consequences for patients, resulting in delayed treatment and poor recovery of function. Nevertheless, radiographs in emergency settings are often read out of necessity by emergency medicine clinicians who lack subspecialized expertise in orthopedics, and misdiagnosed fractures account for upward of four of every five reported diagnostic errors in certain EDs. In this work, we developed a deep neural network to detect and localize fractures in radiographs. We trained it to accurately emulate the expertise of 18 senior subspecialized orthopedic surgeons by having them annotate 135,409

decreases the specificity of radiologists without improving their sensitivity, resulting in an increased incidence of unnecessary diagnostic tests and biopsies with no improvement in cancer detection rates (9–12). A contributing factor to the ineffectiveness of early CAD systems is their underlying technology. Many early CAD algorithms functioned by identifying regions of an input image containing predefined texture patterns or geometric shapes, with the expectation that alerting clinicians to these visual features would be useful. Because of the limitations in the image analysis algorithms on which early CAD systems were based, they often would reliably mark pathological regions of images at the expense of overzealously identifying many nonpathological regions.



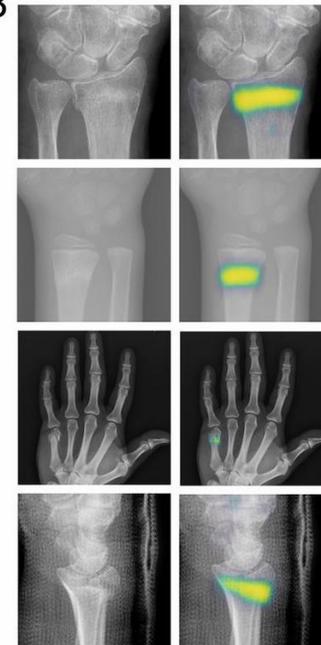
A



Original Radiograph

Output Image

B



Original Radiograph

Output Image

# Using Artificial Intelligence to Detect COVID-19 and Community-acquired Pneumonia Based on Pulmonary CT: Evaluation of the Diagnostic Accuracy

Lin Li, BS • Lixin Qin, PhD • Zeguo Xu, BS • Youbing Yin, PhD • Xin Wang, PhD • Bin Kong, PhD • Junjie Bai, PhD • Yi Lu, MS • Zhenghan Fang, MS • Qi Song, PhD • Kunlin Cao, PhD • Daliang Liu, PhD • Guisheng Wang, PhD • Qizhong Xu, MS • Xisheng Fang, BS • Shiqin Zhang, BS • Juan Xia, BS • Jun Xia, PhD

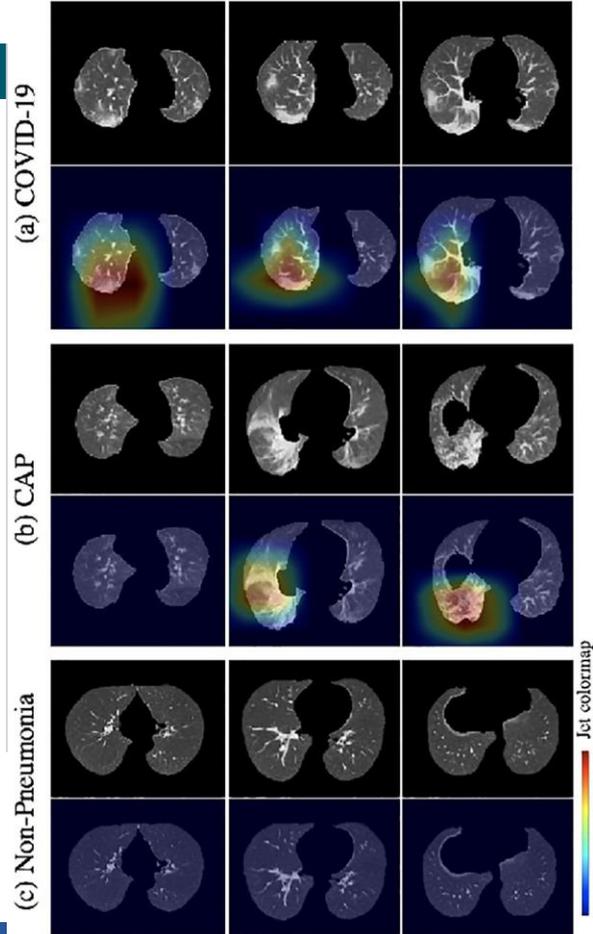
From the Department of Radiology, Wuhan Huangpi People's Hospital, Wuhan, China (L.L., Z.X., X.F., S.Z., Jun Xia); Jiangnan University Affiliated Huangpi People's Hospital, Wuhan, China (L.L.); Department of Radiology, Wuhan Pulmonary Hospital, Wuhan, China (L.Q.); Keya Medical Technology Co, Ltd, Shenzhen, China (Y.Y., X.W., B.K., J.B., Y.L., Z.F., Q.S., K.C.); Department of Radiology, Liaocheng People's Hospital, Liaocheng, China (D.L.); Department of CT, The Third Medical Center of Chinese PLA General Hospital, Beijing, China (G.W.); and Department of Radiology, Shenzhen Second People's Hospital/the First Affiliated Hospital of Shenzhen University Health Science Center, Shenzhen, China 518035 (Q.X., Jun Xia). Received March 7, 2020; revision requested March 12; revision received March 13; accepted March 19. Address correspondence to Jun Xia (e-mail: [xiajun@e-mail.szu.edu.cn](mailto:xiajun@e-mail.szu.edu.cn)).

Conflicts of interest are listed at the end of this article.

Radiology 2020; 296:E65–E71 • <https://doi.org/10.1148/radiol.2020200905> • Content codes: **CH** **CT** **IN**

**Background:** Coronavirus disease 2019 (COVID-19) has widely spread all over the world since the beginning of 2020. It is desirable to develop automatic and accurate detection of COVID-19 using chest CT.

**Purpose:** To develop a fully automatic framework to detect COVID-19 using chest CT and evaluate its performance.



# Artificial Intelligence



The screenshot displays the Zebra HealthCXR software interface. At the top, it says "AI Suspected" in a teal banner. Below this, the Zebra logo is shown next to the text "Pleural Effusion".

**About this product (HealthCXR)**

The Zebra HealthCXR device is a software workflow tool designed to aid the clinical assessment of adult Chest X-Ray cases with features suggestive of pleural effusion in the medical care environment. HealthCXR analyzes cases using an artificial intelligence algorithm to identify suspected findings. It makes case-level output available to a PACS/workstation for workflow prioritization or triage. HealthCXR is not intended to direct attention to specific portions or anomalies of an image. Its results are not intended to be used on a stand-alone basis for clinical decision-making nor is it intended to rule out pleural effusion or otherwise preclude clinical assessment of X-Ray cases.

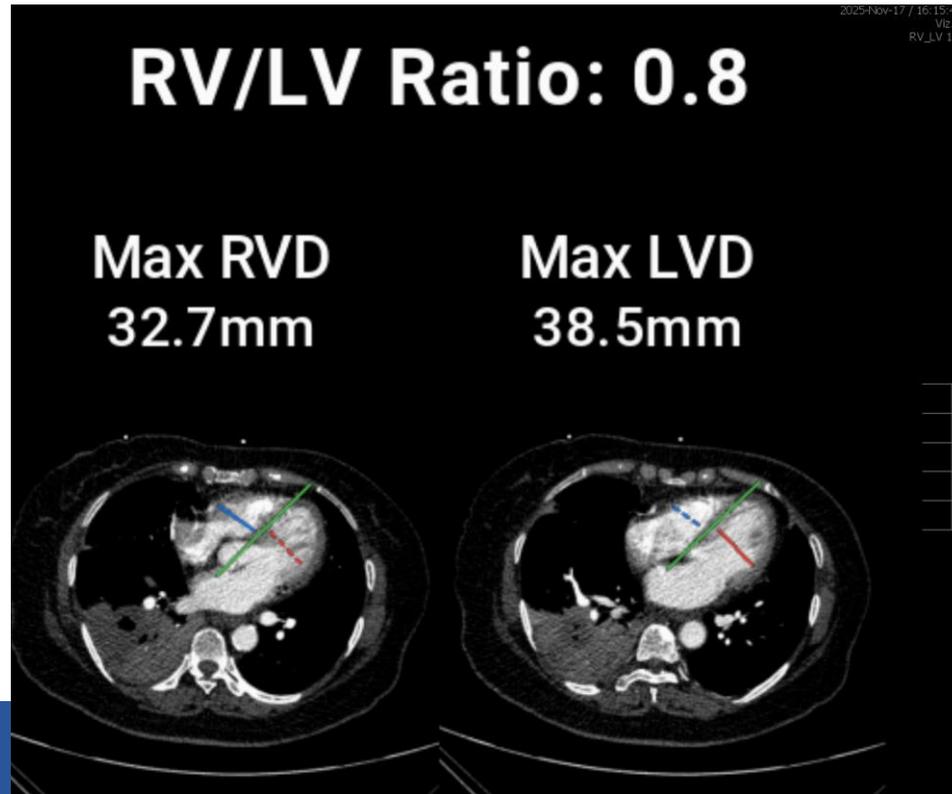
**About Zebra Medical Vision**

Zebra Med's mission is to provide radiologists the tools they need to make the next leap in patient care. Zebra Med is empowering radiologists with its revolutionary AI offering, which helps health providers manage the ever-increasing workload without compromising quality.

- Manufacturer: Zebra Medical Vision Ltd.
- Shefayim Commercial Center, Shefayim, 6099000 Israel
- For support: support@zebra-med.atlassian.net

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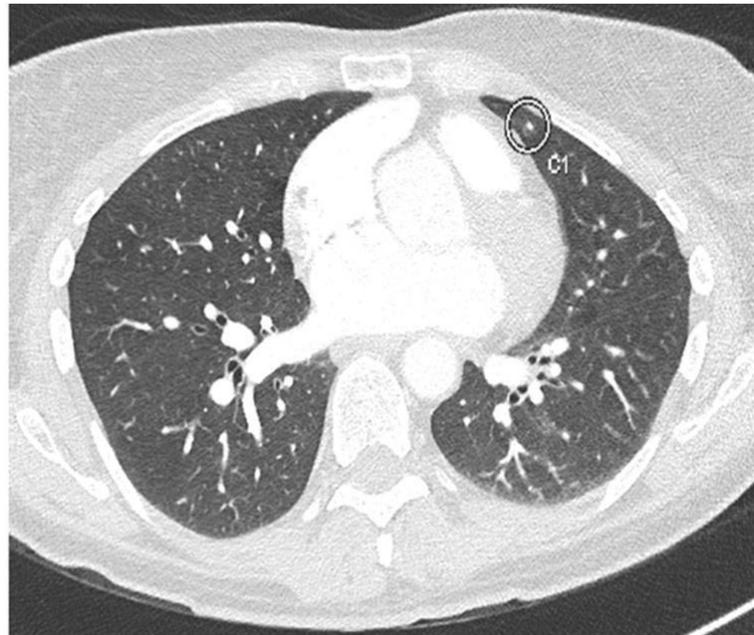
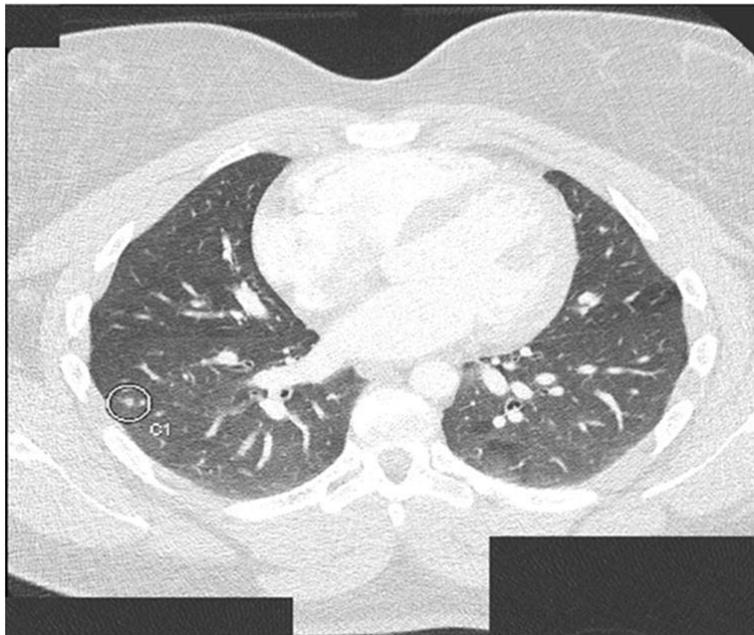
# Artificial Intelligence



## Integration of fully automated computer-aided pulmonary nodule detection into CT pulmonary angiography studies in the emergency department: effect on workflow and diagnostic accuracy

Amirhossein Mozaffary, Tuocce Aqirlar Trabzonlu, Pamela Lombardi, Adeel R. Seyal, Rishi Agrawal & Vahid Yaghmai

*Emergency Radiology* 26, 609–614 (2019) | [Cite this article](#)



# Artificial Intelligence Center at UCI SOM



## MISSION STATEMENT

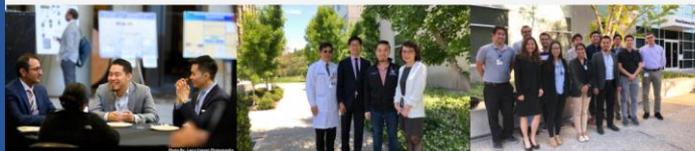


Accelerating healthcare through the deployment of artificial intelligence (AI) based healthcare tools

The Center for Artificial Intelligence in Diagnostic Medicine (CAIDM) at the University of California, Irvine is a cross-disciplinary initiative with the mission to empower health care providers, researchers, and patients through the deployment of artificial intelligence (AI) healthcare applications.

The CAIDM has undertaken several projects to drive the advancement of science and medicine in AI. It acts as a resource for academia and industry partners seeking to leverage AI for biomedical healthcare applications by providing technical expertise and pioneering new approaches that will bring about significant changes in the healthcare system.

The CAIDM accomplishes this goal by integrating the clinical expertise of our providers at UCI with multiple disciplines, bridging the gap between science and technology. The Center recognizes that capitalizing on the knowledge of both our clinical colleagues and data scientists is critical for designing impactful applications that will have long-term value, ultimately improving patient care.



**UCI Health**

# Image Guided Therapies

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Using imaging to guide therapy by interventional radiologists to treat tumors

# Radiologists

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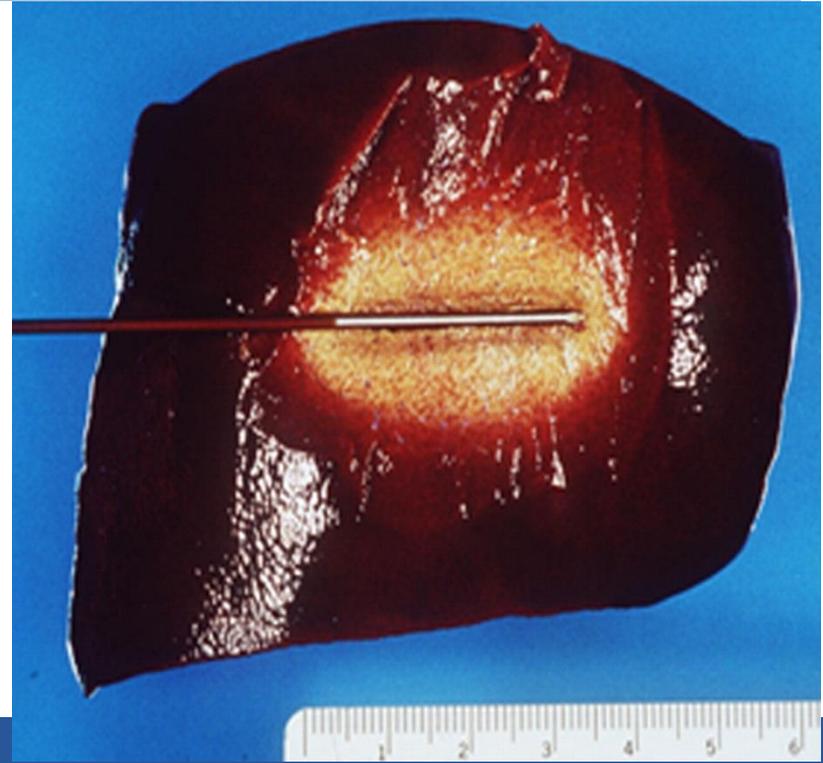
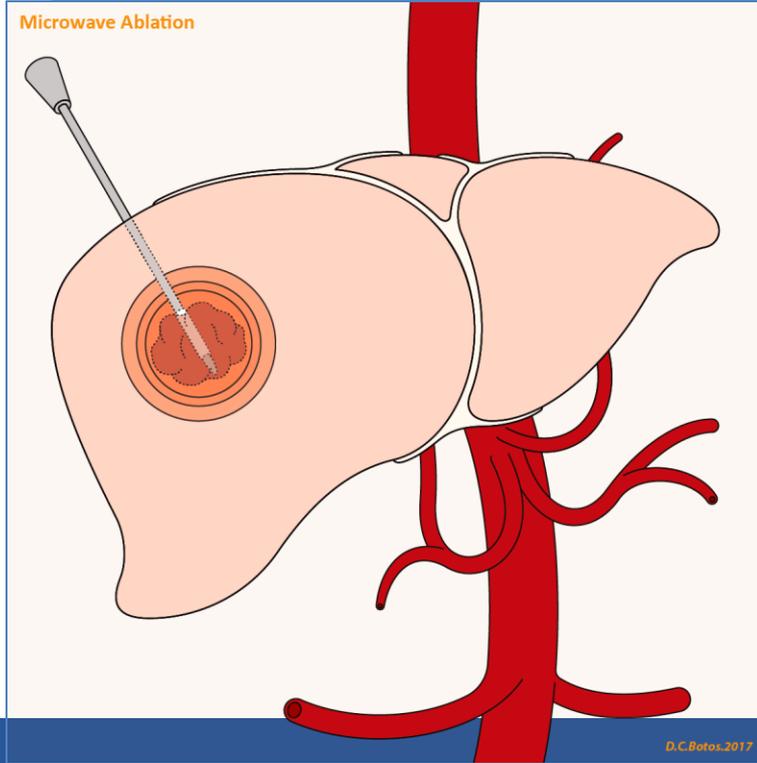


# Liver-Directed Therapy

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- Goal is induction of necrosis in selected tumor

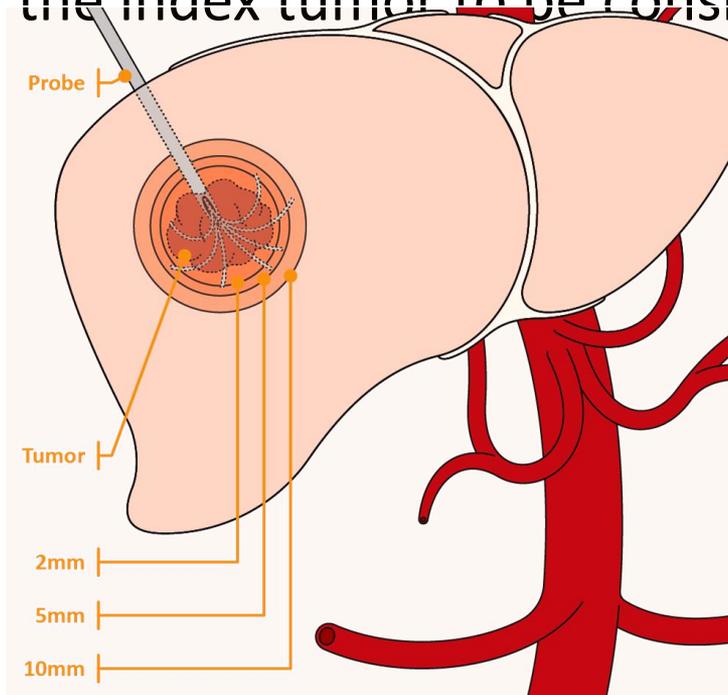
# Microwave Ablation



Muneeb Ahmed; Christopher L. Brace; Fred T. Lee Jr; S. Nahum Goldberg; *Radiology* 2011, 258, 351-369.

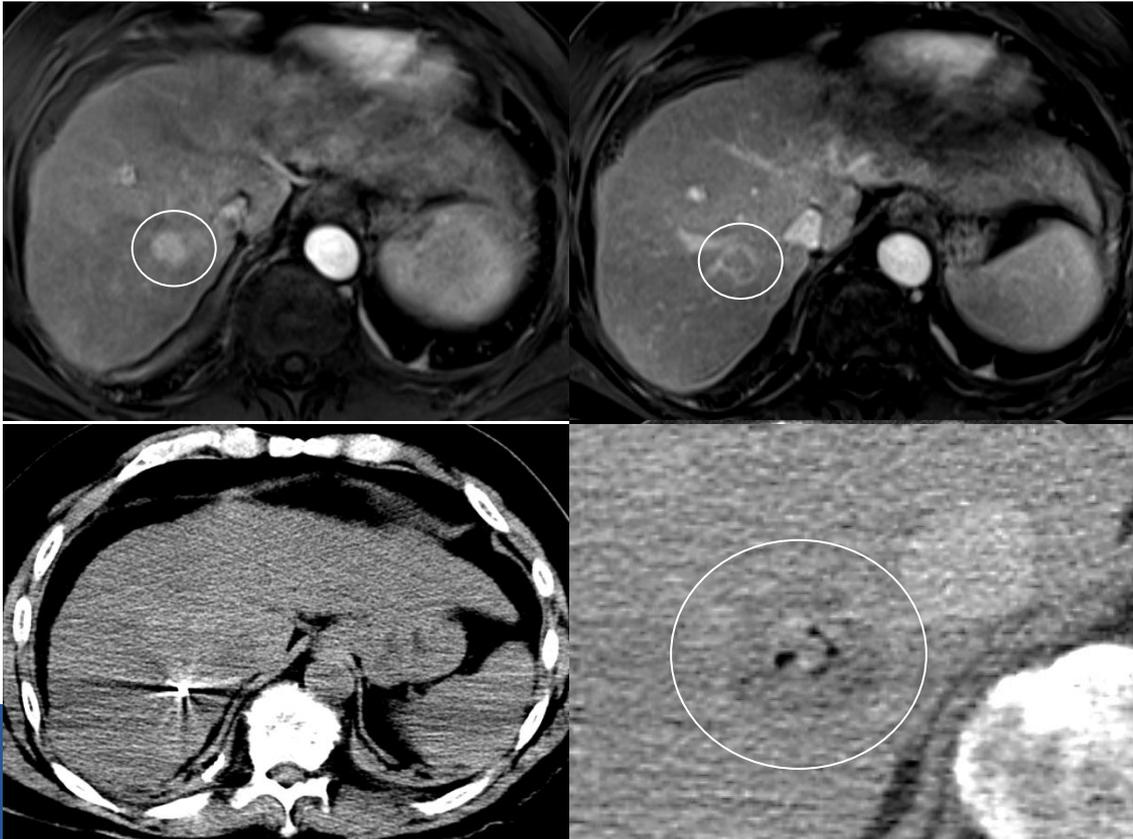
# Ablation Margin

- The thickness of the ablative margin must be ***at least 5 mm*** for ablation of the index tumor to be considered complete



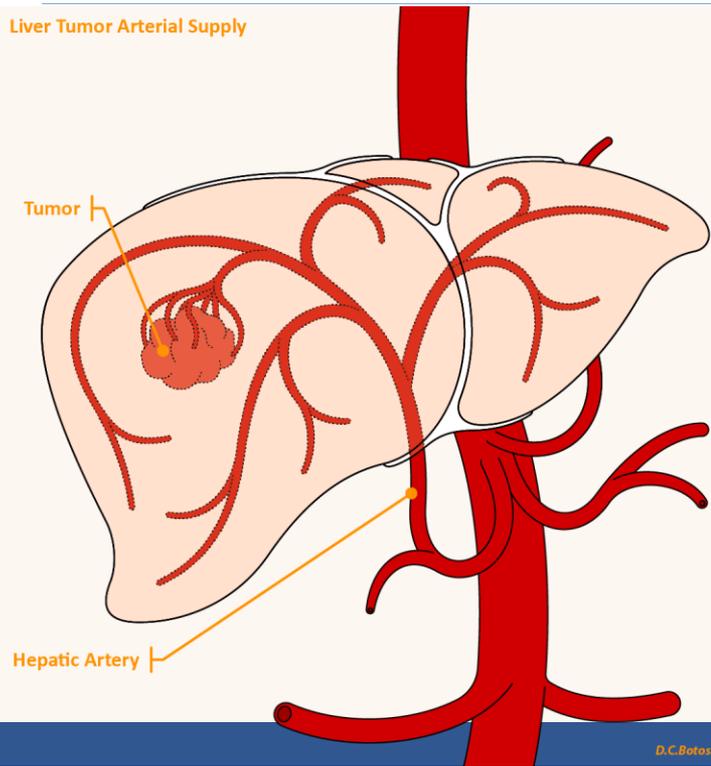
# Image-Guided MWA Liver Cancer

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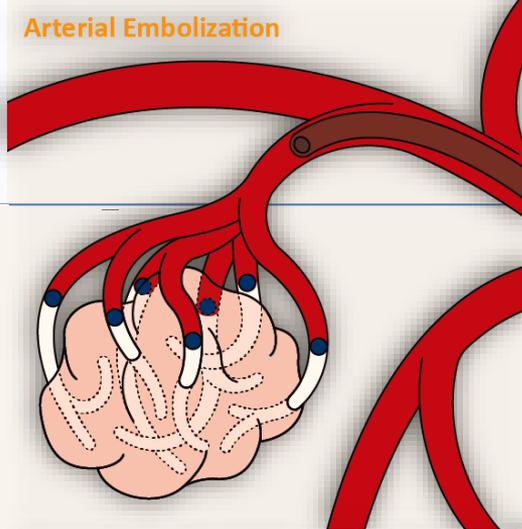


# Embolization Therapies

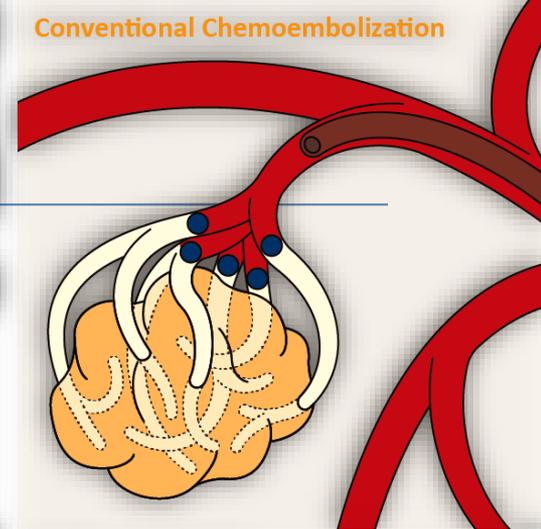
Liver Tumor Arterial Supply



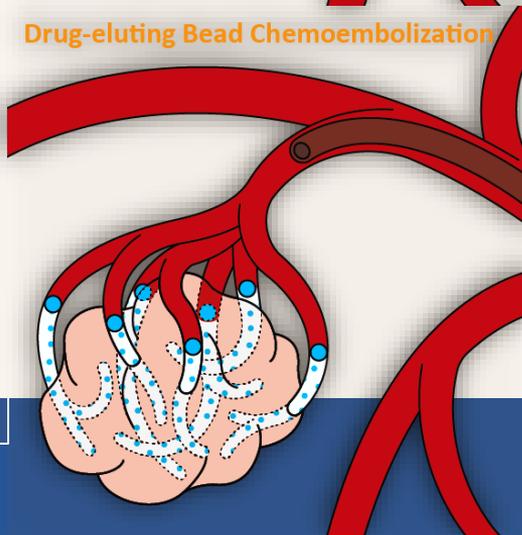
Arterial Embolization



Conventional Chemoembolization

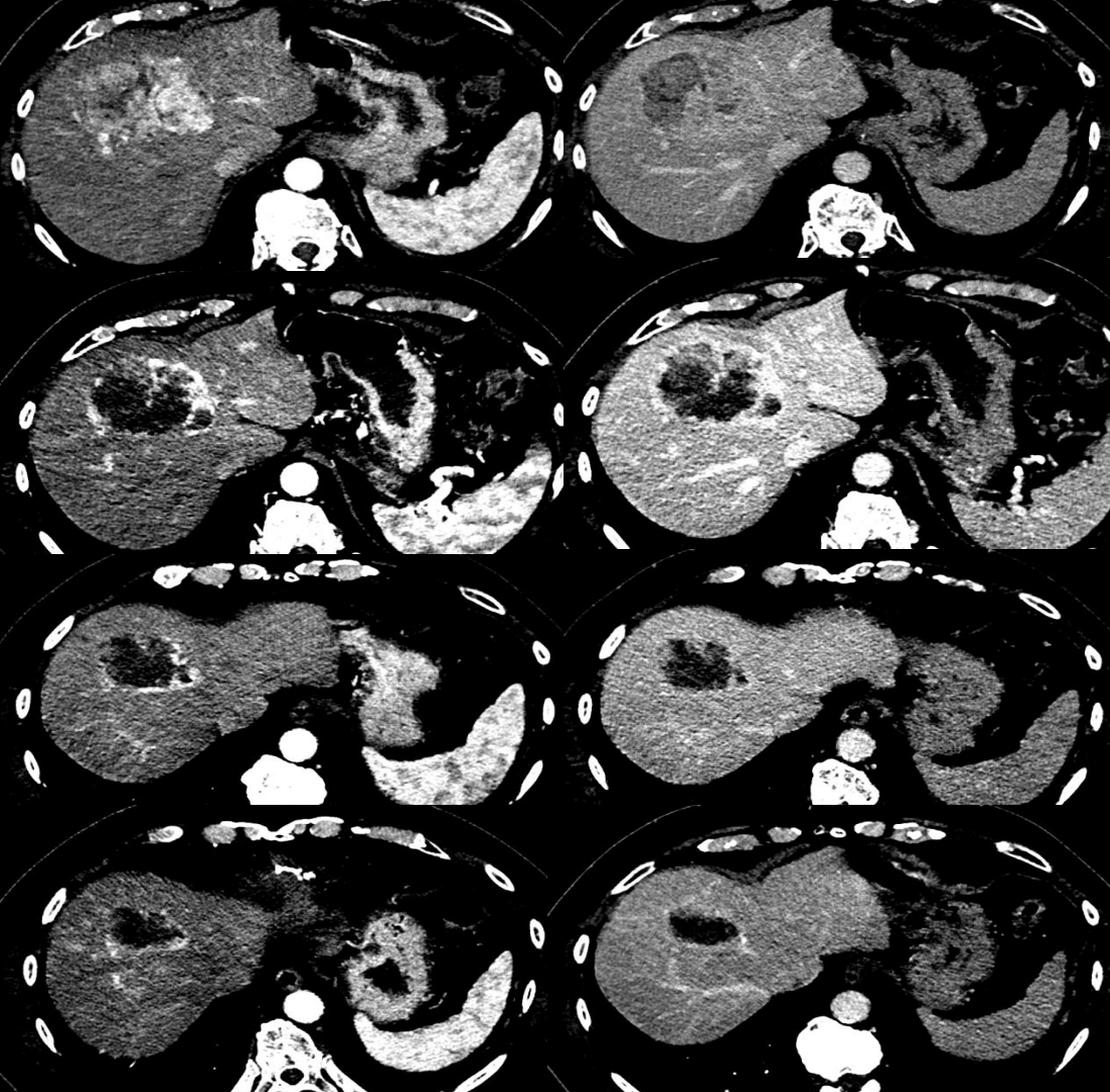


Drug-eluting Bead Chemoembolization



Radioembolization





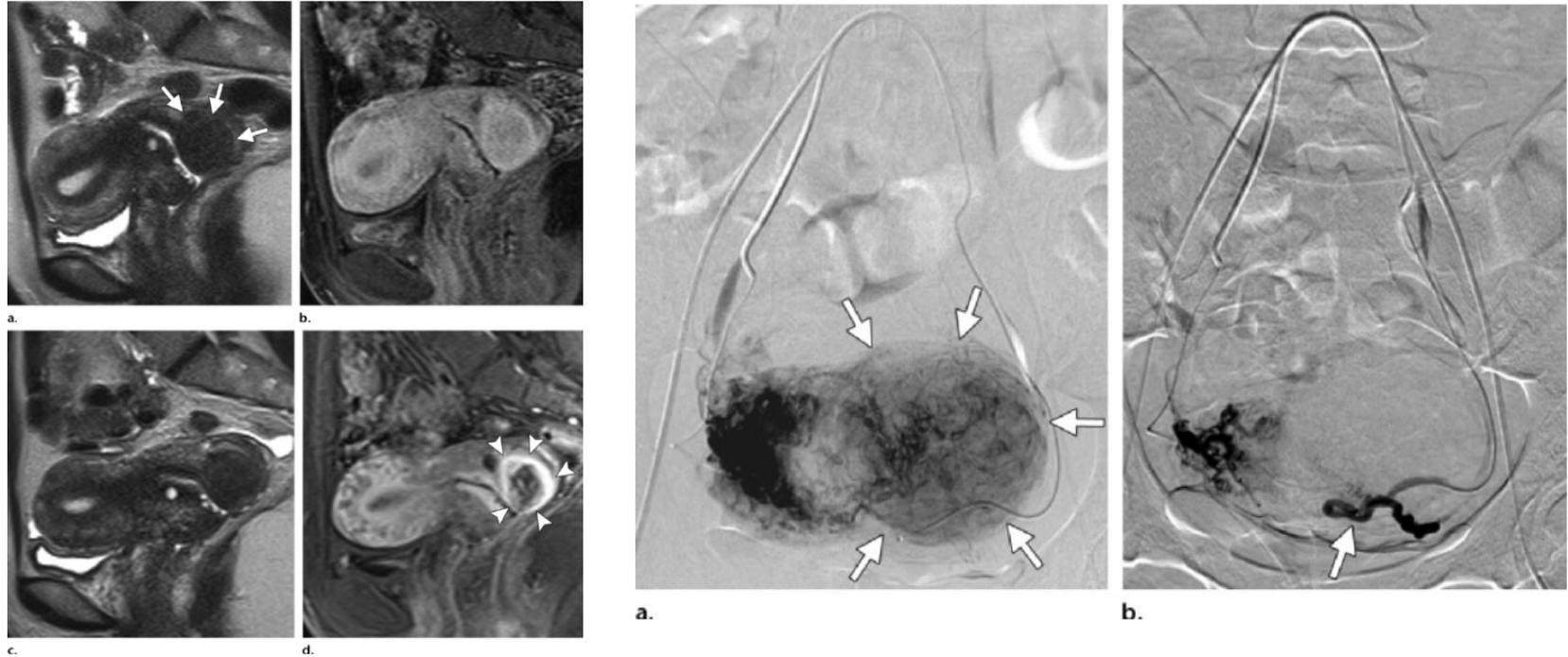
**HCC**  
**Pre-TARE**

**One month post-TARE**

**Three months post-TARE**

**Six months post-TARE**

# Uterine Fibroid Embolization by IR



# Prostatic Artery Embolization for Benign Prostatic Hyperplasia: Patient Evaluation, Anatomy, and Technique for Successful Treatment

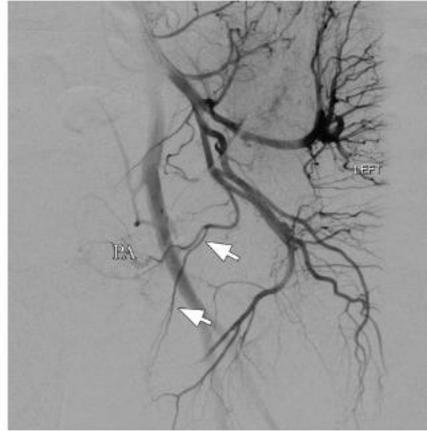
*Andrew C. Picel, MD  
Ting-Chin Hsieh, MD  
Rachel M. Shapiro, PA  
Alex M. Vezeridis, MD, PhD  
Ari J. Isaacson, MD*

**Abbreviations:** IIA = internal iliac artery, IPA = internal pudendal artery, IPSS = International Prostate Symptom Score, PA = prostatic artery, PAE = prostatic artery embolization, PERFECTED = proximal embolization first, then embolize distal, PSA = prostate-specific antigen, PVR = postvoid residual,  $Q_{\max}$  = maximal urinary flow rate, TURP = transurethral resection of the prostate

RadioGraphics 2019; 39:1526–1548

Symptomatic benign prostatic hyperplasia is a common condition in the aging population that results in bothersome lower urinary tract symptoms and decreased quality of life. Patients often are treated with medication and offered surgery for persistent symptoms. Transurethral resection of the prostate is considered the traditional standard of care, but several minimally invasive surgical treatments also are offered. Prostatic artery embolization (PAE) is emerging as an effective treatment option with few reported adverse effects, minimal blood loss, and infrequent overnight hospitalization. The procedure is offered to patients with moderate to severe lower urinary tract symptoms and depressed urinary flow due to bladder outlet obstruction. Proper patient selection and meticulous embolization are critical to optimize results. To perform PAE safely and

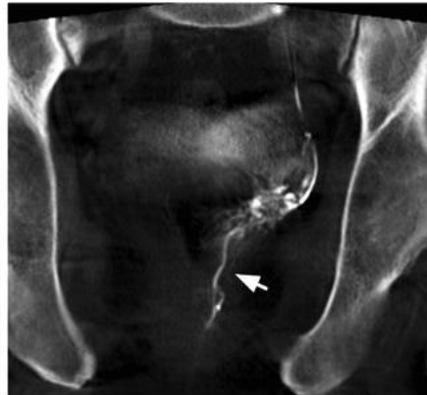
# Prostate Artery Embolization



a.



b.



# Ultrasound: Histotripsy

Non-invasive, Non-thermal, and Non-ionizing Focused Ultrasound

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# Medical Imaging Technology Advances

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Significant advances in medical imaging technologies

Development of interventional techniques

Applications of artificial intelligence in medical imaging