THURSDAY DECEMBER 1, 2022

THE OFFICIAL NEWSPAPER OF THE RSNA ANNUAL MEETING

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RSNA® 2022

Daily Bulletin

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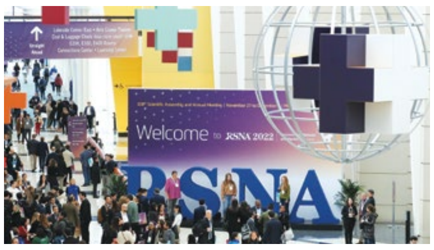
INSIDE THURSDAY



EXCLUSIVE ONLINE CONTENT

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AI Central to Radiation Oncology Clinical Trials, Practice

By Richard Dargan

AI can boost radiation oncology clinical trials and clinical practice by providing better risk stratification, workflow and follow-up, according to experts who spoke at a panel discussion during Wednesday's plenary session.

(Left to right) Gensheimer, Feng, Li and Le

Discussion moderator Quynh-Thu Le, MD, from Stanford Medicine in Stanford, CA, said that AI is already in use in radiation oncology in the form of automatic segmentation, radiation treatment plans and quality assurance tools.

"Application of AI in radiation oncology is here to stay," said Dr. Le, chair of the Department of Radiation Oncology and the Katharine Dexter McCormick and Stanley McCormick Memorial Professor at Stanford University.

AI also has potential in clinical trials, an area where a large proportion of patients do not meet study criteria and many studies fail to complete recruitment on time.

Dr. Le said that AI can help simplify eligibility criteria to expand the pool of eligible patients and provide more patients with access to trials. However, the need for continual updates will make it difficult to test AI tools in prospective clinical trials using the traditional designs.

"We need to come up with some novel designs and we need to work together with a new organizational framework to leverage the full power of AI," Dr. Le said.

CONTINUED ON PAGE 10

Possible Alterations in Imaging Patterns in CT for Delta-VOC of SARS-CoV-2

By Mary Henderson

Imaging patterns found on pulmonary CT scans of COVID-19 patients may vary depending on which variant of concern (VOC) has infected the patient according to new research presented Wednesday.

Yüksel

"The typical CT findings in COVID-19 patients are well-understood," said Can Yüksel, MD, a radiology resident at the University Hospital RWTH in Aachen, Germany. "However, CT morphology associated with the Delta VOC may diverge from the predominant COVID variants."

COVID-19 pneumonia has been described as bilateral, multifocal ground glass opacifications (GGOs), and consolidations with peripheral emphasis and interlobular septal thickening.

Differences in Imaging for Variants

To determine whether the Delta variant may be associated with a different imaging phenotype, Dr. Yüksel's team assessed 161 CT studies of patients confirmed with SARS-Covid-2 infection with a positive PCR test result within two days of the CT exam. The CT scans were performed between January and September of 2021 at University Hospital RWTH.

After exclusions, 86 CTs of unique patients were analyzed, including 25 with non-VOC, 22 with the Delta VOC, and 39 with the Alpha VOC.

"Patients with the Delta variant were significantly younger than patients in the Alpha and non-VOC cohorts," Dr. Yüksel said.

"These findings may indicate that CT morphology is altered based on the virus variant. Radiologists may face additional phenotypes for COVID-19, especially if Omicron and future variants lead to further changes."

Can Yüksel, MD

The average age of the Delta cohort was 49.1 years old; in the Alpha group it was 60.8, and in the non-VOC cohort it was 68. The vaccination rate for the entire cohort was 11.6% with a similar number of vaccinated patients in each subgroup.

The CT scans were analyzed for the distribution, configuration, and degree of involvement of GGOs and consolidations, the mean density and multifocality of lesions, and other CT morphological signs known to be associated with atypical pneumonia.

The researchers found no congruence between vaccination status and the presence of pathological lung alterations. Observed differences between the variants included:

- Consolidations with basal emphasis were more often seen in Alpha versus non-VOC.
- Consolidations were less often centrally emphasized in Delta versus non-VOC.
- GGOs and multifocal lesions were less likely to appear in Delta patients.

Most significantly, Dr. Yüksel said round pulmonary masses with a surrounding ground-glass halo were observed in three Delta patients but in none of the patients with the Alpha or non-VOC variants.

"This pattern is typically found in fungal infections and has not been established as a notable imaging pattern in COVID-19 pneumonia," he said.

The patients were all under 30 years old and otherwise healthy. None were suspected of a pulmonary co-infection.

"These findings may indicate that CT morphology is altered based on the virus variant," he said. "Radiologists may face additional phenotypes for COVID-19, especially if Omicron and future variants lead to further changes."

Thursday At a Glance

RSNA/AAPM Symposium

11 a.m. – Noon | E450A

Guang-Hong Chen, MD

Together We Can Make a Difference

Panelists will discuss successful collaboration between radiologists and physicists in technical developments and clinical translations in medical imaging.

Maryellen L. Giger, PhD

Gillian M. Newstead, MD

7:30 A.M. – 4:30 P.M.
The Art of Imaging Exhibit
Learning Center

8 A.M. – 9 A.M.
Science and Education Sessions

9 A.M. – 9:30 A.M.
Poster Discussions
Learning Center

9 A.M. – 3 P.M.
Cutting-Edge Research Presentations
Learning Center Theater

9:30 A.M. – 11 A.M.
Science and Education Sessions

12:15 – 1:15 P.M.
Poster Discussions
Learning Center

1:30 P.M. – 4 P.M.
Science and Education Sessions

View the full program and add sessions to your calendar at *Meeting.RSNA.org*.

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Daily Bulletin

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Minoshima is R&E Chair

Minoshima

Satoshi Minoshima, MD, PhD, was named chair of the RSNA R&E Foundation Board of Trustees.

Dr. Minoshima is the Anne G. Osborn Chair and Professor of the Department of Radiology and Imaging Sciences at the University of Utah in Salt Lake City. His scientific contributions in the field of neuroscience are imaging phenotypic characterizations of neurodegenerative diseases such as the discovery of very early sign of Alzheimer's disease in the posterior cingulate cortex as well as invention and worldwide dissemination of diagnostic statistical mapping technology. He has published numerous peer-reviewed articles, book chapters, review articles, proceedings and scientific abstracts, lectured extensively, and supported industry partners to advance imaging technology, sciences and practice.

A leader in organized radiology, Dr. Minoshima served as the chair of the RSNA Molecular Imaging Committee, president of the Brain Imaging Council for the Society of Nuclear Medicine and Molecular Imaging (SNMMI), chair of the SNMMI Scientific Program Committee, and the president of the SNMMI. He is currently serving as chair of the SNMMI Value Initiative. He also works with the United Nations International Atomic Energy Agency to advance neuroimaging in dementia.

Dr. Minoshima has received multiple awards including the Tetalman Memorial Award, the Kuhl-Lassen Award, the Presidential Distinguished Service Award and the Henry Wagner Jr. Lecture Award from the SNMMI. He was awarded a gold medal from the American Roentgen Ray Society and the University of Washington Presidential Entrepreneur Faculty Fellow Award. Dr. Minoshima is an honorary member of the Japanese Radiological Society and received the Healthcare Design Top 10 MVP Award.

Other changes to the R&E Foundation Board of Trustees are, Michael J. Harsh appointed secretary and Bonnie Joe, MD, PhD, reappointed for a second term. New trustees are Michael S. Gee, MD, PhD, Carolyn C. Meltzer, MD, and Bruce G. Haffty, MD.

Physics Tip

American Association of Physicists in Medicine

The Joint Commission definition of Sentinel Event changed Jan. 1, 2022. There is no longer a 15 Gy threshold, instead it is triggered by fluoroscopy resulting in permanent tissue injury when clinical and technical optimization were not implemented and/or recognized practice parameters were not followed.

Shear Wave Elastography US Can Provide Information About Tendon Structure

By Melissa Silverberg

Achilles tendinopathy is a common tissue injury that affects both athletes and the general population with pain, swelling and impaired physical function during daily activities.

While US has been a common tool to diagnose, it has not always provided the most clinical information, such as the ability to assess the tendon structure and stiffness. This is needed to know when a patient is ready to return to normal activity.

A developing use of shear wave elastography US could help provide clinicians and patients with more information, according to Scott Crawford, PhD, assistant professor in the Departments of Kinesiology and Orthopedics & Rehabilitation at the University of Wisconsin, Madison.

"It's a really exciting proposition to see how we can use this work to inform practices and improve the overall quality of life for individuals struggling with chronic pain."

Scott Crawford, PhD

"Shear wave imaging can non-invasively quantify tendon elasticity," Dr. Crawford said. "The purpose of the study was to determine the characteristics of both traditional sonographic measures and regional shear wave speed, or SWS, between limbs in patients with Achilles tendinopathy."

Study Looked at Tendon Stiffness and Thickness

Participants were recruited from April 2014 to Nov. 2017 as part of a randomized trial among patients between 18 and 65 years of age who had experienced unilateral mid-substance Achilles tendon pain for more than six months. The patients had failed conservative treatments, had no steroid injection within the past six weeks and had no history of surgery or systemic disease.

Overall, 20 subjects were enrolled in the study. Researchers then used traditional sonographic measures of tendon structure as well as regional SWS collected in a resting ankle position, for both the symptomatic and non-symptomatic ankle.

Crawford

Using shear wave imaging to estimate tendon stiffness, the team used lower SWS only in the free tendon and compared to the contralateral limb, indicating that alterations in tendon elasticity associated with Achilles tendinopathy were localized there and did not involve the proximal passive tendon structures of the nearby limbs.

The results also found that symptomatic tendons were thicker and had more hyperemia and hypoechogenicity, or decreased response during US exam, than the other tendon.

Further Investigation Needed

Dr. Crawford said that because the study was so small and did not have a control group of healthy individuals, further studies are needed.

"A reliable quantitative measure of tendon elasticity allows for clinical validation studies to address important topics such as return to activity and the effectiveness of rehabilitation protocols. Large clinical trials should consider including advanced technique such as SWS especially when evaluating emerging injection therapies like platelet-rich plasma or percutaneous tenotomy," Dr. Crawford said. "It's a really exciting proposition to see how we can use this work to inform practices and improve the overall quality of life for individuals struggling with chronic pain."

Access the presentation, "Regional Ultrasound Shear Wave Elastography of Mid-substance Achilles Tendinopathy: A Pilot Study Assessing Shear Wave Speeds in Symptomatic Achilles Tendons Compared to the Contralateral Achilles," (W3-SSMK08-1) on demand at *Meeting.RSNA.org.*

Novel Algorithm Removes Calcium From Vascular Exams

By Richard Dargan

A novel algorithm successfully removes calcifications in CT angiography (CTA) examinations while maintaining the quality of the original images, according to a study presented Wednesday. Researchers said the algorithm has the potential to improve diagnostic accuracy of CTA exams when dense calcifications are present.

Patients with vascular stenosis have a buildup of plaque (fatty deposits containing calcium, cholesterol and other substances) inside the arteries that obstructs blood flow. Currently, non-invasive assessment of vessel obstruction in the presence of heavy calcification limits the diagnostic capabilities for accurate assessment of this stenosis. Just as light cannot travel through a wall to take a picture, X-rays have a difficult time traveling through dense matter such as calcium.

Koons

"This causes calcium blooming artifact on images making calcium appear larger than its physical size and making it difficult for radiologists to accurately assess luminal patency," said presenter and study co-author Emily Koons, a PhD student at the Mayo Clinic Graduate School and Mayo's CT Clinical Innovation Center in Rochester, MN.

"Removing calcium from the image eliminates blooming artifact, revealing a more accurate luminal patency. Use of this commercial calcium removal algorithm can potentially help improve diagnosis from CTA exams with dense calcification present."

Emily Koons

Koons and colleagues evaluated the performance of a novel calcium removal algorithm for vascular exams performed on a clinical photon-counting CT (PCCT) system.

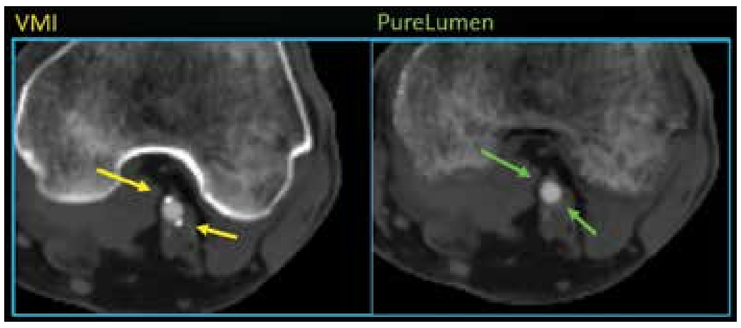
Patients undergoing CTA exams were scanned on a PCCT using a multi-energy mode and 120 kV. The study included patients with identifiable calcification in their CTA images. Of the 28 patients, 24 had abdominal CTA and the remaining four underwent lower extremity runoff CTA.

Researchers identified 331 plaques from the 28 patients enrolled in the study. The amount of calcification ranged from small in 148 plaques to medium in 123 and large in 60.

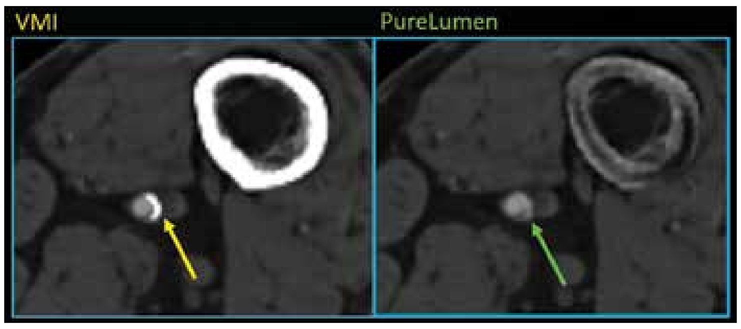
Algorithm Removes Calcium Blooming

Two sets of images were reconstructed: 70 keV virtual monoenergetic images (VMI) and calcium-removed 70 keV VMI. An experienced cardiovascular radiologist evaluated all cases, focusing on vessels inferior to the aortic bifurcation, including iliac, femoral, popliteal, tibioperoneal, anterior tibial, posterior tibial and peroneal arteries.

In 259 plaques (78%), the algorithm either completely removed the calcification or left only minimum residual calcification. The overall image quality score of the calcium-removed images was identical to that of the original images. In the original images, calcium blooming was observed in 182 (55%) plaques, which was fully eliminated in the calcium-removed images.



CTA of the superficial femoral artery before (left) and after calcium removal.



CTA of the popliteal artery before (left) and after calciuim removal. *Images courtesy of Emily Koons.*

"Removing calcium from the image eliminates blooming artifact, revealing a more accurate luminal patency," said Koons. "Use of this commercial calcium removal algorithm can potentially help improve diagnosis from CTA exams with dense calcification present."

Improved accuracy of luminal stenosis estimations helps both physician and the patient, Koons noted, potentially avoiding unnecessary invasive vascular interventions.

Currently, phantom testing is underway to further evaluate the technology.

"We are also exploring how the algorithm can potentially increase radiologist confidence in the carotid and coronary arteries," Koons said.

Access the presentation, "Calcium Removal in Vascular Exams Using a Novel Calcium-Separation Algorithm in Photon-Counting-Detector CT," (W1-SSVA03-6) on demand at *Meeting.RSNA.org.*

Study Emphasizes Benefits of DBT in a Safety-Net Hospital

By Lynn Antonopoulos

Lowered abnormal interpretation (recall) rates and decreased false positive rates are among key reasons to use digital breast tomosynthesis (DBT) screening, according to a Wednesday presenter.

"One of the more important results of our study is the effect of DBT on lowering abnormal interpretation rates of screening mammography, especially in younger women and those receiving baseline examinations," said presenter Ted Goh, MD, an R1 (PGY-2) diagnostic radiology resident at Boston Medical Center, a large urban safety-net hospital.

For the study, Dr. Goh and colleagues conducted a retrospective review of all DBT and digital mammography (DM) screening mammograms conducted between January 2012 and December 2018 on women 40 years of age and older.

The team used a propensity score matching algorithm to control for the differential selection of DBT versus DM based on age, breast density category and potential prior screening. They also manually extracted BI-RADS category, breast density and mammographic finding data from imaging report texts.

"Using our institution's tumor registry, we identified screen-detected and interval cancer diagnoses," said Dr. Goh, who noted that the researchers performed statistical analyses to compare screening performance and cancer outcomes between DM and DBT matched cohorts.

Results Highlight DBT's Role in Reduced Unnecessary Recall

From an initial pool of 72,960 screening examinations, they identified 26,250 (13,125 DM and 13,125 DBT) performed in 16,060 women. "Abnormal interpretation for DBT were significantly lower than that of DM," said Dr. Goh who highlighted a reduction in unnecessary recall rates for DBT at 12.1% compared to 14.7% for DM.

"Radiologists may also combat access problems by working with breast cancer support groups and developing partnerships with mobile mammography clinics to introduce screening services in underserved neighborhoods."

Ted Goh, MD

Results showed greater specificity for DBT at 88.1% versus 85.7% for DM. Improved abnormal interpretation rates and specificity were observed with DBT when women were stratified by age, fatty versus dense breast tissue and baseline exams.

Despite these findings, Dr. Goh noted that there was no significant difference in cancer detection rate, interval cancer rate, sensitivity or positive predictive value between groups. "This was unexpected, as several studies in the literature have reported increased cancer detection with DBT screening," he said. "It may be partially due to our study design that inevitably reduced our sample size, and to the fact that most of our cancer cases had actually been detected in the diagnostic setting where patients are receiving exams due to symptoms, rather than screening."

Goh

A total of 94 cancers were detected—56 for DM and 38 for DBT—with most invasive and in situ cancers identified in Black women, largely detected through DM screening.

"These patients were disproportionately screened using DM rather than DBT compared to women of other races, a finding that is consistent with prior research and racial disparities in screening mammography," Dr. Goh said.

He emphasized radiologists' role in leading outreach initiatives to improve DBT access and said that radiologists can work with local, government-funded early detection programs and hospital-based patient navigators to implement culturally sensitive educational initiatives.

"Radiologists may also combat access problems by working with breast cancer support groups and developing partnerships with mobile mammography clinics to introduce screening services in underserved neighborhoods," he said. "Ultimately, each imaging center possesses its own unique challenges to improve screening engagement in its local area."

Dr. Goh's research earned an RSNA Trainee Research Prize. Access the presentation, "Impact of Digital Breast Tomosynthesis," (M4-RCP48) on demand at *Meeting.RSNA.org.*

Physics Quiz

American Association of Physicists in Medicine

Q The reconstruction kernel/filter used in CT can alter the HU values of an image?

a. True

b. False

[Answer on page 9.]

Last Call
Nov. 30

New this year, Last Call at the Exhibit Halls gave members the opportunity to enjoy final moments visiting the exhibits floor.

Food and drink were huge hits at Last Call at the Exhibit Halls


Discovery Theater offered a variety informative programs and entertainment to help members relax and unwind.


A diverse line-up of music performances helped members take a break and tap their feet.

2023 RSNA Board of Directors (left to right): Richard E. Heller III, MD; Pari V. Pandharipande, MD, MPH; Sanjeev Bhalla, MD; Jinel A. Scott, MD; President Matthew A. Mauro, MD; Carolyn C. Meltzer, MD; Chair Curtis P. Langlotz, MD, PhD; Secretary-Treasurer Umar Mahmood, MD, PhD; Jeffrey S. Klein, MD; and Adam E. Flanders, MD, FSIIM.

Inside the Residents Lounge, trainees could take advantage of the perfect selfie station to proclaim, "I Am the Future of Radiology."

The 3D mural, featuring depth-perception defying RSNA letters, by artist Nate Baranowski, was a huge draw for a fun reminder of the meeting.

Throughout RSNA 2022, members networked, shared the best tips and tricks to navigate the meeting and met up with friends, new and old.

The RSNA letters in the Grand Concourse are a huge draw for a perfect meeting photo.

When It Comes to Intracranial Hemorrhage Detection, Radiologists May Outperform AI

By Nick Klenske

Intracranial hemorrhage (ICH) is a major cause of mortality and morbidity, resulting from variable underlying causes such as hypertension, trauma, ruptured aneurysms, malignancy and coagulation disorders.

"The accurate and timely detection of ICH are critical factors for patient survival and appropriate management," said Cody Savage, BS, a 4th year medical student at the University of Alabama at Birmingham (UAB) School of Medicine.

The current standard for detecting ICH is non-contrast head CT followed by interpretation by a radiologist – a process that can be supported by AI. In fact, AI solutions for computer-aided detection and triage (CADt) of ICH identified on non-contrast head CT have U.S. Food and Drug Administration (FDA) clearance and are already being used at multiple medical centers.

But just how effective is this technology at improving detection and interpretation?

That is the question Savage decided to ask.

"The accurate and timely detection of ICH are critical factors for patient survival and appropriate management."

Cody Savage

Human vs AI

According to Savage, data showing that AI supported CADt increases diagnostic accuracy and/or reduces report turn-around-time (TAT) have mostly been obtained from retrospective single institutional studies.

"The problem is that retrospective studies are prone to bias and assumptions that may not hold true in a real-world clinical practice environment," Savage explained.

To address these shortcomings, a recent UAB study evaluated a CADt system's actual effectiveness for detecting ICH in non-contrast head CT in a clinical practice setting. The large single-center prospective study evaluated accuracy, miss rate and report TAT for radiologists working with and without a CADt system in a real-world setting.

"What we found was that AI assistance did not improve the accuracy, miss rate or report TAT of radiologists," Savage said.

Savage went on to note that the ability of the CADt system to improve report TAT in the clinical practice setting likely depends on the deployment method.

Furthermore, while AI assistance was shown to decrease the miss rate in the outpatient and ED settings and mildly improve the accuracy in the outpatient setting, this was not the case for the inpatient setting where the prevalence of ICH, post-surgical cases and repeat imaging are higher.

Savage

"In my opinion, the benefits of AI for detection and triage of ICH are probably overstated," Savage said.

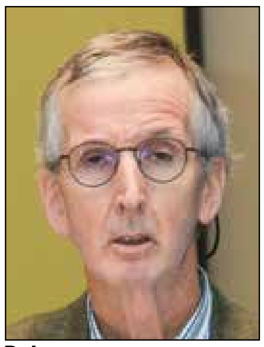
A High Degree of Skepticism Needed

Because these results conflict with those of prior retrospective studies, the results from those studies need to be interpreted with a high degree of skepticism.

"Radiology groups interested in using a CADt system should carefully consider their clinical practice setting, expectations for improvement and deployment method," Savage concluded. "AI vendors should also review the results of our study and work to improve the human-to-AI interface accordingly."

Access the presentation, "Prospective Real-World Comparison of Standard of Care vs. AI for Detection and Triage of Intracranial Hemorrhage on Non-contrast Head CT," (W6-SSNR12-2) on demand at *Meeting.RSNA.org*.

Imaging Used to Scan Artwork and Antiquities To Ensure Authenticity


Daly


Yaghmai


Brown

By Mary Henderson

The ability to non-invasively investigate ancient treasures is an unconventional but highly useful application of modern imaging technology.

Wednesday afternoon, a panel of experts detailed how CT is helping the art world prove the provenance of religious statues, diagnose needed repairs for fragile art objects and uncover forgeries.

"Fakes, forgery and art theft has been a major problem throughout recorded history," said Barry Daly, MD, professor of radiology at the University of Maryland and consultant to the Walters Museum in Baltimore.

Dr. Daly shared the story of a Dutch art collector who had paid millions for a Chinese Buddha statue dating to the 11th century AD, only to have a CT scan of the statue reveal a mummified monk inside. The discovery ultimately helped prove that the statue had been stolen from a temple in rural China in 1995, which was a disaster for the private owner.

"While private art collectors may shy away from scanning their art collection, museums are more open to discovering whether they have a true work of art or an incredibly convincing forgery," Dr. Daly said. "Museum pieces may be more interesting as a result because fame and infamy are both crowd pleasers."

Dr. Daly also performed a CT scan on a medieval reliquary, which revealed the tree ring pattern in the wood. To the relief of the museum conservator, the ancient sarcophagus wasn't a 19th century knock-off—it dated to 1218 AD.

Many Professionals Needed During Scans

CT imaging provides documentation—or a fingerprint—of precious artifacts that reveal how an item was constructed, altered or restored. Fingerprinting is also used to establish provenance to combat theft and forgeries.

"A lot of logistics and planning goes into fingerprinting a precious object," said Vahid Yaghmai, MD, professor of radiology at the University of California, Irvine "One day a $20 million dollar violin is in Carnegie Hall, the next day, it's in a CT scanner in Chicago."

Considerations include security, calibrating the scanner and being ready to go once the item arrives. A team of experts including the radiologist, conservator, technologist and legal and PR people is also necessary.

Imaging a precious artifact—such as a cello—with the thinnest CT slices and highest kernel values possible can provide details of the interior, including wormholes in the wood, cleats added during restoration and the density of the wood.

Perspective From A Conservator

"I'm often asked by my colleagues why we use medical CT to examine museum specimens," said Jonathan Brown, MS, Regenstein Senior Conservator at The Field Museum of Chicago. "And since it's fast, dimensionally accurate and non-destructive, a much better question would be, why wouldn't we use medical CT all the time."

When it's feasible to do so, Brown uses CT to see inside complex objects for diagnosis and treatment, to understand previous restorations and maybe to spot the occasional fake.

Brown challenged the audience to spot the fake among a series of images of ancient Egyptian cat mummies. Of the three images, two cat mummies proved to be fake—one contained stuffing and a second was filled with bones of an unknown animal.

"The medical community in Chicago has been incredibly generous with their time and facilities and we've found out a lot working together," Brown said. "Get involved. If someone wants something scanned, answer the phone, say yes. You'll have a great time and you'll get to work on some really interesting problems."

Metabolic Shift Toward Lactic Acid Production May Help Identify Pancreatic Cancer in Premalignant and Early Stages

By Jennie McKee

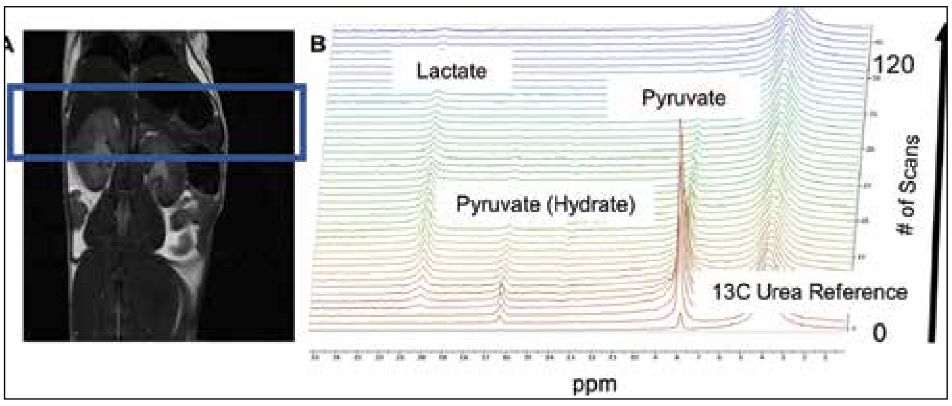
Research presented Wednesday suggests that hyperpolarized [1-^{13}C]pyruvate MRI can be used to detect pancreatic cancer in its premalignant and early stages by measuring the dynamic altered metabolism of pyruvate to lactate.

"We chose to study this topic because of the large mortality and late presentation of pancreatic cancer," said Grace Murley (formerly Grace Isakson), BA, BS, a graduate research assistant at UTHealth Houston Graduate School of Biomedical Sciences/ MD Anderson Cancer Center in Houston.

"There is only an 11% 5-year survival rate of patients diagnosed with pancreatic cancer," she continued. "This is in part due to the aggressiveness of the cancer and its asymptomatic nature until late-stage disease. My advisor, Pratip Bhattacharya, PhD, has been working on hyperpolarized MRI for use in metabolic imaging for many years, and came up with the idea of looking for a metabolic shift in pre-malignant pancreatic lesions."

Rather than only monitoring tumor growth, the researchers combined anatomical and metabolic MR imaging with the goal of detecting pancreatic cancer early. They genetically engineered three mouse models to develop pre-invasive pancreatic intraepithelial neoplasia (PanIn) precursor lesions (KC), invasive pancreatic cancer (KPC) and no lesion (control), respectively. They also engineered a fourth model to develop intraepithelial papillary mucinous neoplasia (IPMN) lesions as a result of doxycycline induction.

The investigators performed dynamic nuclear polarization on [1-^{13}C]pyruvate at 3T for hyperpolarization to enhance the signal. They then acquired the expected pyruvate ^{13}C MR spectra over the area of interest with a 7T Bruker MRI scanner.



A representative image from a PanIN mouse model with corresponding hyperpolarized pyruvate spectra. A) Anatomical images obtained on MRI via T2_RARE sequence, 17 slices, 10 mm/slice with coronal slicing of a PanIN mouse. The blue square indicates the area used for metabolic imaging and was selected to incorporate the pancreas. ***Image courtesy of Grace Murley, BA, BS.***

Murley and colleagues acquired images for the PanIN models when the mice were ages 14, 21 and 28 weeks. In addition, they took images at seven weeks for the IPMN mouse models that received doxycycline (Dox+) and those that did not receive doxycycline (Dox-).


Murley

Results Point to Opportunities for Improved Patient Care

In KC models, the lactate-to-pyruvate ratio increased in comparison to the control model during progression from low-grade PanIN to high-grade PanIN. The researchers also found a significant increase in the lactate-to-pyruvate ratio (0.35) for the first time point (0.27) in the KPC mouse model.

In addition, there was a significant increase in the second time point lactate-to-pyruvate ratio for the KPC model compared to KC (0.26) as well as control mice (0.15). Finally, there was a statistically significant difference in the lactate to pyruvate ratio between Dox+ mice and Dox- mice (p=0.007) as demonstrated by the IPMN model.

Based on these findings, Murley concluded that the transformation from normal pancreatic tissue to premalignant pancreatic lesions can be detected by observing the metabolic shift toward lactic acid production.

"We were able to see the shift before the presence of visible lesions in the pancreatic intraepithelial neoplasia model," she said. "This is very promising, given that diagnosing pancreatic cancer before the presence of symptoms is so challenging."

The results indicate that it may be possible to detect neoplasia even before the development of malignancy, which could lead to noninvasive early detection of pancreatic premalignant lesions in patients, Murley said.

"We are excited to start clinical trials with a high-risk pancreatic cancer clinic at MD Anderson," she added.

Murley acknowledged the contributions of her fellow researchers, including Jose Enriquez, MD; Prasanta Dutta, PhD; Florencia McAllister, MD; and Pratip Bhattacharya, MD.

Access the presentation, "Real-Time Metabolic Imaging Biomarkers for Detection of Pancreatic Premalignant Lesions," (WSA-STCE-3) on demand at *Meeting.RSNA.org.*

Physics Quiz

American Association of Physicists in Medicine

A

[Question on Page 5.]

a. There is always a tradeoff between noise and spatial resolution when choosing a reconstruction kernel. In addition, some kernels have additional processing that can alter HU values – typically increasing HU for bone and other bright structures to accentuate their contrast

Education Exhibit Highlights Role of 3D Printing in Complex Surgery

By Lynn Antonopoulos

The use of 3D printing as part of complex spine surgery not only helps surgeons visualize target pathology, but it can also provide valuable assistance in surgical planning and rehearsal.

With technologies becoming more affordable and accessible, advancements in 3D printing are revolutionizing clinical care. Imaging is a key factor in the development of 3D models, which can help surgeons reduce time and costs and improve outcomes for the most challenging surgeries.

"Integration of the information provided by multimodality imaging exams necessary for surgical planning can be a difficult task," said presenter Lumarie Santiago, MD, professor of radiology at the University of Texas MD Anderson Cancer Center in Houston. "This is particularly true in cases where multiple surgical specialties are working in concert."

In her case-based education exhibit, Dr. Santiago covered practical considerations for the use of 3D printing in preparation for complex spine surgeries.

Dr. Santiago described the 3D printing workflow and shared details about quality assurance as part of the planning process. She noted that the 3D printing workflow begins with determining the optimal imaging exam and sequence for performing tumor segmentation. "High-quality imaging is the basis for segmentation which includes anatomy of interest, pathology and structures that may affect the surgical approach," she said. "Imaging is our truth."

Dr. Santiago described the processes of registration and using fusion to capture the most useful information from the imaging.

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> **Lumarie Santiago, MD**

Santiago

When segmentation is complete, it's accuracy is verified and the resulting 3D rendering is reviewed by the surgeon. Dr. Santiago's exhibit detailed the processes for working closely with the surgeon to prescribe surgical planes, and for integrating them into the 3D model. "After exporting the 3D model into the printer software and printing it, the accuracy of the print is verified by measuring target anatomy in three dimensions and comparing it to its imaging correlate," Dr. Santiago said.

After thorough preparation, throughout rehearsal and intraoperatively, the 3D printed model aids communication of the surgical approach to members of the multidisciplinary team.

Access and Visualization Influence Material Selection

Material selection is a critical part of the 3D printing process with material strength and flexibility and the planned surgical approach included among important factors for consideration.

"The approach for a particular case may require displacement of anatomy to allow access for surgical instruments or protect it from injury," Dr. Santiago said. "Selection of materials with similar properties to the anatomy involved in the case allows surgeons the opportunity to practice these maneuvers and test fit instruments and other devices prior to surgery."

Dr. Santiago said materials that highlight pathology and resemble tissue properties influence material selection for personalized 3D models. In addition, use of removable parts allows for visualization and manipulation of the anatomy each specialty will manage. Examples included using clear materials to allow for disease visualization in small or difficult to access areas like the epidural space.

The 3D printing team at Dr. Santiago's institution includes a biomedical engineer, radiologists and surgeons who all play important roles in the process that begins with imaging.

"Radiologists contribute their expertise in imaging protocol optimization, imaging interpretation and segmentation verification, among others," Dr. Santiago said. "3D printed models bridge the gaps in communication between multidisciplinary teams and the patients they treat."

Access the education exhibit, "3D Printing and Digital Surgical Rehearsal in Complex Spine Surgery," (INEE-8) on demand at *Meeting.RSNA.org*.

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AI Central to Radiation Oncology Clinical Trials,Practice

Electronic medical records (EMR) provide a potentially rich vein of data that machine learning can mine for improved clinical decision-making, according to Michael Gensheimer, MD, clinical associate professor in radiation oncology at Stanford Medicine.

Recent research highlights the possibilities. Dr. Gensheimer shared results of a study that showed that an EMR-based algorithm did better than Stanford doctors in predicting short-term survival for patients with metastatic cancer.

Limitations Remain Barrier to AI

Data quality continues to be a key limitation. EMR records often fail to capture the date of a patient's death, meaning that studies using them could overestimate survival time. Documentation errors from patient-physician encounters are also plagued with errors—a problem that could be ameliorated with natural language processing that automatically extracts structured information from clinical notes.

Datasets also lack the necessary diversity to serve all patients. "We need to do better collecting data from underserved patient populations," Dr. Le added.

And then there is the issue of dataset sizes, something that can only be addressed through collaboration.

"There is a ton of medical data out there, but generally single institutions don't have that much," Dr. Gensheimer said. "We need to work on collaborating so that we can start to make our models better understand our patients' trajectories."

As a pathologist, Felix Y. Feng, MD, professor at the University of California in San Francisco, discussed using pathology-based deep learning (DL) tools to personalize treatment decisions, with a focus on prostate cancer.

Prognostic indicators are important to prostate cancer patients because treatment is based on the aggressiveness of the disease. A multi-modal AI tool developed using clinical data from more than 5,600 patients and more than 16,000 digital pathology slides has shown promise in this area, Dr. Feng said.

"I think the main take-home message here is that this AI prognostic tool outperforms standard risk stratifications approaches," he said.

The AI model also proved to be effective at predicting who will respond to androgen suppression therapy, a treatment for prostate cancer that carries side effects like impotence and osteoporosis.

Radiologic features of the tumor provide a rich source of information for AI-derived algorithms, said Ruijiang Li, PhD, associate professor of radiation oncology at Stanford Medicine.

Along with the commonly used metric of tumor size, AI algorithms use morphologic complexity and spatial variations between different regions of the tumor to risk-stratify patients.

A tumor's microenvironment plays a critical role in cancer progression and treatment response. Dr. Li suggested that a deep-learning algorithm could be trained to predict the status of this microenvironment through a CT signature of stroma cells, for instance.

"I think the future will be one in which we combine these different data sources and disciplines together in a multimodal framework that can really maximize our precision for predicting outcomes and guiding treatment decisions," Dr. Li said.


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