INTERNET NEWS

BS. Nguyễn Văn Công

CLINICAL NEWS | INTERVENTIONAL

Stenting shows little benefit over medical therapy for reducing stroke

Will Morton

Jul 1, 2025

- Stent placement does not appear to reduce the risk of recurrent strokes compared with medical therapy in patients with narrowing of arteries in the brain, according to a study published July 1 in *Radiology*.
- The finding is from a prospective trial in China in patients with intracranial atherosclerotic stenosis (ICAS) and supports similar findings from earlier trials, noted lead author Bonaventure Ip, MD, of The Prince of Wales Hospital in Hong Kong, and colleagues.
- "The results of our study support the current recommendations of medical therapy over stenting for secondary stroke prevention in patients with symptomatic ICAS," the group wrote.
- ICAS is caused by the build-up of plaque in the arteries due to atherosclerosis and is a major cause of ischemic stroke with a risk of recurrence. Endovascular revascularization therapy (stenting) has been hypothesized as a treatment, yet previous trials have shown little benefit of the procedure over medical therapy, the authors noted.
- However, previous trials included patients with concurrent branch atheromatous disease adjacent to the stent target, with these patients being at higher risk of complications during the procedure, they added. In this study, to further evaluate the use of stenting in ICAS, the researchers first excluded patients with branch atheromatous disease using three-dimensional rotational angiography.
- The study included 150 participants (mean age, 61 years old, 45 women) with transient ischemic attack or ischemic stroke attributed to severe ICAS who were randomized into stenting (n = 74) and medical therapy (n = 76) groups. The primary end point was a composite of transient ischemic stroke, ischemic stroke, intracranial hemorrhage, and death within 30 days or any ischemic stroke from 30 days to one year.

- According to the results, stenting did not result in a reduction in ischemic stroke cumulative incidence compared with medical therapy with antiplatelet drugs at one year (stenting versus medical therapy: 12 of 74 [16%] vs. 18 of 76 [24%], p = 0.26). Stenting also did not reduce the cumulative incidence of ischemic stroke compared with medical therapy over a 10-year follow-up period, the researchers reported.
- “Intracranial stenting did not result in a reduction in the cumulative incidence of stroke or death at 30 days or stroke from 30 days to one year,” the group wrote.
- To date, despite considerable efforts to introduce endovascular revascularization therapy for severe ICAS, no randomized control trial has shown its benefits over intensive medical therapy, the authors noted. Ultimately, further studies with larger sample sizes are needed to substantiate the findings, the researchers concluded.
- In an accompanying editorial, Joan Wojak, MD, of Louisiana State University School of Medicine in New Orleans, noted that primary stent placement has become a focus due to its historical success compared with angioplasty alone in patients with coronary artery disease. The long struggle to develop effective endovascular therapy (thrombectomy, for instance) in patients with coronary artery disease ultimately resulted in disruptive evolution and the widespread acceptance of the therapy, she wrote.
- “Establishing a role for endovascular therapy in the treatment of symptomatic intracranial atherosclerotic stenosis has proved to be even more elusive,” Wojak concluded.

CLINICAL NEWS | MRI

Cardiac MRI shows heart damage caused by air pollution

Kate Madden Yee
Jul 1, 2025

Cardiac MRI shows the effects of air pollution on the heart -- and the findings aren't good, according to a study published July 1 in *Radiology*.

The research adds to growing evidence that air pollution is a cardiovascular risk factor, contributing to residual risk not accounted for by typical clinical predictors such as smoking or hypertension, the RSNA noted in a statement.

"Even modest increases in air pollution levels appear to have measurable effects on the heart," said senior author Kate Hanneman, MD, of the University of Toronto in Canada. "Our study suggests that air quality may play a significant role in changes to heart structure, potentially setting the stage for future cardiovascular disease."

Heart disease is the main cause of death around the world, the investigators noted. Although prior work has indicated that poor air quality contributes to cardiovascular disease, changes in the heart resulting from exposure to air pollution have remained unclear, they explained, observing that fine particulate matter in the air may contribute to diffuse myocardial fibrosis, a form of scarring in the heart muscle that can precede heart failure. ("Fine particulate matter" can include vehicle exhaust, industrial emissions and wildfire smoke, and particles are small enough to enter the bloodstream through the lungs.)

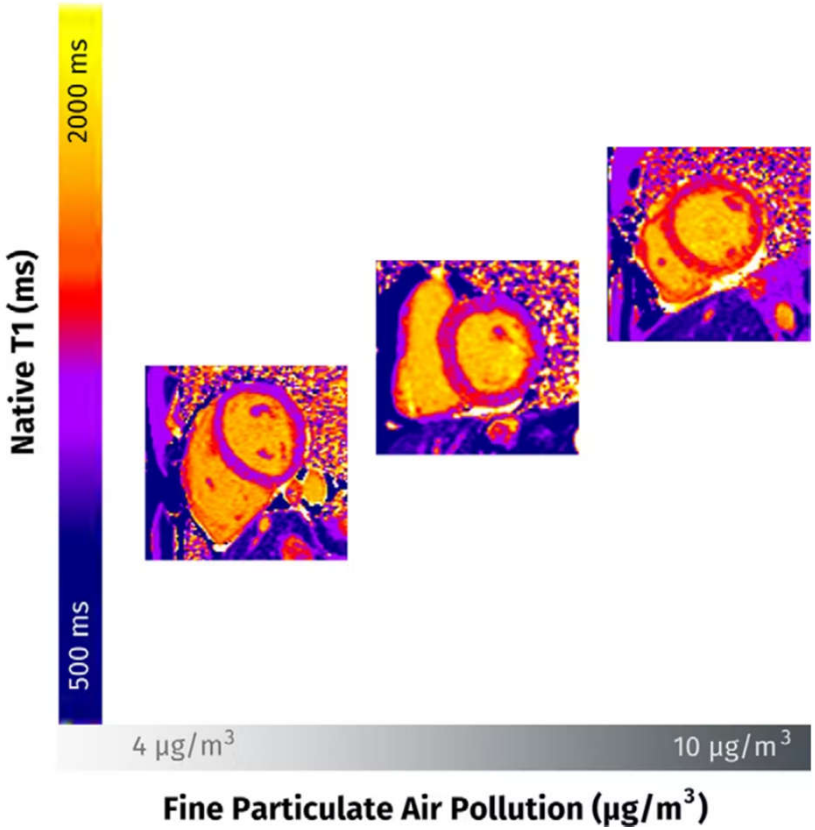
With Hanneman, a team led by Jacques Du Plessis, MD, also of the University of Toronto, explored the relationship between long-term exposure to fine particulate matter with 2.5-µm or smaller aerodynamic diameter (PM2.5) and the extent of diffuse myocardial fibrosis quantified with cardiac MRI native T1 mapping z scores (used to assess myocardial tissue characteristics; score expressed as zero, positive, and negative, with positive scores indicating potential abnormality).

The study included a total of 694 patients who underwent cardiac MRI between January 2018 and December 2022. Of these, 493 had dilated cardiomyopathy and 201 had normal findings. Du Plessis' team quantified diffuse myocardial fibrosis and assessed patients' residence-specific ambient PM2.5 concentration (the mean of daily exposure concentration in the year before cardiac MR imaging using measurements from the nearest air quality monitoring station).

- The group reported the following:
- In multivariable models, each 1-µg/m3 increase in one-year mean PM2.5 exposure was associated with a 0.3 higher native T1 z score in patients with dilated cardiomyopathy ($p < 0.001$) and 0.27 higher native T1 z score in controls ($p = 0.02$).

- For absolute values, each 1-µg/m3 increase in one-year mean PM2.5 exposure was associated with 9.1 msec higher native T1 at 1.5-tesla imaging ($p = 0.01$) and 12.1 msec higher native T1 at 3-tesla imaging ($p < 0.001$). (An elevated native T1 typically indicates abnormal changes in the myocardial tissue composition.)

- The largest effect sizes for the association of PM2.5 exposure with native T1 z scores were in women ($p < 0.001$), smokers ($p = 0.04$), and patients with hypertension ($p = 0.004$).



Images from cardiac MRI native T1 mapping show that higher long-term exposure to fine particulate air pollution is associated with higher extent of myocardial fibrosis. Images and caption courtesy of the RSNA.

- Overall, higher long-term exposure to fine particulate air pollution was connected to higher levels of myocardial fibrosis in both the patients with cardiomyopathy and the controls, suggesting that "myocardial fibrosis may be an underlying mechanism by which air pollution leads to cardiovascular complications," the authors wrote.
- How can clinicians gauge a patient's cardiac health in relation to poor air quality? Neighborhood data can help, according to Hanneman.
- "A simple way to estimate someone's exposure to air pollution is by looking at air quality data for the neighborhood they live in -- information that is publicly available in many areas," she told *AuntMinnie*. "Some health providers may ask about environmental exposures during routine visits. For people who want a more detailed assessment, portable air monitors are available that provide real-time air quality data."
- In any case, the effects of air pollution on lung health can be mitigated both on individual and societal levels, Hanneman noted.
- "On a personal level, people can take steps like limiting outdoor activity on days when air quality is poor and using indoor air purifiers to reduce exposure," she said. "On a broader scale, public health efforts include improving air quality standards, reducing emissions from traffic and industry, and addressing sources such as wildfire smoke to improve air quality for everyone."
- In an accompanying commentary, Davis Vigneault, MD, DPhil, of Stanford University emphasized the role radiology can play in tackling the problem of air pollution exposure and heart disease risk.
- "The study … suggests several interesting avenues for future research, including the investigation of particulate pollution components, related co-pollutants, and at-risk subgroups," he noted. "Moreover, [the] work sets an important example of how imaging research may be used beyond the diagnosis of an individual patient to guide public policy interventions to improve health outcomes more broadly."

CLINICAL NEWS | CT

CT, MRI reveal hidden brain changes linked to increased fall risk

Kate Madden Yee
Jun 27, 2025

- CT and MR neuroimaging reveal covert brain infarcts and white-matter hyperintensity (WMH) changes that appear to be associated with increased fall risk, researchers have reported.
- The two imaging findings can be indications of hidden cerebrovascular disease, which has been linked to future stroke, dementia, and higher mortality rates, wrote a team led by Úna Clancy, PhD, of the University of Edinburgh in the U.K. The findings were published June 27 in *Stroke*.
- "Since [cerebrovascular disease] is highly prevalent, especially in advancing age, it is important to identify the full spectrum of clinical presentations and outcomes associated with [it]," the group explained. "This will allow us to clinically identify as many affected patients as possible, institute management strategies, communicate prognosis, plan healthcare delivery, and aid recruitment to treatment trials."
- Covert brain infarcts and white-matter hyperintensities are often found incidentally on brain imaging in patients who haven't manifested typical stroke symptoms, and in addition to suggesting the presence of cerebrovascular disease, they can also indicate cerebral small vessel disease -- which has in turn been associated with neurophychiatric, cognitive, and gait symptoms (which may include falling) that don't necessarily fit the definition of stroke or dementia.
- As the impact of covert brain infarcts and white-matter hyperintensities on fall risk in the general population isn't clear, Clancy and colleagues conducted a study that investigated the time to a first fall following incidentally detected covert brain infarcts and white-matter hyperintensities. Their research assessed CT and MR imaging results from 241,050 patients over the age of 50 registered with Kaiser Permanente Southern California. The team used natural language processing to cull evidence of covert brain infarcts and white-matter hyperintensities from imaging reports and tracked any associations between the two findings with falls requiring medical attention.

- Overall, the investigators found covert brain infarcts in 31.1% of the study cohort over a follow-up of three years; 21.2% of patients had recorded falls during that timeframe. They also reported the following:

Single fall incidence rate per 1,000 person-years on CT and MR imaging		
Finding	CT	MRI
Covert brain infarcts and white-matter hyperintensities	129.3 falls per 1,000 person-years	109.9 falls per 1,000 person-years
White-matter hyperintensities	109.9 falls per 1,000 person-years	71.4 falls per 1,000 person-years

The group noted that the adjusted hazard ratio (with one as reference) for a single index fall in individuals with covert brain infarcts was 1.13 on CT and 1.17 on MRI, and that patients' risk of fall increased when both covert brain infarcts and white-matter hyperintensities were identified on CT or MR imaging:

•The adjusted hazard ratio for a single index fall in individuals with covert brain infarcts on CT was 1.13 and 1.17 on MRI.

•On CT, the risk of a single index fall increased by white-matter hyperintensity severity, with an adjusted hazard ratio of 1.37 for mild white-matter hyperintensities and 1.57 for both moderate and severe.

•On MRI, index fall risk also increased with increasing white-matter hyperintensity severity, with an adjusted hazard ratio of 1.11 for mild, 1.21 for moderate, and 1.34 for severe.

- "The presence of both [covert brain infarcts] and [white-matter hyperintensities] carries more than double the incidence rate of a single index fall versus no [covert brain infarcts/white-matter hyperintensities]," the team wrote.
- The study findings could help not only to reduce healthcare costs but also to offer better care to aging patients, according to the authors.
- "Falls are a major contributor to emergency unscheduled healthcare, and [cerebrovascular disease] is highly prevalent among older people on clinical neuroimaging," they concluded. "Our results show that the two are closely linked: when [covert brain infarcts] and [white-matter hyperintensities] are detected, this confers additional prognostic risk for future falls … Adding this knowledge to the clinical implications of [cerebrovascular disease] means that integrated care systems can better prognosticate and plan care for the high proportions of older adults who attend health services."

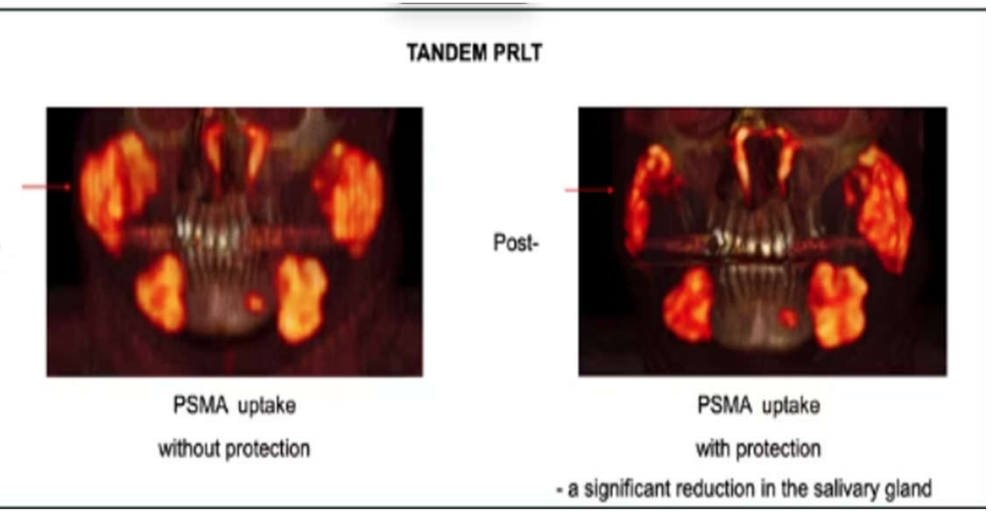
CLINICAL NEWS | MOLECULAR IMAGING

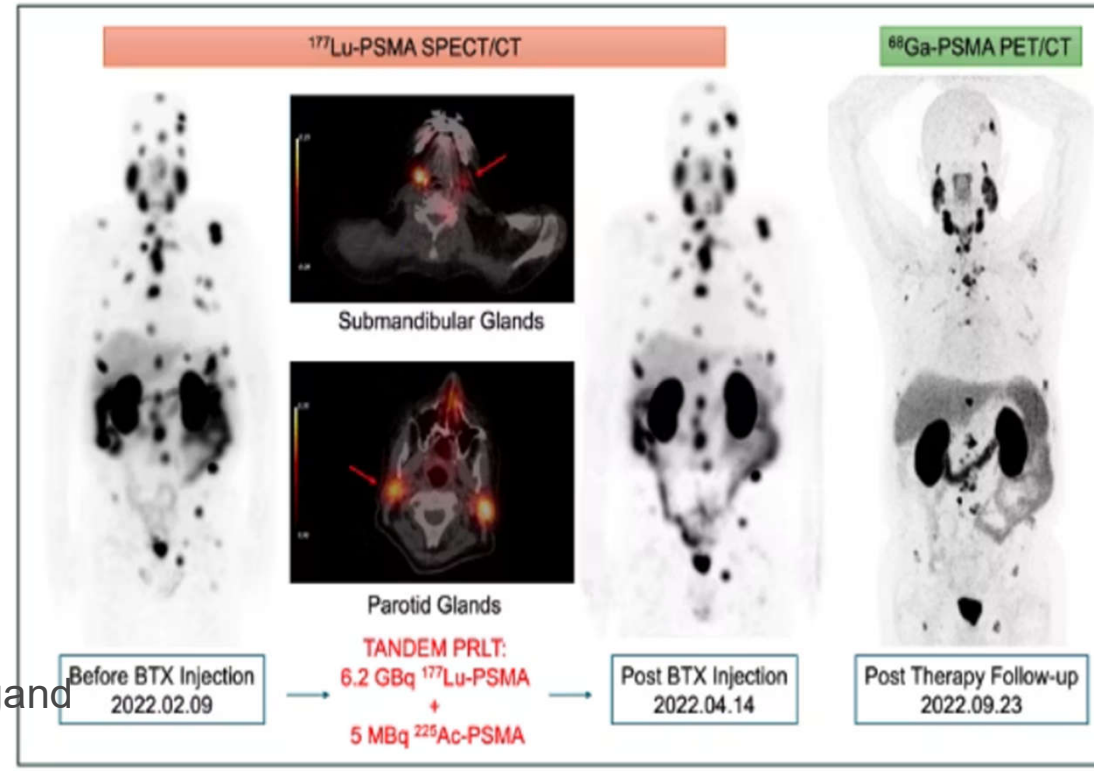
SNMMI: Botox may prevent debilitating dry mouth for some mCRPC patients

Liz Carey
Jun 24, 2025

- Botox injections combined with an anti-nausea patch may help advanced metastatic castration-resistant prostate cancer (mCRPC) patients avoid severe dry mouth and continue their radioligand therapy, suggested early research presented June 24 at the 2025 Society of Nuclear Medicine and Molecular Imaging (SNMMI) annual meeting.
- Salivary gland toxicity is a known side effect of some prostate-specific membrane antigen (PSMA)-targeted radioligand therapy (RLT) -- especially alpha-emitting actinium-225 (Ac-225) -- that can lead to debilitating dry mouth syndrome, or xerostomia, according to a group led by Jingjing Zhang, MD, PhD, of the Theranostics Centre of Excellence in the Yong Loo Lin School of Medicine at the National University of Singapore.
- However, the combination of botulinum toxin (BTX) Type A (IncoA) and the nausea patch (scopolamine) may offer a dual-protective approach and both, having established safety profiles, could be immediately applied in experienced centers offering PSMA radioligand therapy, Zhang and colleagues wrote.
- To explore the impact of the dual approach, the group conducted a preclinical, early-stage radiopharmaceutical oncology study that included 14 patients undergoing one to two cycles of tandem PSMA-targeted radioligand therapy, lutetium-177 (Lu-177) at 5.05 ± 1.09 GBq and Ac-225 at 6.87 ± 3.14 MBq per cycle.
- Each patient received 16 BTX treatments consisting of 115 to 250 units of ultrasound-guided BTX IncoA injections in their parotid glands, and between 70 to 80 units in their submandibular glands on opposite sides of the body, three to four weeks prior to their combined Ac-225 and Lu-177 PSMA therapy. Four patients were treated with BTX alone, while the others received a combination of BTX plus the scopolamine patch.

- Three days before treatment, the nausea patches were applied behind the ears, where they remained until two hours after the treatment.
- The patients also underwent pre-therapy PSMA PET/CT to confirm tumor and salivary gland uptake and SPECT/CT post-therapy for restaging, according to the team.
- The researchers found that BTX-treated parotid glands showed a mean 30% reduction (range 19% to 47%) in PSMA uptake ($p < 0.001$) compared to the opposite parotid gland. They also reported a mean 17% reduction (range 10-51%) in PSMA uptake in injected submandibular glands ($p = 0.004$) compared to the opposite submandibular glands.
- Post-injection SPECT/CT images revealed a marked reduction in PSMA radioligand uptake in the BTX-treated glands, with parotid gland uptake ratio shifting from 0.93 to 1.15 and submandibular gland ratio from 1.39 to 2.14, confirming targeted protection, the investigators noted.





In a patient, pretreatment PET/CT demonstrated comparable tracer uptake. Postinjection SPECT/CT images revealed a marked reduction in PSMA radioligand uptake.

- Patients who received BTX without scopolamine showed no significant difference in the uptake between injected and noninjected salivary glands, they reported, adding that injections generally were well tolerated and, importantly, no patient discontinued combination PSMA therapy due to dry mouth.
- One injection-related local hematoma occurred in a patient with thrombocytopenia, the team reported. Also, scopolamine-induced moderate dry mouth occurred but lasted 72 hours.
- “This study offers a promising therapeutic strategy for reducing radiation-induced salivary gland toxicity without compromising PSMA tumor uptake,” Zhang said. “The significance of this work lies in its direct patient benefit and its potential to expand the therapeutic utility of PSMA radiopharmaceutical therapy, particularly with alpha-emitting radionuclides like 225Ac.”
- The investigators concluded that the combined approach may enhance patient quality of life following PSMA radioligand therapy, particularly with alpha-emitting radionuclides, although further studies with larger patient cohorts and longer follow-up periods are warranted.

CLINICAL NEWS | WOMENS IMAGING | BREAST

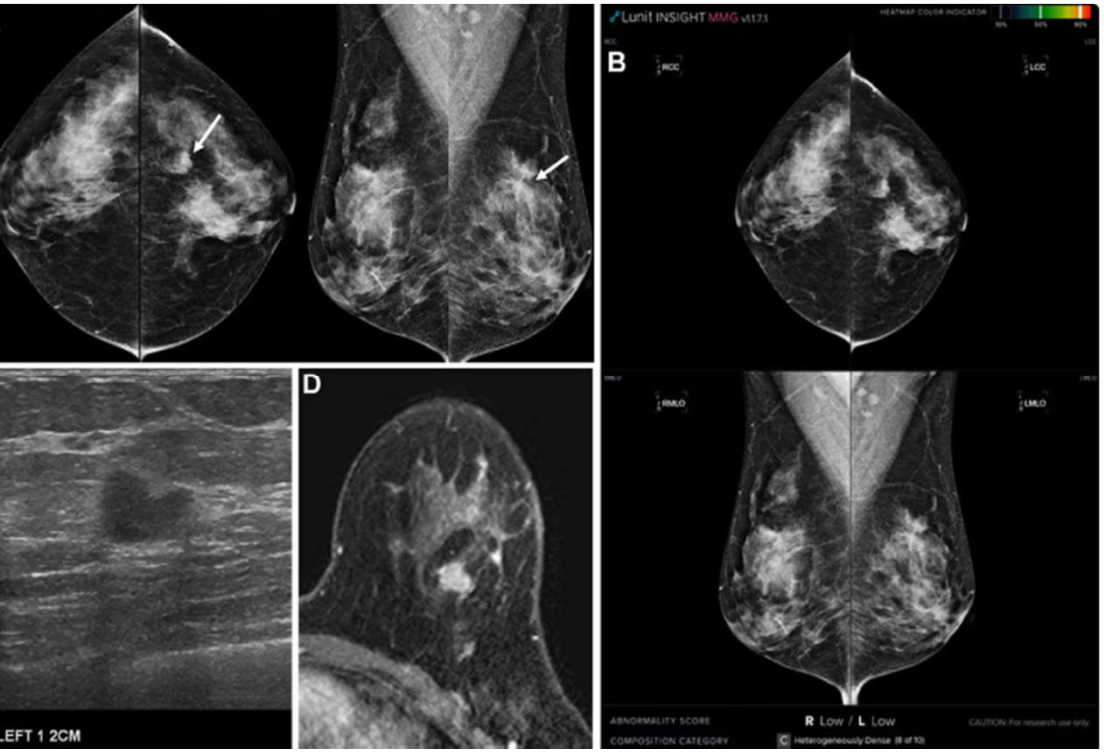
Particular breast cancer features contribute to AI-mammography misses

- Particular breast cancer characteristics contribute to AI-mammography misses -- and radiologists should keep them in mind when using the technology with mammography, according to a study published June 24 in *Radiology*.
- These characteristics include luminal cancers, dense breast tissue, nonmammary zone locations, architectural distortions, and amorphous calcifications, wrote a team led by Ok Hee Woo, MD, of Korea University Guro Hospital in Seoul.
- "Although AI is useful for detecting advanced-stage invasive cancers, it is inadequate for identifying cancers with some of the features revealed in this study," the group noted. "Understanding the features of AI-missed invasive cancers on mammograms can help readers use AI appropriately in clinical practice, thus contributing to its further optimization."
- AI has come to be regarded as a promising tool for helping read mammograms, but it can still miss breast cancers, Woo and colleagues wrote. Few studies have evaluated AI-read mammography's false-negative rate in invasive cancers, and the "clinicopathologic and radiologic features of AI-missed invasive cancers and reasons for missing cancers remain underexplored."
- The group investigated the false-negative rate of AI mammograms by molecular subtype (hormone receptor–positive [luminal] vs. human epidermal growth factor receptor 2 [HER2]-enriched vs. triple-negative) and tracked the features of and reasons for these missed cancers. The team's study included 1,082 women diagnosed with 1,097 cancers between January 2014 and December 2020.

- A commercial AI software was used to read the mammograms (Lunit Insight MMG). AI-missed cancers were defined as "those for which AI did not identify a precise location matching the reference standard." Three radiologists, blinded to whether breast cancer had been missed by AI-mammography, classified any cancers as either "actionable" or "under threshold"; readers aware of AI-missed cancers determined reasons for the misses in a further review.
- AI missed 154 of 1,097 cancers (14%). These missed cancers had the following characteristics:
- They were found in younger women.
- Tumor size was less than or equal to 2 cm.
- They had a lower histologic grade and fewer lymph node metastases.
- More of them were categorized as BI-RADS 4.
- The cancers had lower Ki-67 expression and fewer nonmammary zone locations.
- Of the AI-missed cancers, 61.7% were actionable, the researchers found. Further reasons for the misses included dense breast tissue (n = 56), nonmammary zone locations (n = 22), architectural distortions (n = 12), and amorphous microcalcifications (n = 5).

- Regarding the false-negative rate, the team also reported the following:

AI mammography's false-negative rate by breast cancer subtype*	
Type of breast cancer	False-positive rate
HER2-enriched	9%
Luminal	17.2%
Triple-negative	14.5%



Images in a 42-year-old asymptomatic woman. (A) Digital mammograms show an irregular spiculated mass in the left upper outer quadrant (arrows). (B) Artificial intelligence (AI) software did not mark this lesion due to a low abnormality score. (C) Ultrasound and (D) breast MRI scans revealed a 1.1-cm irregular mass in the left upper outer breast at the 1-o'clock position. Breast-conserving surgery was performed; the lesion was confirmed as a 1.1-cm invasive ductal carcinoma (luminal subtype, histologic grade 3) without axillary lymph node metastasis. The lesion was classified as actionable; three radiologists categorized it as suspicious. The reason for the AI miss was that the lesion was obscured by overlying dense breast tissue. CC = craniocaudal, MLO = mediolateral. Images and caption courtesy of the RSNA.

- In an accompanying editorial, Lisa Mullen, MD, of Johns Hopkins University School of Medicine in Baltimore, urged radiologists using AI with mammography to "pay close attention to dense breasts and nonmammary zone areas, as well as search carefully for architectural distortion, microcalcifications, and small lesions."
- "When using AI, it is critical for radiologists to understand what could be potentially missed by the software so that [they] can use the information to decrease the chance of missed cancers," she concluded.

Visualizing functional diseases that were difficult to determine with conventional CT, and contributing to extending healthy lifespans

A CT system for scanning standing patients

A CT scanner uses X-rays to obtain cross-sectional images of the body, enabling visualization of lesions just a few millimeters in size within the body. Until now, examinations were generally performed with the patient lying on a couch, making it difficult to diagnose diseases that cause pain while standing, such as knee osteoarthritis or disc herniation. A new CT scanner that allows examinations of standing and seated patients is attracting interest.

Upright CT for early detection of decline in physical function in a super-aged society

Keio University Hospital is a designated Special Functioning Hospital that provides advanced medical care, develops and evaluates advanced medical technologies, and treats over one million patients per year. One of Japan's leading medical institutions, the hospital is also certified as a clinical research core hospital* that promotes clinical research and trials necessary for the development of innovative pharmaceuticals and medical devices originating in Japan.

Keio University Hospital is conducting clinical research in a variety of fields, including industry-academia collaboration, and one of these research themes is an upright CT scanner jointly developed by Professor Masahiro Jinzaki of the Department of Radiology, Keio University School of Medicine, and Canon Medical Systems.

The first clinical system was introduced at Keio University Hospital in 2017, with ongoing studies on its clinical usefulness. We spoke to Professor Jinzaki, system inventor and leader of the research group, about the background of upright CT.

Keio University Hospital

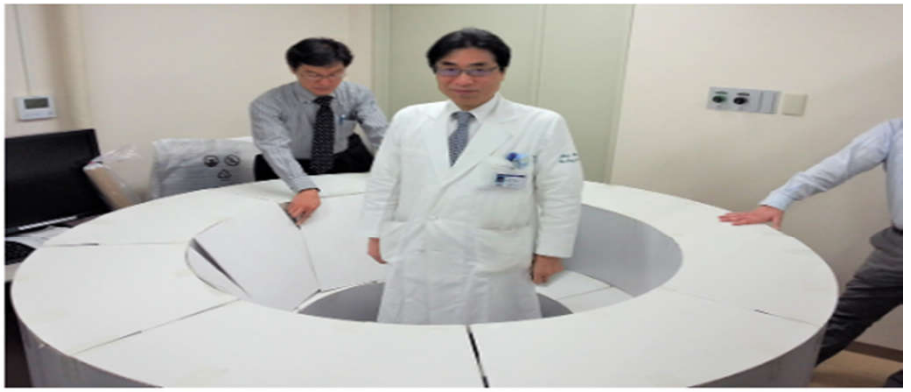
Professor, Department of Radiology, Keio University School of Medicine
Vice Director of Keio University Hospital
Masahiro Jinzaki

In the past, diagnostic imaging using CT was typically combined with contrast X-ray examinations. As CT technology evolved, 2D (single-slice) scanning was succeeded by 3D (volume) scanning and, in the late 2000s, 4D (dynamic) scanning. Once dynamic CT imaging became possible, contrast X-ray examinations were gradually replaced by CT exams.

"Generally, CT scanning is performed with the patient lying on a couch, but humans spend most of their time standing. Because the weight loading on the body differs between lying and standing, we thought there might be cases where accurate diagnosis couldn't be made with a conventional CT scan performed on a patient lying down. In addition, it isn't possible to obtain natural images of movements such as swallowing or walking in a scan performed on a patient lying down, and we felt that it was difficult to properly evaluate patients unless they were standing."

Providing quick and safe examinations for patients

Professor Jinzaki, who had been nurturing the idea of upright CT, proposed joint development to Canon Medical Systems (formerly Toshiba Medical Systems) in 2012, and after two years of consideration and preparation, the development project began in 2014. Although a prototype was soon completed, the road to the first clinical trial in 2017 was not smooth.



Professor Jinzaki experiencing the size of the system using a life-size cardboard model (photographed in 2015)

In conventional CT, the patient lies on a couch that is moved into a doughnut-shaped gantry for scanning. With upright CT, the patient stands in the center of a doughnut-shaped gantry or is seated in a special chair, and the gantry itself moves up and down during scanning.

"When developing upright CT, we focused on how to maintain the patient's posture during scanning. The scan cannot be performed with the patient leaning against the system. An important focus in upright CT is how to keep the patient stable in a natural posture during the scan."

Even when people think they are standing straight, they may be swaying, and if scanning takes a long time, the image will be blurred. This is particularly likely to occur for elderly patients with declining motor function. Repeated testing of parts to support the patient was required until we finally discovered that lightly resting the back against a support pillar would provide stability.

Canon Medical Systems technology is utilized in the mechanism that moves the gantry with a mass of approximately two tons up and down at high speed while keeping it horizontal. Canon Medical Systems has developed the world's first* CT scanner that can capture a 16-cm wide image field in a single rotation around the patient. By adding new controls to this technology, a vertical-movement gantry for upright CT was made possible. With upright CT, it is now possible to scan the abdomen in approximately five seconds, ensuring both short examination times and safety.

"The concept of upright CT emerged in the late 1970s, but it was never implemented. In those days, scan times were long, and it would have been unrealistic to scan a standing patient. Even with the scan times possible around the year 2000, I think it would still have been difficult to achieve. When we wanted to create an upright CT scanner, the high-speed and high-definition CT technology that Canon Medical Systems already possessed was a great advantage."

Expectations for identification of the causes of pain that can't be determined with conventional CT

"My patient was so happy when the cause of the pain was finally identified," said Professor Jinzaki, as he shared with us the words of the first patient.

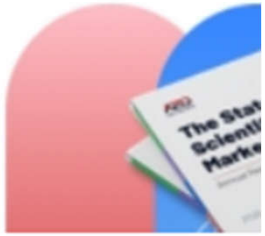
The pain occurred only when the patient was standing. Examination with conventional systems had not been able to determine the cause of the pain, so this patient was finally referred to Keio University Hospital. An upright CT scan revealed the cause of the pain, and surgery was performed. Professor Jinzaki says he will never forget the joy he saw in the patient's face when he directly spoke with the patient after the operation.

Upright CT is expected to enable proper diagnosis, even for patients who have previously given up on investigating the cause of their symptoms, and help them to maintain and extend their healthy lifespan. Furthermore, upright CT is well received by patients, as the examination procedure is simpler than conventional CT. Previously, the positioning procedure required that a medical professional attend to the patient in the examination room, have them lie on a couch, and set them in an appropriate scan position. With upright CT, however, patients only need to stand in a designated position. There is no need for them to remove their shoes or lie down, and the examination time can be reduced by approximately 40%. For medical facilities, this will enable them to conduct 1.6 times as many examinations in the same amount of time, and it will also reduce contact between medical staff and patients, thereby reducing the risk of infection.

Enabling disease prevention with examination results and contributing to extending healthy lifespans

The usefulness of upright CT was demonstrated by Professor Jinzaki and his research group. In 2023, upright CT was also introduced to the Center for Preventive Medicine at Keio University and used for health checkups. Concerning the future of upright CT, Professor Jinzaki says, **"In an aging society, it is important to detect functional decline at an early point in order to maintain health. For example, by tracking changes in bone and muscle mass over time, we can predict the risk of future decline and take measures to prevent it, or quantify posture and provide advice, and we hope to use the test results obtained by upright CT to help prevent disease and contribute to extending healthy lifespans."**

Canon Medical Systems will continue to improve its technology in order to realize Professor Jinzaki's vision of the future of medical care.



Posted in | News | Artificial Intelligence

AI-Enhanced Imaging Technique Offers a Safer, More Comfortable Option for Breast Cancer Screening

Researchers at Caltech have developed a new imaging technique known as photoacoustic computed tomography (PACT), combining laser, ultrasound, and artificial intelligence (AI) to detect breast cancer.

Image Credit: Okrasiuk/Shutterstock.com

Tested in a clinical study with 39 patients, PACT matched the diagnostic accuracy of mammography and MRI, without exposing patients to radiation or causing physical discomfort. By analyzing hemoglobin patterns using machine learning, the system pinpoints tumors early, offering a safer and more patient-friendly alternative to existing screening methods.

Rethinking Breast Cancer Screening

Conventional breast cancer screening tools each come with limitations. X-ray mammography uses radiation and often causes discomfort. Ultrasound results can vary by operator skill, while MRI offers high resolution but is expensive and less accessible. For over 20 years, Caltech's Lihong Wang has been working to address these issues with PACT—a non-invasive method that uses near-infrared lasers and ultrasonic sensors to map breast tissue with high precision.

Instead of imaging tissue directly, PACT captures functional changes by detecting oxygenated hemoglobin, typically elevated in areas of tumor activity. This approach allows the system to visualize features as small as 0.25 millimeters, up to 4 centimeters beneath the surface.

In trials conducted with City of Hope, PACT accurately distinguished between benign and malignant tissue, performing on par with traditional screening tools. Its ability to highlight subtle cancer patterns—especially in dense breast tissue—offers an important advantage over conventional imaging, where false positives are common.

How PACT Works

At the core of PACT is its hybrid "light-and-sound" imaging method. Pulses of near-infrared laser light travel through the breast, where hemoglobin molecules absorb the energy and emit ultrasonic signals. These signals are then captured by 512 sensors to generate detailed images of blood vessel activity—key markers of tumor growth, known as angiogenesis.

Unlike X-rays, which only provide structural data, PACT delivers both anatomical and functional information. Two laser wavelengths differentiate between oxygenated and deoxygenated hemoglobin, revealing areas of tumor hypoxia, a common feature in aggressive cancers. The experience for patients is also significantly improved. Instead of compression plates, scans are done with the breast submerged in warm water, with each scan lasting just 15 seconds during a breath-hold.

The technology shows particular promise for screening dense breast tissue, where X-rays can struggle, resulting in up to 15 % false positives. Future versions of PACT aim to expand its capabilities further by imaging lipid content and collagen, adding new layers of specificity.

The Role of AI and What’s Next

- Machine learning plays a key role in taking PACT from an imaging tool to a diagnostic system. Caltech researchers have trained neural networks on thousands of breast tumor images, teaching the algorithm to recognize cancer-related microvascular patterns. These include subtle signs like uneven blood vessel growth and oxygen deprivation, often too faint for human eyes to detect.
- The team is now focused on three major improvements: expanding the training database to include a wider range of cancer subtypes, creating real-time image classification tools, and integrating complementary data sources, such as thermal imaging. They're also working on making the system more compact; currently, it resembles the size of an MRI bed. FDA clearance trials are planned for 2026, with commercialization on the horizon.
- Dr. Wang envisions PACT as a first-line screening tool, particularly for high-risk patients who require frequent monitoring. Because it’s radiation-free, it can be used regularly without cumulative risk—something not possible with current screening techniques. Beyond breast cancer, the team is also exploring applications for melanoma depth measurement and thyroid nodule evaluation, underscoring PACT’s broader potential in medical imaging.

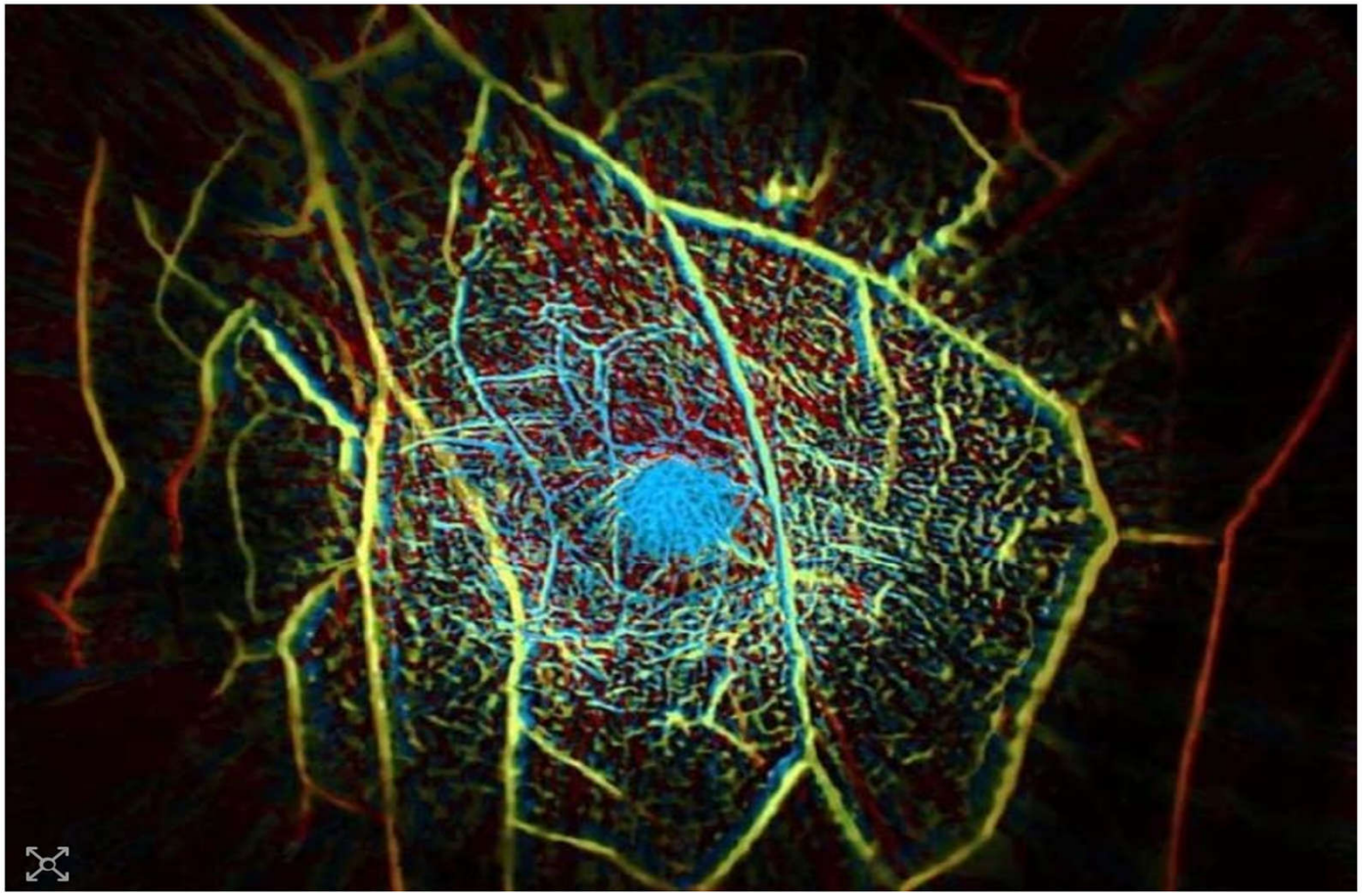
Final Thoughts

- PACT offers a compelling step forward in breast cancer detection by blending advanced optics, ultrasound, and AI into a single, patient-friendly tool. It meets the diagnostic performance of established methods while eliminating the key drawbacks of radiation exposure and discomfort.
- As research continues and clinical adoption grows, PACT could play a vital role in improving early detection, especially for patients with dense breast tissue or those needing regular scans.

DIAGNOSTIC IMAGING | RESEARCH UPDATE

Photoacoustic CT looks to replace mammography

19 Jun 2018 Tami Freeman



False-colour image showing the vascular structure of a healthy breast created with the PACT scanner. (Courtesy: Caltech)

- Mammography, the current gold standard for breast cancer screening, is a valuable but less than ideal imaging modality. The scans expose patients to X-ray radiation, are less sensitive in dense breast tissue and require breast compression – which can deter women from attending mammography appointments.
- Now, researchers at Caltech Optical Imaging Laboratory have developed an alternative: a single-breath-hold photoacoustic computed tomography (PACT) system. The device, developed in the lab of Lihong Wang, can find tumours in as little as 15 s by shining pulses of near-infrared laser light into the breast (*Nature Commun.* **9** 2352).
- During a PACT scan, the incident light diffuses through the breast and is absorbed by haemoglobin in the patient's red blood cells, causing the molecules to vibrate ultrasonically. These vibrations travel through the tissue and are detected by a 512-element ultrasonic transducer array. The recorded data are then used to construct an image of the breast's internal structures.
- PACT creates images with a high in-plane spatial resolution of 255 μm, at a depth of up to 4 cm. Because the 1064 nm light is so strongly absorbed by haemoglobin, the images primarily show the blood vessels present in the tissue being scanned. This is useful for detecting cancer as many tumours induce the growth of new blood vessels, surrounding themselves with dense networks of vascular tissue.

- A patient undergoing a PACT scan lies face down on a table with the breast to be imaged placed in a recess containing the ultrasonic sensors and laser. As the scan takes just 15 s, the patient can hold their breath while being scanned, resulting in a clearer image with negligible breathing-induced motion artefacts. “This is the only single-breath-hold technology that gives us high-contrast, high-resolution, 3D images of the entire breast,” says Wang.
- In a pilot study, the team used PACT to image the breasts of one healthy volunteer and seven breast cancer patients. By assessing blood vessel density, PACT correctly identified eight of nine biopsy-verified breast tumours. Tumours were clearly revealed even in radiographically dense breasts, which could not be readily imaged by mammography.
- Wang has founded a company to commercialize the PACT technology and conduct large-scale clinical studies. “Our goal is to build a dream machine for breast screening, diagnosis, monitoring and prognosis without any harm to the patient,” he says. “We want it to be fast, painless, safe and inexpensive.”