**CT Slice: Shining a Light on Dose**
**By Beth W. Orenstein**
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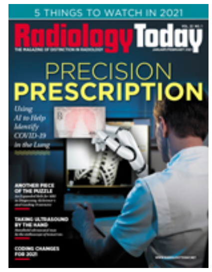


Over the past decade, patients have become less fearful that radiation from medical imaging, particularly from CT scans, could increase their risk of cancer, with good reason, says Arun Krishnaraj, MD, MPH, director of the division of body imaging and of body procedures and chief of the section of body imaging at the University of Virginia Health System in Charlottesville. Since 2009, when several imaging organizations, including the ACR and the RSNA, launched the Image Wisely campaign, the principle of ALARA has been priority one. “That ALARA guides what we do is having a major impact across the board,” Krishnaraj says. He adds, however, that “the issue of radiation exposure is still in the public consciousness.”

Certain populations, including pediatric patients, screening programs, patients with obesity, and patients who receive regular imaging to monitor chronic conditions or ongoing treatment, remain rather vulnerable, Krishnaraj says. Anything that radiologists can do to help lower radiation dose in these and other vulnerable populations is most welcome, he says.

In addition to ALARA, manufacturers of CT scanners have developed dose reduction tools that have been proven effective. Major health systems and academic centers may have the funds and ability to upgrade their CT scanners so their patients have access to these newer lower-dose tools; however, smaller hospitals and imaging facilities, particularly those in more rural areas of the country, where budgets are tight and upgrade costs aren’t as easily absorbed or valued, may not, Krishnaraj says. Furthermore, the ongoing pandemic has also led to budget cuts, which can lead to postponement of heavy equipment procurement.

Some of the older equipment in these facilities may still use filtered back projection (FBP), one of the earliest forms of CT image reconstruction. FBP processes images quickly and generates high-quality images for higher-dose exams. Unfortunately, this method is particularly susceptible to the dose:noise ratio paradox and, as a result, does not work well for low-dose procedures; a lower signal-to-noise ratio generally results in images having grainy appearances.

Iterative reconstruction (IR) was introduced in the late 2000s and has become the predominant technique for improving the quality of lower-dose imaging studies. IR reduces noise by applying various filters to CT images after they are acquired. This step enhances image quality of lower-dose procedures. IR is better than FBP when it comes to reducing dose exposure, but it can take substantially longer to process images and is prone to producing images that many describe as “waxy” or having a “blurry” appearance, Krishnaraj says.

**Deep Learning Lowers Dose**
PixelShine, deep learning (DL) processing software recently introduced by AlgoMedica of Sunnyvale, California, enables imaging facilities to universally reduce dose protocols while obtaining high-quality scans on any vendor’s CT scanners, according to the company. Mikael Strindlund, CEO of AlgoMedica, says PixelShine can quickly and consistently improve the quality of all CT images, independent of clinical application and CT manufacturer, because it allows care providers to universally adjust protocols to decrease radiation dose. The software reduces the need for specialized protocols, simplifying technologist workflow and enabling a harmonization and standardization of image quality across all installed CT scanners, he says.

PixelShine processes images in seconds—substantially faster than IR methods—improves clinical confidence and productivity and retains the full fidelity of the image dataset with no information loss, Strindlund says. Because it works with any scanner, it has the potential to extend the utility of any older CT scanner that doesn’t have the ability to scan at a lower dose, he adds.

The University of Virginia (UVA) has used PixelShine for low-dose lung cancer screening and found it to be useful, Krishnaraj says. The Centers for Disease Control and Prevention has said that low-dose CT is the only approved screening method for lung cancer. “In real-world use,” Krishnaraj says, “low-dose lung cancer screening with CT is anything below 2.5 millisieverts. That’s about where most people are living these days. We wanted to push the envelope and see what we could achieve by combining IR and the PixelShine algorithm. With this application, we are now at the 1 or sub-1 mSv level.”

Granted, Krishnaraj says, lung tissue attenuates far less than other organs or tissue such as abdomen or spine. “Still, it’s remarkable to think that we can acquire such high-quality images of the lungs for cancer screening at submillisievert doses.” PixelShine should “enable us to get to the point where we can reduce the dose to approximate that of a chest X-ray but still have the diagnostic confidence provided by an FBP CT image,” he adds.

UVA also is applying PixelShine’s DL algorithm to its CT colonography dataset. “CT colonography obtains a very low-dose image for 3D reconstruction, but those images are reviewed on 2D workstations,” Krishnaraj says. The problem is in identifying extracolonic findings—imaging findings incidentally detected outside the colon and rectum. “Extracolonic findings are hard to read,” he explains.

A study is underway using PixelShine to identify extracolonic findings on a CT colonography dataset. The researchers will compare what PixelShine finds with what a reader looking at full-dose CT scans found. “We will look to see whether we could have obviated the need to call the patient back for a full-dose CT,” Krishnaraj says. “Could we have made the findings from low-dose CT colonoscopy prospectively with the PixelShine algorithm?”

The algorithm also allows researchers to pursue novel areas, Krishnaraj says. For example, UVA’s project is looking at body composition and total body fat. “It’s pretty well known that visceral fat—fat that is stored deeper in the skin and wrapped around major organs—is linked with stroke and other serious health risks," Krishnaraj says. A study is underway to determine whether adopting lifestyle changes such as exercise could lower one's visceral fat.

The researchers are hoping to use PixelShine and its in-house algorithm to study whether starting a high-intensity exercise program could help patients reduce their visceral fat. Patients are training for a 10-mile race. Ideally, the participants will be screened at the beginning of their training, midtraining, and post training to see whether their total body fat has changed over time. "We couldn't do this without the PixelShine algorithm," Krishnaraj says. "If you run your algorithm on a very low-dose scan, there's too much noise for it to perform accurately, but when we apply the PixelShine filter to it, it performs 90% as well as the full-dose phantom."

Krishnaraj also sees an important role for the algorithm in pediatrics, due to increased radiation risk for children, whose cells are rapidly reproducing. Pediatric studies are always acquired at a lower dose but are often low quality as a result. "We tend to use MRI for pediatrics," he says. "But it takes much longer to acquire such images, and MRI may require sedation. We would like to use PixelShine on very low-dose pediatric CT scans that normally are of poor image quality, to see how PixelShine can improve the images."

As CT is used for managing population health, "we need to make sure scans are as safe as possible," Krishnaraj says. "And we know that radiation is a potential carcinogen even at low doses. So anything we can do to dial that back is great."

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