PHILIPS

Computed Tomography

Confident diagnosis in the first scan with IQon Elite Spectral CT

Case studies by Dr. Gopal Punjabi, Chief of Radiology, Hennepin Healthcare

Philips IQon Elite Spectral CT is the world's first and only detector-based spectral solution for every patient, delivering valuable clinical insights for confident disease management. No compromise to your workflow, this proprietary approach to CT provides extraordinary diagnostic quality, with spectral results 100% of the time, in a single routine scan.

CASE 1:

Two hits on one spectral scan...

A 35-year-old female with sudden onset of abdominal pain while watching TV. The conventional CT shows a right adnexal cyst,but otherwise the CT was unremarkable.

On spectral analysis, obvious gallstones are visualized, and this was confirmed on ultrasound, where there was no evidence of acute cholecystitis. It is not uncommon to find gallstones on spectral CT that are not seen on conventional images, and spectral curves nicely illustrate the reason.

The right adnexal cyst is without iodine uptake, consistent with hemorrhagic cyst. Ovarian tissue below the cyst appears enlarged, and on spectral analysis, shows absent iodine uptake. Ovarian torsion was suspected. On the ultrasound, blood flow was seen in the right ovary. During the radiology resident exam, the patient was highly tender over the right ovary.

So we stuck to our spectral guns, and suspected ovarian torsion. The patient was taken to the operating room.

There was no evidence of torsion and a cystic and solid lesion of the right ovary was removed. This was found to be a serous cystadenofibroma on pathology.

On follow-up exam, the patients symptoms had resolved.

Was this a poorly perfused benign ovarian tumor? Was this intermittent torsion, which had resolved by surgery? Or can torsion be called based on spectral CT at all?

As always, we will continue to learn....

> Spectral CT allows you to see things you may not have expected to see. On conventional CT, we miss 30–40% of gallstones, which are isodense to bile. With spectral CT they just pop out. You are missing out if you are not using the technology. Spectral CT makes it seamless.

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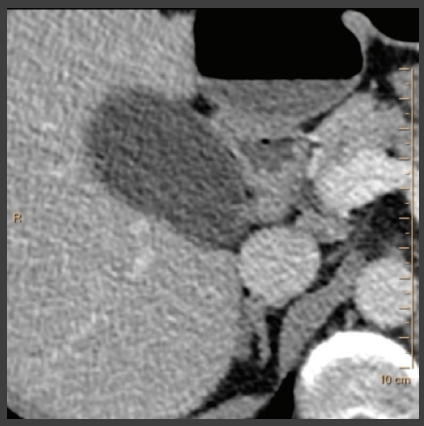
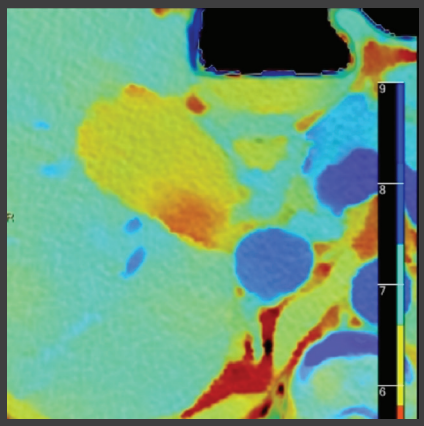
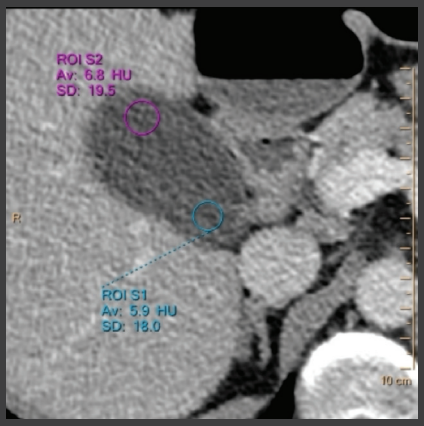


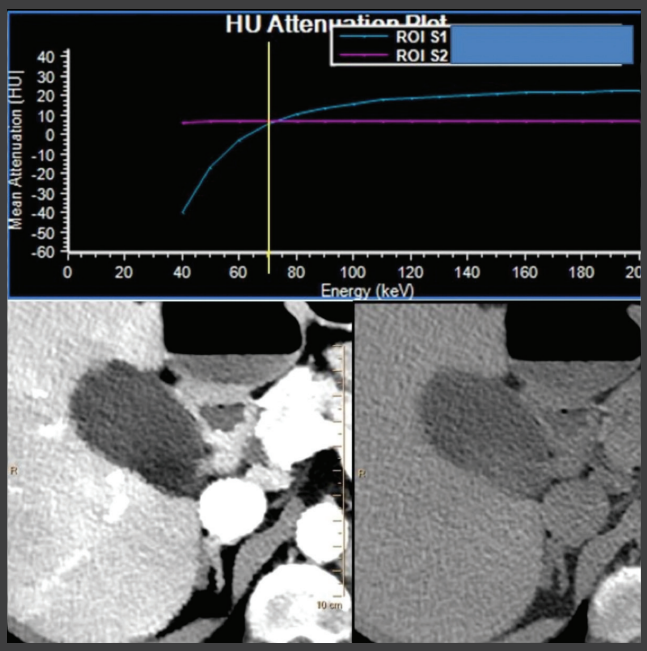
Conventional CT with normal gallbladder.



Gallstones easily seen on effective atomic number overlay image.

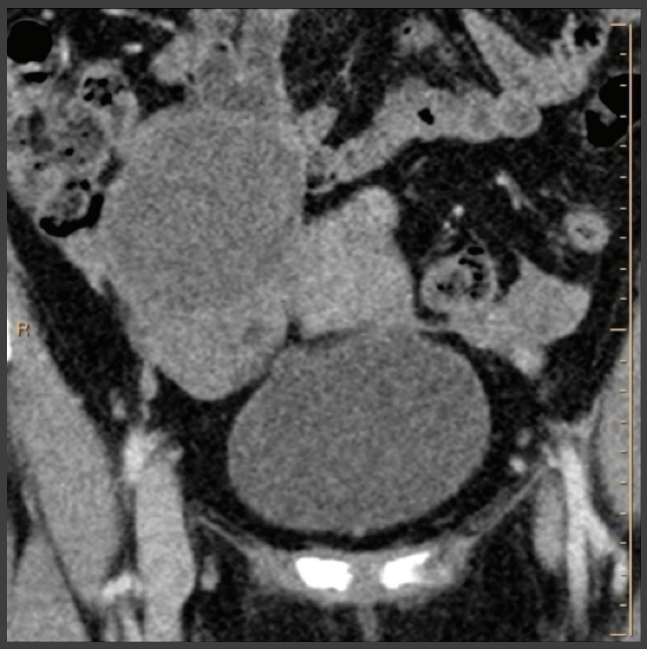


On conventional image, attenuation of bile (magenta ROI) and gallstones (blue ROI) is nearly the same. No wonder they are invisible.

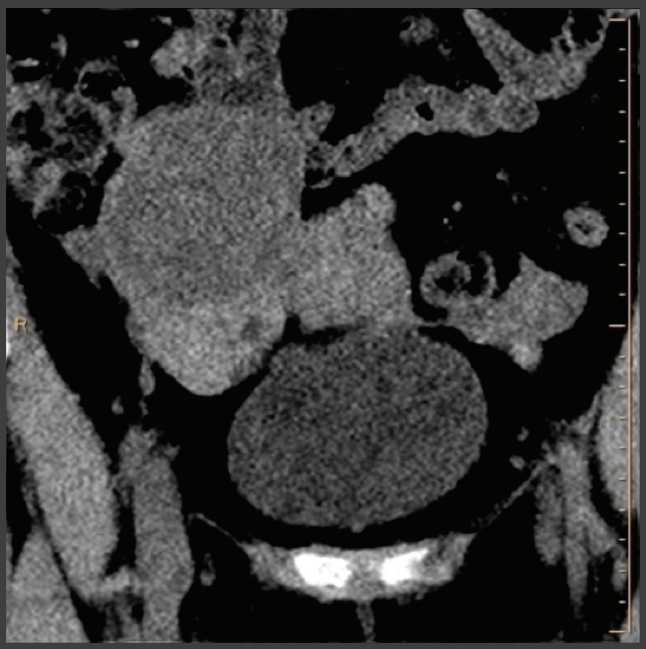


Spectral plot is very enlightening: at 70 kev (yellow line), attenuation curves of bile and gallstones intersect, so they cannot be seen. At 40 keV (left), stones are hypodense relative to bile, and at 200keV (right), they are hypredense. This is obvious on the respective images.

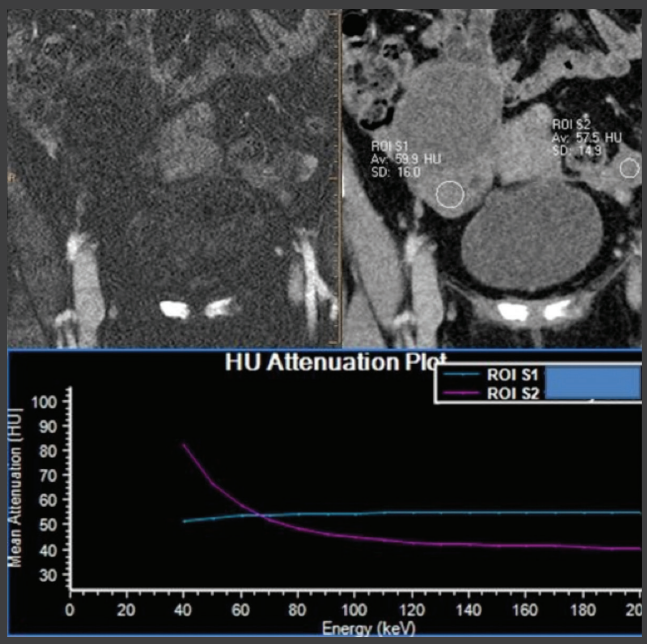
Ultrasound confirms gallstones, but no sign of acute cholecystitis.



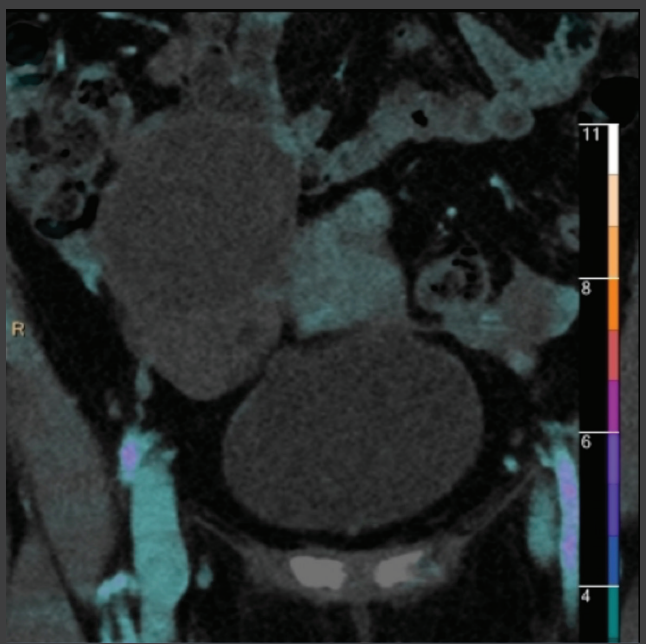
Conventional coronal CT through pelvis shows right ovarian cyst, otherwise unremarkable.



Virtual non-contrast image shows ovarian parenchyma below cyst is somewhat hyperdense.



Iodine map shows no uptake in parenchyma below right ovarian cyst. Spectral curves confirm suspicion: magenta curve (ROI in left ovary) shows rise on low keV, consistent with iodine uptake. Blue curve (ROI in right ovarian parenchyma) remains flat, and actually decreases a bit on lower keV, consistent with lack of iodine.



Iodine overlay image shows absent iodine uptake.

CASE 2:

Let us solve this one...

A 44-year-old female with history of gastritis presents with abdominal and chest pain. Her pain is located diffusely over the upper quadrants and radiates into her chest and back. She described the pain as crushing and associated with difficulty breathing. Patient also complained of having pain in upper extremities, described as numbness/tingling which was worse in her upper left arm and associated with weakness.

EKG was not significantly changed from baseline. Troponin came back positive. A CT angiogram of the chest was performed which was negative for aortic pathology. Echo showed no focal wall motion abnormality.

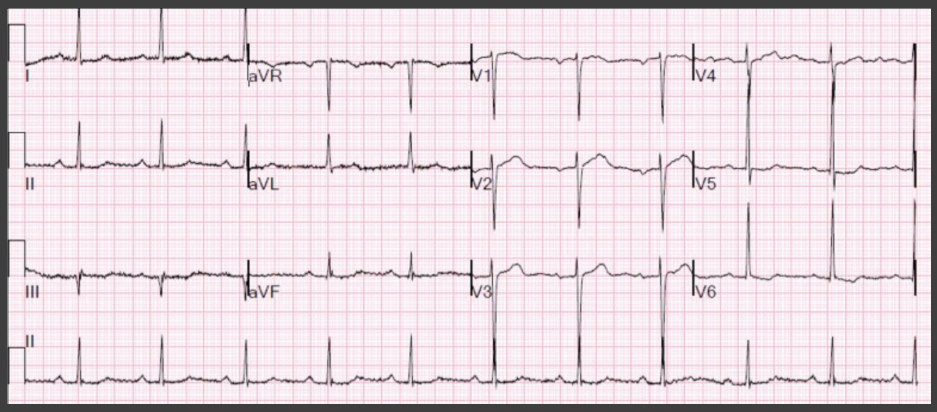
Patient was then taken to cath lab: mild plaque, no angiographically significant obstructive coronary artery disease was found.

So now what?

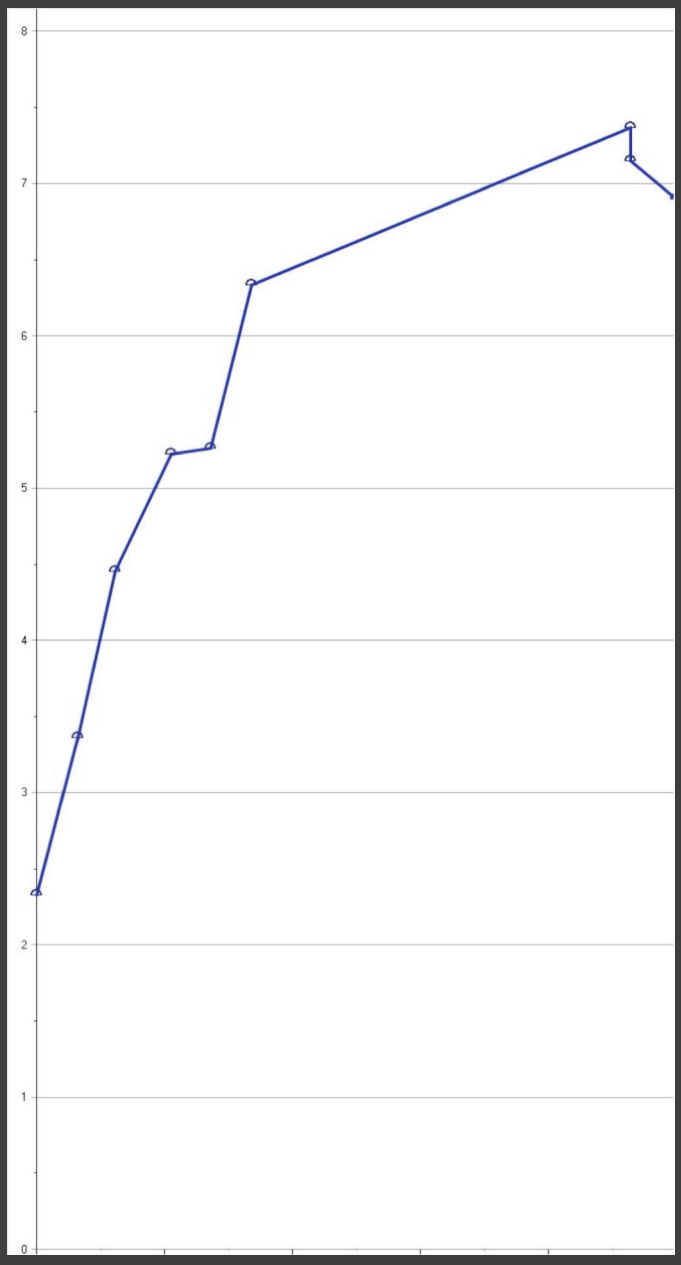
Cardiac MRI performed a few days later: Small (about 1.2 cm) transmural infarct in the inferior wall.

Now let us go back to the CT scan. The conventional images through the heart are underwhelming. Turn on spectral CT, and there is an obvious perfusion defect in the inferior wall, corresponds exactly with the focus of delayed enhancement on MRI!

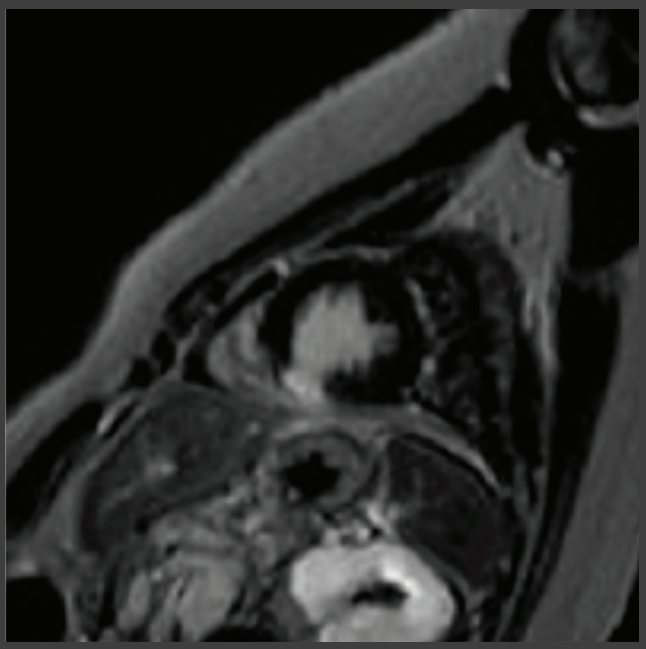
As we do more spectral CT imaging, we will see more mysteries like this solved, or not mystifying in the first place. This was likely a small thrombotic coronary occlusion that resolved by the time of the catheter angiogram, with scarring well depicted on subsequent cardiac MR. Patient was treated as a NSTEMI.



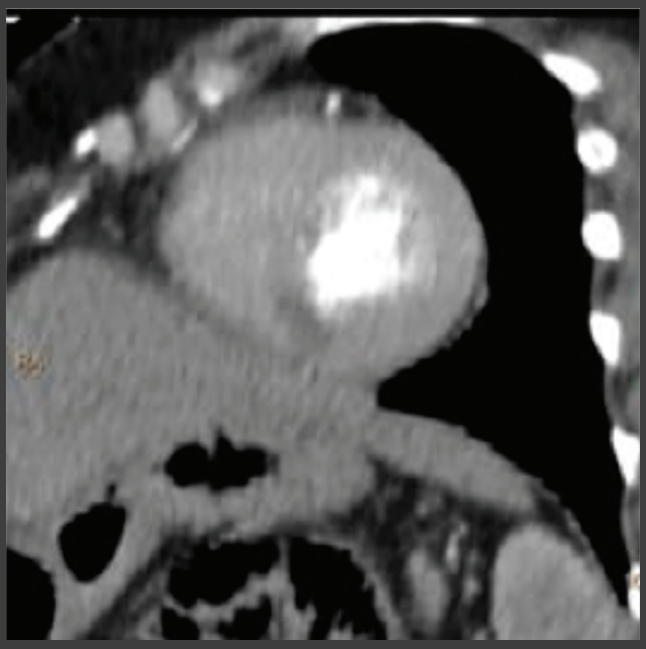
EKG is inconclusive



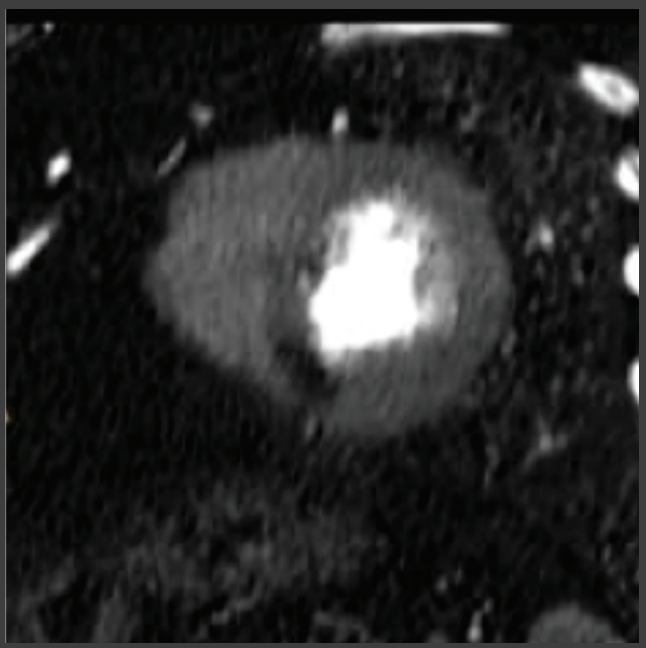
Troponin trend: Obviously positive! The negative echo and cath make the case interesting.



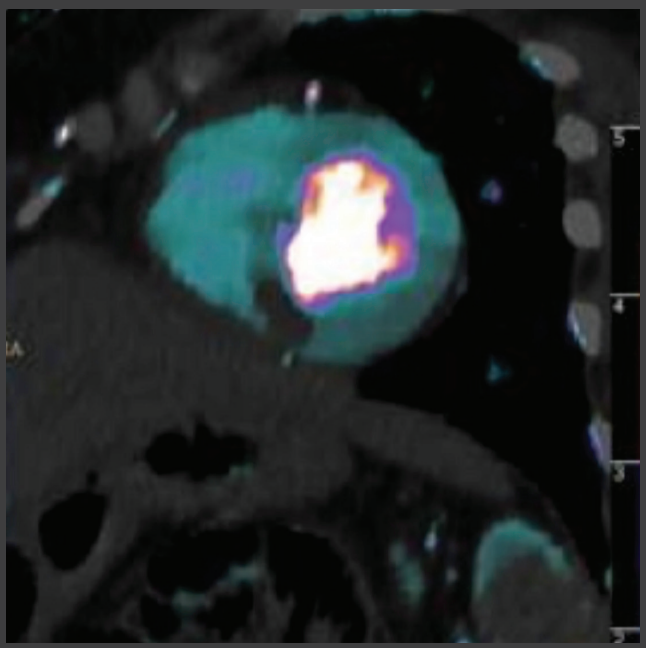
MRI: Small focus of transmural delayed enhancement in the inferior wall (missing piece of the donut), consistent with a myocardial infarction.



Conventional CT, short axis plane: Underwhelming.



Iodine map, short axis plane: The perfusion defect is obvious!



Perfusion defect shown very nicely on iodine overlay. Note how well it corresponds to the delayed enhancement on MRI.

CASE 3:

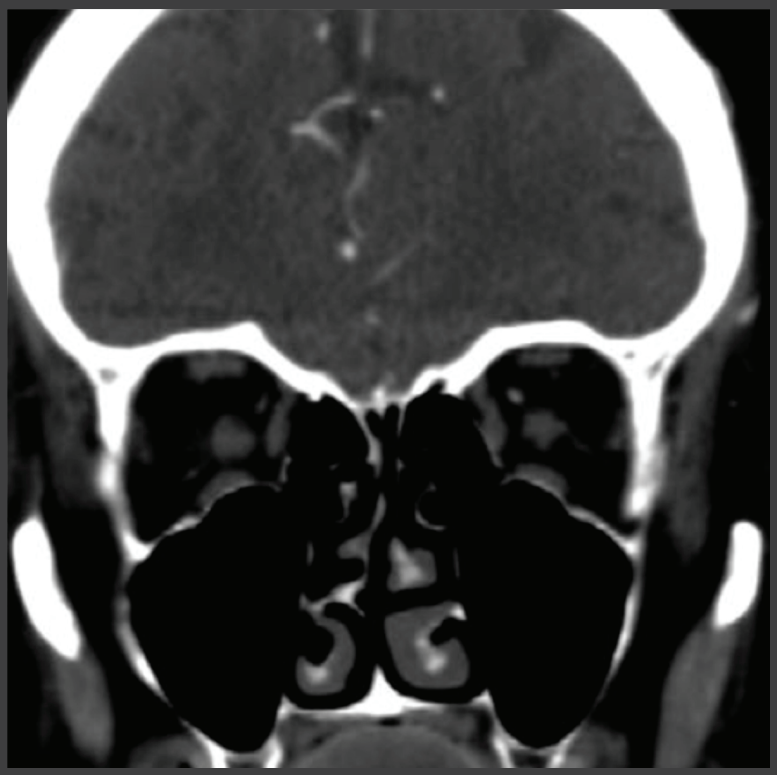
Optic nerve perfusion in CRAO

Full disclosure: I am a body imager, and this is the first neuroradiology case I am posting here, courtesy of my dear friend and colleague, Dr. Ben Hoffman.

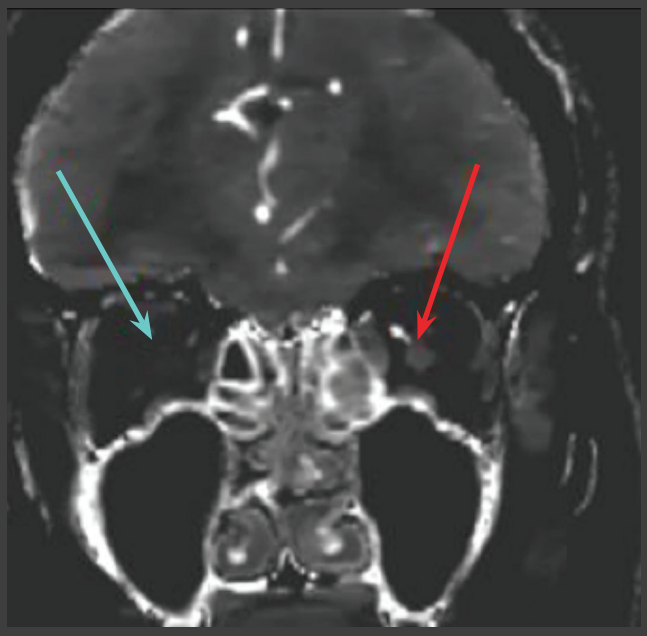
A 91-year-old female presents with sudden painless loss of vision in her right eye. Fundoscopic exam was consistent with central retinal artery occlusion. Head CT showed chronic left medial occipital infarct, and changes of small vessel disease. CT angiogram performed as part of stroke workup showed left PCA stenosis, ophthalmic arteries were patent.

Dr. Ben Hoffman turns on spectral. And lo and behold, the right optic nerve shows no iodine uptake. To the best of my knowledge, lack of perfusion on CT in CRAO has not been described before.

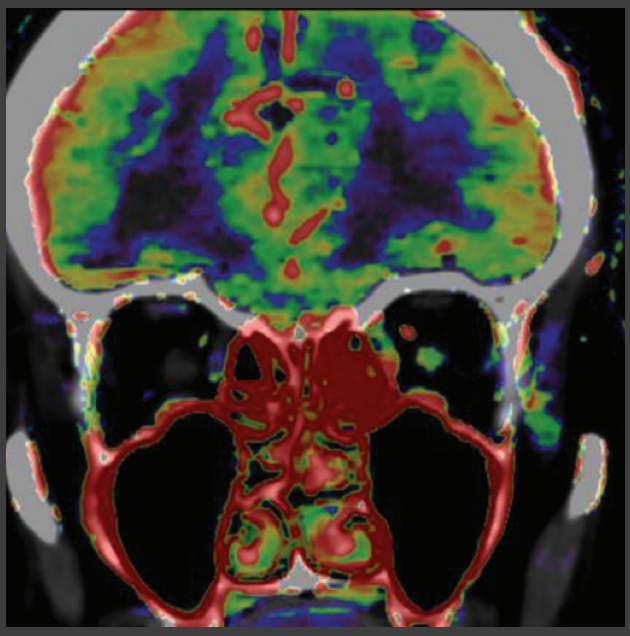
Patient was outside the window to administrator tPA, and was treated with hyperbaric oxygen, unfortunately with minimal improvement.



Conventional CT, coronal plane.
The optic nerves are unremarkable.



Iodine map: Absent uptake in right optic nerve (blue arrow). The left optic nerve shows good iodine uptake (red arrow).



Iodine overlay shows finding nicely!

CASE 4:

My oh MI!

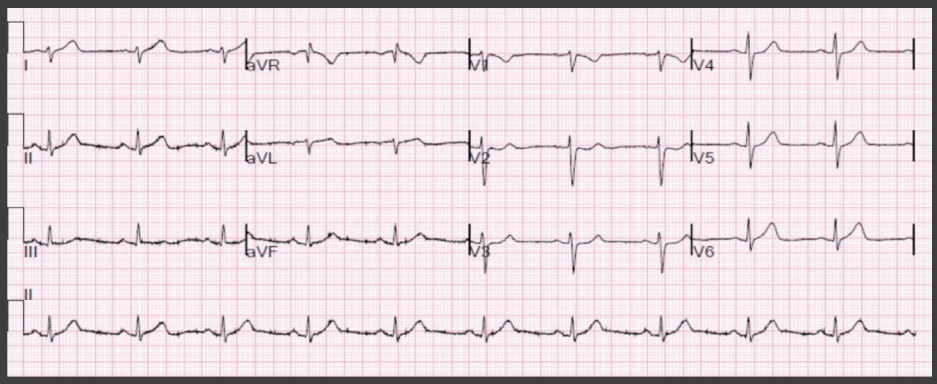
A 39-year-old female with no prior cardiac history presents to the ED with right sided chest pain. Initial EKG with minimal ST-depression, and initial troponin elevated to 0.04, concerning for NSTEMI. Basic labs were largely unremarkable (mild leukocytosis and hypokalemia). Sublingual nitro did not provide any pain relief. A repeat EKG showed dynamic changes – resolution of ST depression. Delta troponin significantly increased to 1.04.

A CT angiogram of the aorta was performed to rule out dissection, and cardiology was consulted.

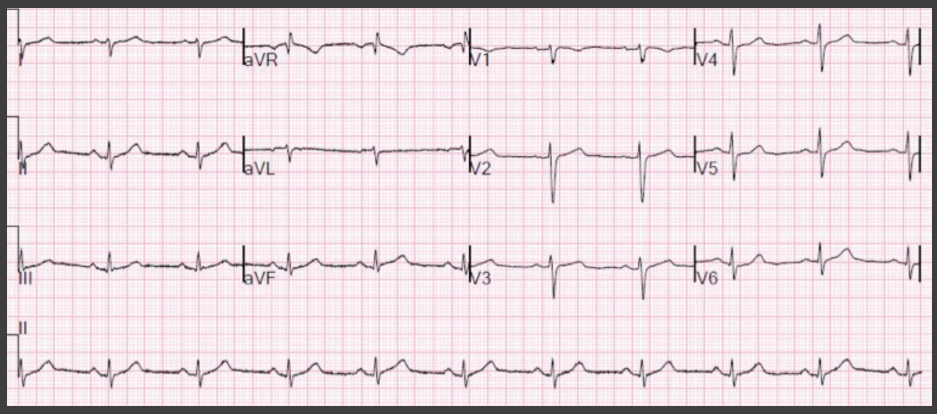
CTA shows no dissection. But look closely, and on the conventional images you can see relatively sharply defined endocardium in the lateral wall of the left ventricle, while the rest of the endocardium is fuzzy. I like this previously undescribed sign, it helps me detect cardiac hypoperfusion on non-gated scans.

Now look at spectral images. There is clear iodine deficit in the lateral wall. This is well seen on the fusion image. This is an acute MI in the circumflex territory.

Occluded OM1, likely from a spontaneous dissection found in the cath lab and treated with angioplasty. Troponin peaked at 20. The patient was discharged from the hospital after day 3, and placed on plavix.

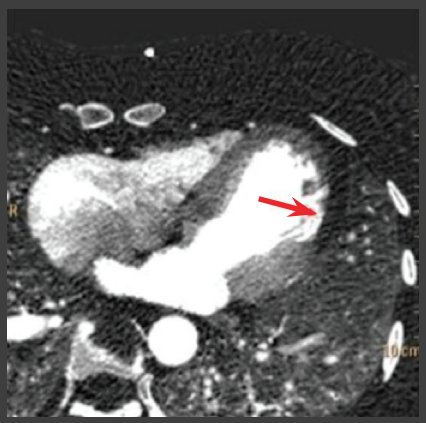


First EKG: Subtle ST segment changes, below the threshold of a radiologist.

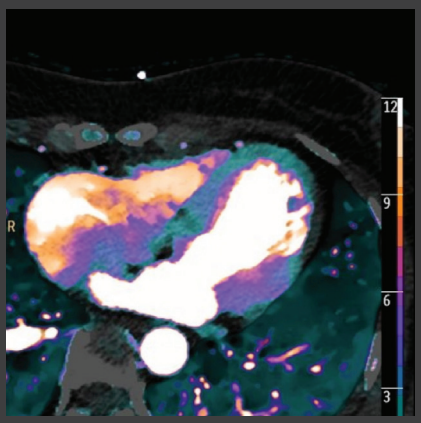


Second EKG: Dynamic ST changes. Wish I could tell you more.

Conventional CT: Focal sharply defined endocardium (red arrows). This is a very good sign for an acute MI on non-gated chest CT scans.

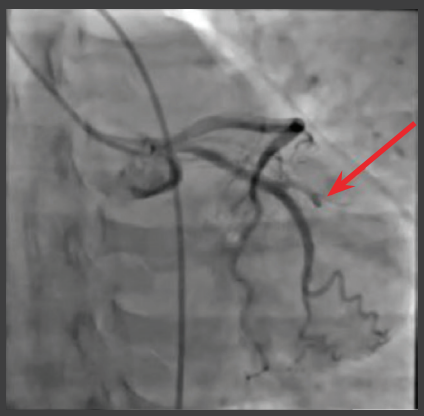


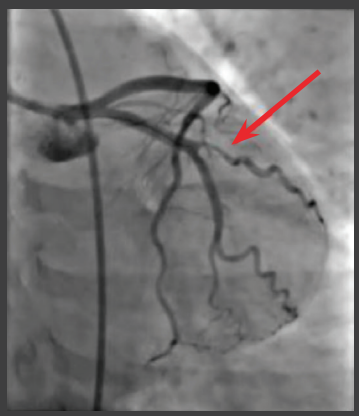
Iodine map: No iodine uptake consistent with hypoperfusion.



Fused image with iodine overlay: Nice depiction of perfusion deficit.

Cardiac cath: Focal occlusion of OM1, likely from a coronary dissection.





Post angioplasty with good flow in OM1.

CASE 5:

What kind of scan would you want?

This 58-year-old male presented to the emergency department with abdominal pain which began suddenly about 4-5 days ago and is associated with fatigue, body aches, nausea, darker skin, white colored stools and itching. Bilirubin is 7.2 mg/dL. Alk phos, AST and ALT were all elevated. Ultrasound shows dilated common bile duct measuring 11 mm. A routine CT scan was performed in the ED.

On the conventional CT scan, there is obvious biliary dilatation. Is there a mass in the pancreas? You would be hard pressed to be sure.

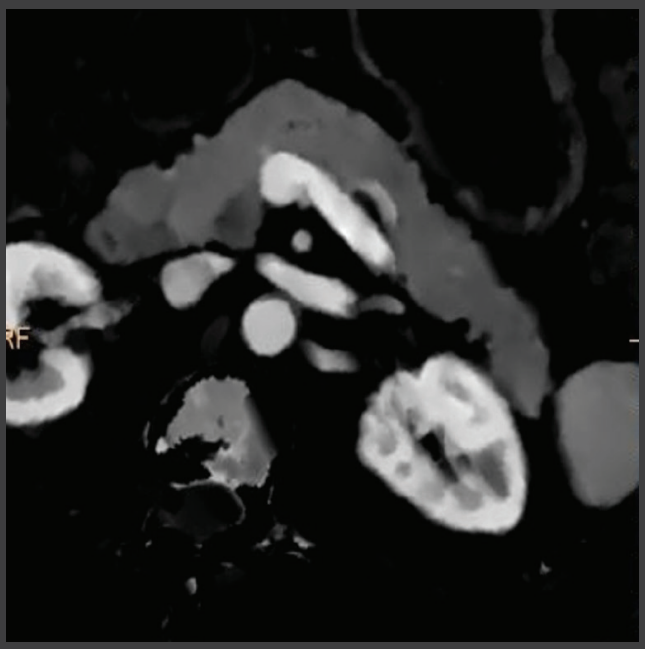
Turn on spectral, and you cannot miss the hypoenhancing mass in the pancreas. This was confirmed on endoscopic ultrasound, and a stent was placed on ERCP. Unfortunately EUS biopsy samples so far have shown only atypical cells. Further sampling is planned.

If this was you, and you (unfortunately) had jaundice, with a suspected pancreas mass, what kind of CT scan would you like your radiologist to have read, conventional or spectral?

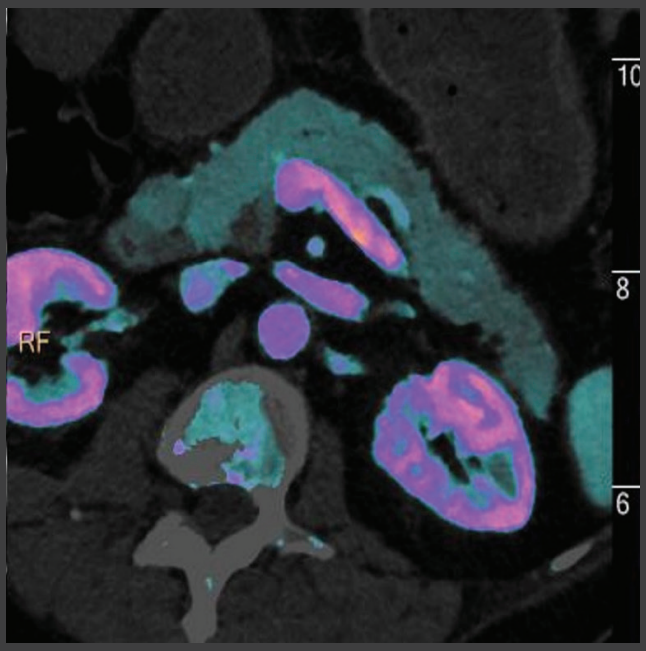
Conventional CT, coronal plane: Biliary dilatation

Conventional CT, axial oblique. Is there a lesion in the pancreas?

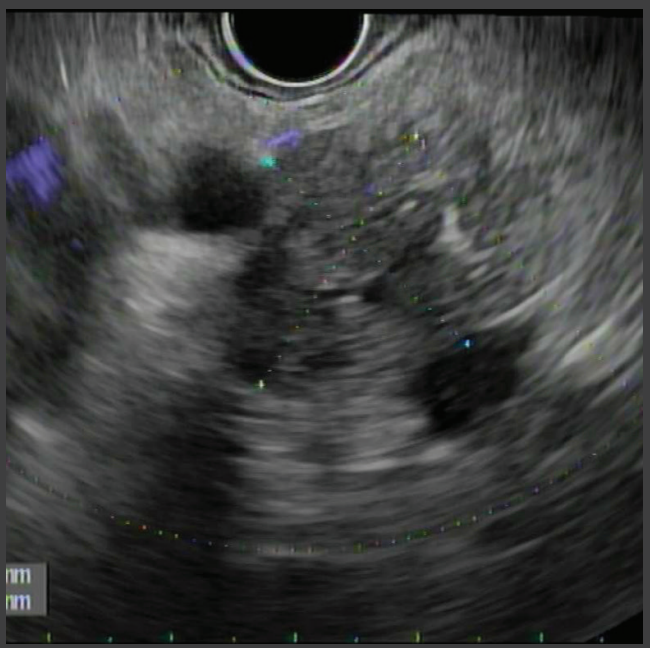
40 keV, axial oblique: Now you're talking! Obvious lesion in head/uncinate process.



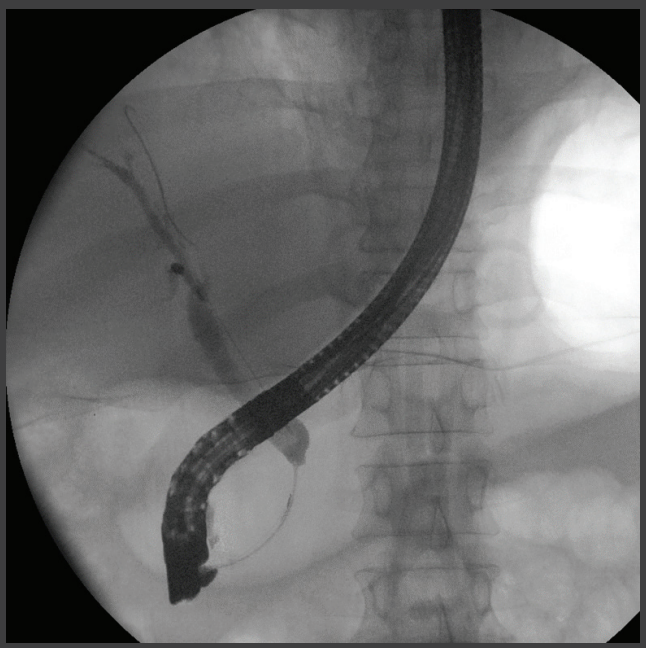
Iodine map, axial oblique: **Lesion is easy to see! Hypoenhancement is characteristic of pancreatic adenocarcinomas.**



Iodine overlay image, axial oblique: **Just showing off.**



EUS confirms mass.



ERCP shows obstruction of distal CBD. A biliary stent was placed.

Results from case studies are not predictive of results in other cases. Results in other cases may vary.

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