INCIDENTAL FINDING DURING CARDIOMYOPATHY WORKUP

Resident(s): Mariya Gusman, M.D.
Attending(s): Raul Palacios, M.D.
Program/Dept(s): Brooke Army Medical Center
DISCLAIMER

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Chief Complaint
- 72 year-old male with shortness of breath.

History of Present Illness
- 72 year-old male presented to the ER complaining of sudden-onset dyspnea that began while he had been lying in bed.
- Denies chest pain.
RELEVANT HISTORY

• Past Medical History
  • DM type II, hypertension, hyperlipidemia, and chronic basal cell skin cancer

• Past Surgical History
  • L-spine fusion and several MOHS excisions for skin cancer

• Medications
  • Metformin, Sitagliptin, Pioglitazone, Glipizide, Ezetamibe, Cetirazine

• Allergies
  • NKDA
DIAGNOSTIC WORKUP

- Physical Exam
  - Diaphoretic.
  - BP: 174/125, HR 96, RR 18
  - No murmurs, rubs or gallops. 2+ pulses. No JVD or pedal edema.
  - Lungs clear to auscultation.

- Laboratory Data
  - ED labs significant only for NT-proBNP of 973.8
  - ECG: incomplete RBBB
Interval development of interstitial markings, thickening of the minor fissure, and prominent central pulmonary vasculature suggest pulmonary congestion.
TTE and CTA performed

- TTE:
  - mildly dilated LA and LV
  - severe diffuse hypokinesis
  - estimated EF of 25%

- CTA:
  - normal coronary origins
  - non-obstructive CAD in LAD, Cx, RCA
  - no aortic aneurysm or dissection
  - no pulmonary embolism
What additional salient findings were noted on the patient’s CTA study?

A. Multiple splenic infarcts.
B. Peripherally-enhancing hepatic lesion.
C. Hepatic vascular malformation.
D. Thickened gastric wall.
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C. Hepatic vascular malformation.
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Also note capsular retraction and nodular liver; this patient does have a history of drinking “5-6 vodka cocktails on weekends”
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Which imaging findings suggest hepatocellular carcinoma in a multiphasic study?

A. **Multiple hypoenhancing lesions.**
B. **Rapid arterial phase enhancement with central filling defect.**
C. **Arterial phase enhancement with rapid venous phase washout.**
D. **Gradual arterial phase peripheral enhancement followed by central filling-in.**
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HCC is hypervascular and recruits blood supply from the hepatic arteries (whereas normal hepatic parenchyma is primarily supplied by the portal venous system.) Hypoattenuation on delayed imaging is also a highly suggestive characteristic. This may be coupled with a thin capsule of persistent enhancement.

[Continue with the Case]
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Continue with the Case
NON-INVASIVE IMAGING: 3 PHASE CT

Arterially enhancing mass in the posterior left hepatic lobe in segments 2/3, measuring 4.6 x 4.9 x 4.8 cm.

On subsequent portal venous phase, the mass becomes isoattenuating to surrounding liver parenchyma.

On the 5 minute delay phase, the mass is slightly hypoattenuating to surrounding liver parenchyma and demonstrates a thin, enhancing capsule.
DIAGNOSIS

- Hepatocellular carcinoma incidentally found during cardiac workup of new-onset pulmonary edema and cardiomyopathy.
- Patient declined hepatic lobectomy due to surgical risks posed by cardiomyopathy.
INTERVENTION: Y90 TREATMENT

- Two products available:
  - SIR Spheres:
    - Resin spheres.
    - Dose calculation driven by body surface area and tumor involvement (tumor volume / liver volume)
  - Theraspheres:
    - Glass spheres.
    - Dose calculation driven by liver mass
- Both deliver internal radiation as Yttrium-90, a beta emitter, undergoes decay.
- Dose of both limited by lung shunt fraction; must be adjusted.
- This patient received SIR Spheres.
Y90 TREATMENT: MAPPING

- Hepatic angiography to evaluate for potential sources of reflux into the gastric or duodenal regions.
- Gastroduodenal and pancreaticoduodenal arteries embolized to prevent such reflux.
- Tc 99m-MAA radiotracer administered.

SPECT imaging:
- focal radiotracer activity in the 5 cm tumoral bed within the posterior left hepatic lobe
- small amount of activity within the remainder of the left liver lobe.

Hepatic/pulmonary shunt calculation:
\[ \% \text{Shunt} = \left( \frac{\text{Lung Counts}}{\text{Liver Counts} + \text{Lung Counts}} \right) \times 100 \]

Lung Shunt 15.8% in this patient
QUESTION 3: MAPPING

In Y90 therapy, which of the following is not a goal of Tc99m-MAA mapping?

A. Embolization to prevent Y90 reflux into gastroduodenal region.
B. Verification that Y90 particles localize to tumor bed.
C. Calculation of lung shunt fraction (with SPECT).
D. Diagnostic confirmation that lesion represents hepatocellular carcinoma.
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SIR SPHERES DOSE CALCULATION

The dose was calculated using the body surface area (BSA) calculation formula:

\[ \text{Radioactivity Required (GBq)} = (\text{Body Surface Area} - 0.2) + \text{Tumor Involvement} \]

BSA (m²) = 0.20247 * height (m)^0.725 * weight (kg)^0.425

Our 5’10”, 230lb patient’s BSA is calculated to be 2.22

TI (Tumor Involvement) = Tumor Volume / Liver Volume

The tumor is estimated to be 86mL; the left hepatic lobe is estimated to be 427mL.

\[ \frac{86}{427} = 0.2 \] (i.e. left lobe TI = 20%)

Radioactivity Required = 2.22 – 0.2 + 0.2 = 2.22 GBq

The BSA formula was developed to calculate WHOLE liver prescribed activity, so we must reduce the result according to what % of the liver the target LOBE accounts for.

In our patient, the left lobe was 35% of the total liver volume; = 2.22 * 0.35 = 0.78 GBq

We reduce this dose by 20% as our patient has cirrhosis = 0.68 GBq

Is the dose low enough to not cause radiation pneumonitis / pulmonary fibrosis?

The lung shunt was calculated at 15.8%.

\[ \text{Lung Dose (Gy)} = 50 * \frac{\text{Activity to Lung (GBq)}}{\text{Lung Mass (kg)}} \]

\[ = 50 * 0.68 \text{ GBq} * 0.158 / 1 \text{ kg} = 5.4 \text{ Gy} \]

Yes! No more than 25Gy must be delivered to the lungs.
Of course. The Sirtex Medical Activity Calculator can be found at: 

apps01.sirtex.com/smac/

- **Important:** the previously discussed formulas and above website are the recommended calculations only for SIR Spheres (resin device)
- With TheraSpheres (glass device), liver volume (and extrapolated liver mass) drive the calculation.
- The recommended dose to the liver is between 80Gy and 150Gy; 120 Gy is a common target dose. The amount of radioactivity required to deliver the target dose is calculated as follows:

  \[
  \text{Radioactivity Required (GBq)} = \frac{\text{Target Dose (Gy)} \times \text{Liver Mass (kg)}}{50}
  \]

- Concern for not delivering too high a dose to the lungs remains, therefore:

  \[
  \text{Actual Liver Dose (Gy)} = \frac{(50 \times \text{Injected Radioactivity (GBq)} \times (1-\text{LUNG shunt}))}{\text{Liver Mass (kg)}}
  \]
Y90 TREATMENT: DOSE ADMINISTRATION

- Approximately 16.8 mCi of yttrium-90 was delivered to the left lobe of the liver via the left hepatic artery in the form of SIR Spheres.
- Periodic injection of contrast through the procedure to verify continual antegrade flow.
CLINICAL FOLLOW UP

- 3 months post-Y90 treatment
  - tumor size reduced from
    \(4.6 \times 4.9 \times 4.8\text{cm} \rightarrow 4.3 \times 3.9 \times 3.5\text{cm}\)

- 6 months post-Y90 treatment
  - tumor size further decreased to
    \(3.1 \times 3.1 \times 3.1\text{cm}\)
  - \(\alpha\text{FP} \ 3.44 \rightarrow 3.27 \rightarrow 3.18 \rightarrow 3.15\)

- 12 months post-Y90 treatment
  - tumor size stable
CLINICAL FOLLOW UP

- Added bonus: at 6 months, cardiology team discovers that cardiomyopathy has resolved.
  - EF 20% → 60%
  - Global hypokinesis → septal hypokinesis

[Images of MRI scans, links to MRI card PRE and POST]
Hepatocellular carcinoma that was incidentally found during cardiac workup of new-onset pulmonary edema and cardiomyopathy.

- Criteria for image-based diagnosis of HCC:
  - Multiphasic contrast CT or MR
  - Lesion >1cm
  - Arterial phase enhancement
  - Venous or delay phase washout

Treatment of HCC with Y90 led to significant decrease in tumor size and (possibly) reversal of patient's cardiomyopathy.

- Two Yttrium-90 devices are available:
  - SIR Spheres: resin, calculation driven by body surface area and tumor involvement (tumor volume / liver volume)
  - TheraSpheres: glass, calculation driven by liver mass
  - Dose of both limited by lung shunt fraction; must be adjusted

Patient stable 12 months out and now a candidate for either additional Y90 therapy or surgical resection of left hepatic lobe.
REFERENCES & FURTHER READING


