99mTc-MDP Uptake in Liver Metastases in a Patient with Gastric Carcinoma

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• Patient: 67-year old male
• Complaint: abdominal pain for the past 4 months
• Initial treatment: as if viral gastroenteritis
• Evolution: persistent abdominal pain, mass sensation and gastrointestinal bleeding.
• Blood tests:
  – hemoglobin 7.7 g dl⁻¹, white blood cell count 1,600, neutrophil 310, platelets 55,000.
  – Blood smear: immature granulocytes and some nucleated red blood cells (suggestive of marrow infiltration by tumor).
• **Upper gastrointestinal endoscopy:**
  - 4 cm corporo-antral gastric ulcer, Bormann III
  - Gastric mucosa biopsy: intestinal-type adenocarcinoma, moderately well differentiated.

• **Abdominal ultrasound:**
  - Liver metastases
  - Omental cake*
  - Retroperitoneal lymph node metastases

* An **omental cake** refers to infiltration of the omental fat by material of soft-tissue density. The most common causes are metastases from ovary, stomach or colon.
Bone scintigraphy: multiple foci of abnormal uptake are noted in the upper abdomen.

Notice abnormal uptake in distal femora and proximal tibiae suggesting marrow expansion most likely because of marrow infiltration by tumor.
CT scan: ring-enhanced liver lesions. Other findings (not shown): exophytic lesion in the lesser gastric curvature and involved regional lymph nodes.

SPECT: spatial coincidence is noted between abdominal hot spots and liver metastases.
Discussion

The prognosis of gastric cancer with liver metastasis is very poor. Gastric cancers with liver metastasis often have multiple liver lesions and surgical resection is rarely indicated.

The liver is the most frequently involved extraosseous site of metastasis. It is uniquely vulnerable, with its extensive vascular bed, high blood flow and dual blood supply.

Metastases in the liver from a variety of carcinomas accumulate Tc-99m MDP, particularly adenocarcinomas of gastrointestinal origin.

Although calcifications in liver metastases occur frequently, regional perfusion changes, tumor necrosis and other factors are implicated in Tc-99m MDP deposition just as often.
Discussion (II)

Scintigraphy with technetium-99m methylene diphosphonate (MDP) delineates a wide spectrum of nonosseous disorders.

Neoplastic, hormonal, inflammatory, ischemic, traumatic, excretory, and artifactual entities demonstrate abnormal soft-tissue uptake of Tc-99m MDP.

Mechanisms leading to increased extraosseous Tc-99m MDP uptake include extracellular fluid expansion, enhanced regional vascularity and permeability and elevated tissue calcium concentration.

Extraosseous calcium is found associated with collagen, osteoid matrix, myofibrils and other organic substrates.
MDP acts as a ligand adsorbing onto tissue calcium, localizing the Tc-99m in the mineral phase with no significant organic substrate interaction.

The calcium phosphate molar ratio, crystalline surface area, and presence of other metallic ions are factors that determine the reactivity of diphosphonates to calcium deposition.

Rapidly calcifying sites are accumulations of pure, amorphous calcium phosphate with a low Ca:PO$_4$ molar ratio and a large surface area. These features produce avid diphosphonate adsorption compared with that of mature (high Ca:PO$_4$ molar ratio, crystalline) hydroxypatite.
Teaching Points

Regarding extraosseous Tc-99m MDP uptake:

- First, rule out artifact:
  - Free pertechnetate uptake by stomach, thyroid and salivary glands.
  - Radiopharmaceutical colloid formation uptake by liver, spleen and lungs.
  - Aluminum breakthrough.
  - *Contamination.
  - *Gamma camera malfunction.

* Gamma camera malfunction and some cases of contamination will show activity in a constant location with respect to the camera, but not the patient.
Teaching Points (II)

• There are many possible causes of soft tissue uptake in and around the abdomen in adults, including calcified liver metastases (usually from colon, lung, oesophagus, breast or prostate), malignant ascites, peritoneal carcinomatosis, amyloid deposition in the liver, metastatic calcification (due to a high calcium - phosphate product with uptake seen in the kidneys, lungs and stomach), muscle trauma and dermatomyositis.

• Mechanisms such as extracellular fluid expansion, enhanced regional vascularity and permeability and elevated tissue calcium concentration (dystrophic calcification) can explain uptake in liver metastases.
References

