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# Diffuse Abdominal Uptake of Technetium-99m-Methylene Diphosphonate in a Patient on Continuous Ambulatory Dialysis During Bone Scintigraphy

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Extra-skeletal uptake of bone seeking radiopharmaceuticals has been documented by scintigraphy. We present a case of diffuse uptake of <sup>99m</sup>Tc-methylene diphosphonate (MDP) in the abdomen of a patient while undergoing continuous ambulatory peritoneal dialysis (CAPD) who had no symptoms or findings referable to the abdomen. We hypothesized that the <sup>99m</sup>Tc-MDP crossed the peritoneal membrane across a concentration gradient. An in-vitro simulation confirms that <sup>99m</sup>Tc-MDP will cross a semi-permeable membrane. Diffuse uptake of <sup>99m</sup>Tc-MDP may be a normal variant in patients on CAPD who have no signs or symptoms of peritonitis.

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## CASE REPORT

A 41-yr-old female with end stage renal disease requiring continuous ambulatory peritoneal dialysis (CAPD) secondary to Lupus nephritis presented to our department for bone scintigraphy to evaluate the possibility of avascular necrosis of the femoral heads. She had presented to her clinician with the complaint of acute left sided hip pain and, because she had been on steroid therapy (15-30 mg prednisone daily), the diagnosis of avascular necrosis of the femoral head was entertained.

She had no complaints of fever or abdominal pain or symptoms of abdominal infection at presentation. A complete blood count on July 19, 1991 showed a white blood cell count of 5,700, hemoglobin of 11.8 and hematocrit of 35.6. A peritoneal aspirate obtained the same day demonstrated clear, colorless fluid with 20 white blood cells/ml (79% lymphocytes, 21% monocytes) and no red cells. A second peritoneal aspirate 3 mo later revealed a total count of 17 white blood cells (1 segmented neutrophil, 7 lymphocytes and 9 monocytes). At our institution, if a peritoneal aspirate contains fewer than 100 cells without symptoms, an active infectious process is considered unlikely.

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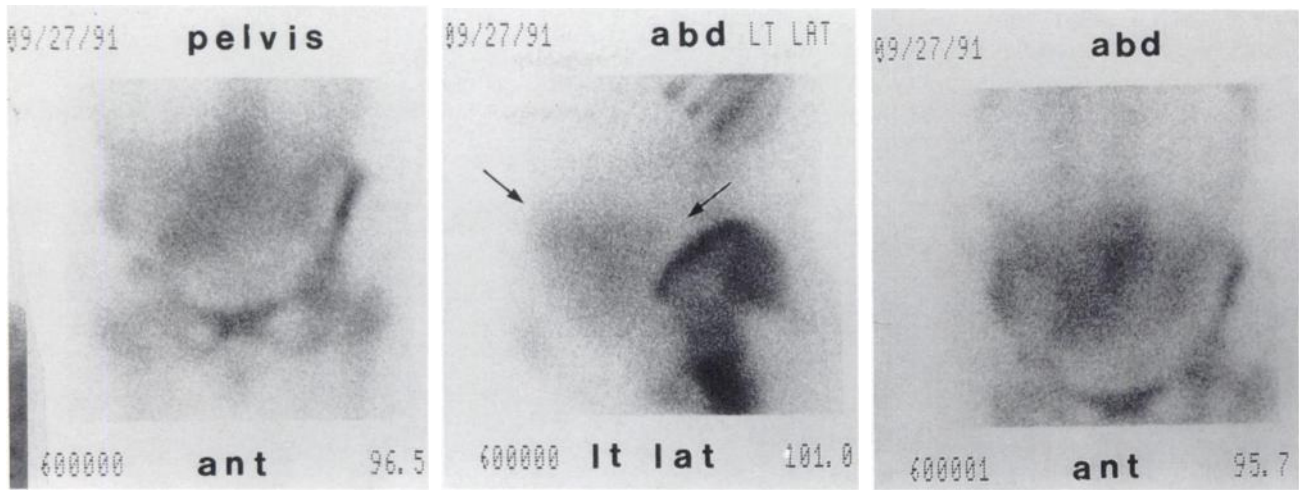
Prior to her arrival to the nuclear medicine department she had taken her usual amount of peritoneal dialysate without complication. She was subsequently injected with 740 MBq (20 mCi) of <sup>99m</sup>Tc-methylene diphosphonate (MDP) and 3 hr post-injection standard planar images were obtained of the patient from the level of the abdomen to the feet in the standing position. Images were obtained utilizing a large field of view camera fitted with a low-energy, all-purpose collimator. A total of 600,000 counts per image were acquired using a 20% window centered at a 140 keV photopeak. The anterior and lateral views of the abdomen and anterior view of the pelvis demonstrate diffusely increased activity in the lower abdomen and pelvis (Figs. 1-3). No accumulation of the radiopharmaceutical is seen in the renal regions. An enhanced computed tomography (CT) scan from July 1991 confirms the presence of free intra-abdominal fluid (Fig. 4) within the peritoneal cavity, as would be expected in a patient on CAPD.

## In-Vitro Simulation

Five milliliters of human fresh frozen plasma and 5 ml of 4.25% dextrose peritoneal dialysate were placed into separate chambers of a dialysis cell separated by a cellulose semi-permeable membrane (Scienceware, Paquannick, NJ). Technetium-99m-MDP, 21.4 MBq (580  $\mu$ Ci), was added to the plasma side of the dialysis cell. One hundred microliter aliquots were then removed from both sides of the dialysis cell at 15-min intervals from time zero to time 120 min and assayed for activity in a well counter. Additional 100  $\mu$ l aliquots were obtained at time 120 min to assess percent free [<sup>99m</sup>Tc]pertechnetate. The percent difference  $\times$  100 of the activity of the dialysate versus plasma was then plotted on a time-activity graph (Fig. 5).

## DISCUSSION

Extra-skeletal uptake of bone-seeking radiopharmaceuticals is well known. Uptake of <sup>99m</sup>Tc-MDP has been reported in both malignant and benign pleural effusions and ascites (1-7). The soft tissues can accumulate <sup>99m</sup>Tc-MDP and other radiopharmaceuticals from a variety of causes: malignancies such as breast and lung carcinoma, malignant melanoma and osteosarcoma, either primary or metastatic, and a host of benign conditions, such as ischemia, infarcts, abscess, vascular calcifications, healing wounds, electrical burns, radiation pneumonitis and nor-



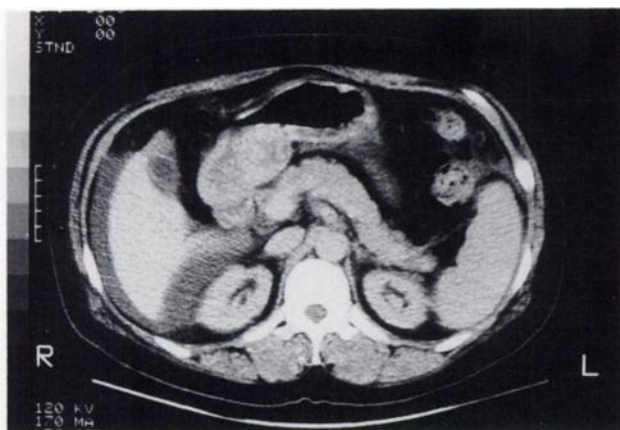
**FIGURES 1-3.** Anterior pelvis, lateral abdomen and anterior view of the abdomen demonstrate diffusely increased activity in the expected abdominal cavity (patient in the standing position). Note the lack of gastric activity that would be seen if free pertechnetate was present.

mal breast tissue (8-11). The uptake of bone-seeking radiopharmaceuticals has even been described in the lungs and thyroid from metastatic calcifications of primary and secondary hyperparathyroidism, amyloid deposits and in the lungs of patients affected by alveolar microlithiasis (12-27).

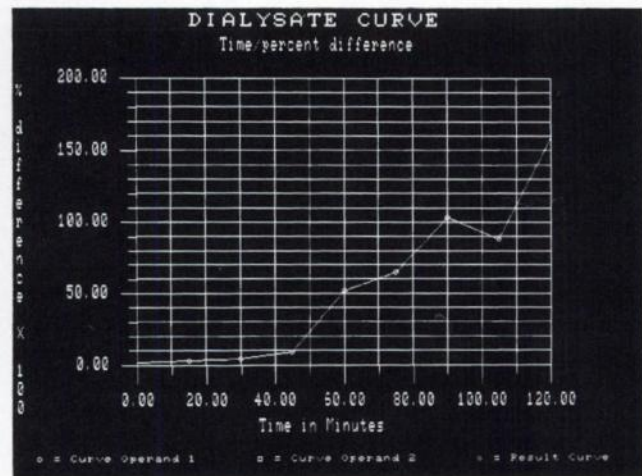
In patients receiving CAPD, nuclear medicine procedures are commonly used to evaluate its potential complications to include: internal and inguinal hernias and patent processus vaginalis, peritonitis and dialysate leaks or exit site drainage (28-32). However, these procedures utilize  $^{99m}\text{Tc}$ -sulfur colloid (SC) or macroaggregates (MAA), not MDP. Technetium-99m SC and MAA have also been used to evaluate patients with ascites for the presence of abnormal abdominal communication (33). Technetium-99m-labeled human serum albumin has been used to evaluate

the intra-abdominal distribution of chemotherapeutics in patients with advanced ovarian malignancies (34). Peritoneal dialysis itself has been known to cause a photopenic defect in the abdomen of patients on CAPD during renal scintigraphy in the work-up of transplanted kidneys (35). Our patient demonstrates diffuse uptake of  $^{99m}\text{Tc}$ -MDP in the abdomen, which apparently is in the dialysate fluid. However, she has no history of malignancy or signs, symptoms or laboratory data to suggest infection at the time her scan was performed. Our review of the literature reveals no prior report of this finding in a patient while receiving CAPD.

In an effort to explain this finding, we hypothesized that  $^{99m}\text{Tc}$ -MDP crossed the peritoneal membrane into the dialysate following its own concentration gradient from the intravascular compartment to the peritoneal dialysate. From our in-vitro simulation, we have demonstrated that  $^{99m}\text{Tc}$ -MDP is capable of crossing a semipermeable mem-



**FIGURE 4.** Selected contrast-enhanced computed tomography scan of the patient through the level of the pancreas demonstrates fluid density in the hepatorenal fossa, the lesser sac, lateral to the liver and within the gallbladder fossa, all to be expected in a patient with free peritoneal fluid. Note the lack of contrast accumulation within the renal collecting systems.



**FIGURE 5.** Time versus activity (percent difference  $\times$  100) of peritoneal dialysate as compared to plasma.

brane through a concentration gradient. Of interest is that percent free [ $^{99m}\text{Tc}$ ]pertechnetate was much higher in the dialysate than in the plasma of our simulation (37.7% versus 6.04%). It may be that the free pertechnetate, being a smaller molecule than the  $^{99m}\text{Tc}$ -MDP complex, can diffuse across the membrane more readily. There may be some dissociation of the  $^{99m}\text{Tc}$ -MDP complex in the plasma as well or as the complex crosses the membrane. In our patient, however, the anterior view of the abdomen does not demonstrate gastric uptake that would be consistent with free pertechnetate in vivo. Further investigation in this area is needed and may help to elucidate to these hypotheses.

We conclude that diffuse abdominal uptake of  $^{99m}\text{Tc}$ -MDP may be a normal finding in a patient on CAPD if no other predisposing conditions can be obtained from the patient's history, laboratory data or examination results.

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