BONE MINERAL STUDY
(Tc-99m-MDP, Tc-99m-HMDP)

Overview

- The Bone Mineral Study, with either Tc-99m-MDP or Tc-99m-HMDP, depicts the distribution of bone mineral metabolism throughout the skeleton. In addition, rapid serial images during the first pass of the radiopharmaceutical through the circulation may be obtained to demonstrate regional perfusion.

Indications

- Detection of bone metastases (1-3).
- Diagnosis of osteomyelitis (4,5).
- Evaluation of musculoskeletal trauma (6-9).
- Assessment of low back pain (10).
- Evaluation of primary benign and malignant bone lesions (11).
- Diagnosis of reflex sympathetic dystrophy (12,13).
- Evaluation of the response of Paget's disease to treatment (14).
- Evaluation of heterotopic ossification.

Examination Time

- Initially: 15 minutes for injection of the radiopharmaceutical; 25 minutes for
- 2-3 hours later: 1 hour for image acquisition.

Patient Preparation

- None:
  - > Hydration does not improve image quality (15).
  - > Alendronate does not interfere with radiopharmaceutical uptake (16).

Equipment & Energy Windows

- Gamma camera: Large field of view, preferably with dual heads.

- Collimator: Low energy, high resolution, parallel hole.
- Energy window: 20% window centered at 140 keV.

Radiopharmaceutical, Dose, & Technique of Administration

- Radiopharmaceutical (17,18):
  - Tc-99m-methylene diphosphonate (MDP).
  - Tc-99m-hydroxymethylene diphosphonate (HMDP).
- Dose: 25 mCi (925 MBq).
- Technique of administration:
  > Routine study: Standard intravenous injection.
  > Three phase study: Oldendorf method.

Patient Position & Imaging Field

- Patient position: Supine (prone position can be used if patient cannot lie supine).
- Imaging field: Entire body (arms may be omitted).

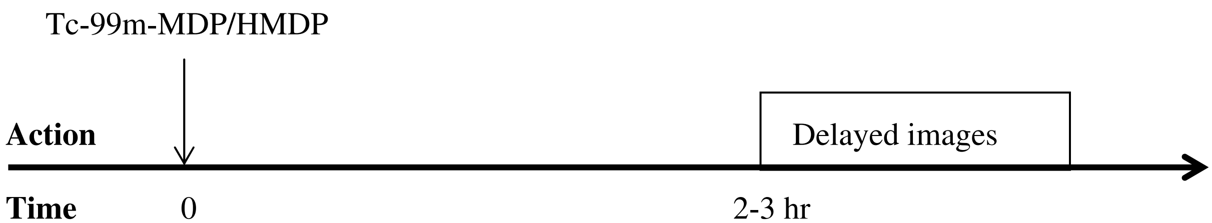
Acquisition Protocol - Routine Study (17)

- Begin image acquisition 2-3 hours following injection of the radiopharmaceutical.
- Have the patient empty his/her bladder immediately before image acquisition.
- Moving acquisition protocol:
  1. Use a camera/table motion of approximately 10-15 cm/min.
  2. Acquire ANT and POST images from the head to the bottom to the feet. (If a single head camera is being used, only ANT images of the lower extremities may be acquired.)
  3. Acquire static "spot" images as indicated.
- Static acquisition protocol:
  1. Acquire an ANT image of the chest for approximately 500-750 K counts, note the time required for acquisition.
  2. Using the same acquisition time used for the ANT chest image acquire ANT and POST images of the rest of the torso and head, and ANT images of the extremities (arms may be omitted).
- SPECT tomographic images are routine for low back pain, and are used in other selected situations (19-22):

1. Image acquisition parameters:
    a) degrees of rotation: 360°.
    b) number of images: 64.
    c) time per image: 20 seconds.
2. Data processing:
    a) reconstruct transverse, sagittal, and coronal image.
    b) filter selection depends on computer software package.

- Have the patient empty his/her bladder at the end of the study.

Protocol Summary Diagram



Data Processing

- None as a routine unless SPECT imaging is performed.

Optional Maneuvers

- Three phase bone scan (4):
    1. Routinely used when the clinical question is infection in the extremities; frequently used for question of stress fracture, avascular necrosis, or primary bone tumor.
    2. The patient position and field of view depend on the area of interest; include both sides of the body, e.g. both legs or both hands, so that the normal side can be used for comparison.
    3. The radiopharmaceutical is administered as a bolus using the Oldendorf technique:
        a) if the site of interest is the hands or arms, a tourniquet should be used instead of a blood pressure cuff and there should be a 3 minutes pause between release of the tourniquet and injection (23).
    4. Acquire serial analog images for 5 seconds each for 60 seconds (12 frames) starting at the time of injection.
    5. Immediately acquire a blood pool image for approximately 1 minute. (The number of counts will depend on the body part being imaged and other factors.)

6. Have the patient return in 2 hours for the delayed images; follow the acquisition protocol for delayed images given above.

- Special views (17):
  1. Images of the scapula with the arms moved forward or up can be used to differentiate activity in the scapula and underlying ribs (24).
  2. The TOD view (tail on detector) is useful for separating otherwise superimposed structures around the pelvic ring. The view is obtained with the patient sitting over the head of the camera.
  3. The skyline view of the elbow improves localization of elbow pathology (25).
  4. Small structures may be magnified with a 2 mm pinhole collimator (26).

- Intraoperative bone imaging: May be used to localize lesions for surgical resection (12,27). The specimen may also be imaged to document that the lesion has been removed.

- Maximum intensity projection (MIP) display: May assist in lesion evaluation (28).

- SPECT-CT imaging: SPECT-CT imaging of the spine is useful in localizing metabolically active vertebral bodies prior to vertebroplasty (29).

Principle Radiation Emission Data - Tc-99m (30)

- Physical half-life = 6.01 hours.

Radiation	Mean % per disintegration	Mean energy (keV)
Gamma-2	89.07	140.5

Dosimetry - Tc-99m-MDP/Tc-99m-HMDP (31,32)

Organ	rads/25 mCi	mGy/925 MBq
Bladder wall		
2 hour void	3.25	32.5
4.8 hour void	7.75	77.5
Kidneys	1.00	10.0
Bone total	0.88	8.8
Red marrow	0.70	7.0
Testes		
2 hour void	0.20	2.0
4.8 hour void	0.28	2.8
Ovaries		
2 hour void	0.30	3.0

4.8 hour void	0.43	4.3
Total body	0.16	1.6

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<u>Normal Findings</u>

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