

**Clinical Protocol: NUCLEAR MEDICINE BONE SCINTIGRAPHY**  
**(Tc-99m hydroxymethylene diphosphonate HDP or methylene diphosphonate MDP)**

**Date Last Reviewed:** 4/2/2025

**Responsible Division:** Division of Nuclear Medicine, Department of Radiology, UT Southwestern

**Policy Basis for Procedure:** To establish a protocol for bone scan whole body, limited, multi-phase (3phase) and/or SPECT (with or without integrated CT) used to detect benign and malignant abnormalities of osseous structures.

**Description of Procedure:** Bone scintigraphy studies evaluate the distribution of osteoblastic activity in benign, malignant, or physiological processes.

**Scope** This policy applies to all individuals working in William P. Clements Jr. University Hospital and all hospital based clinics; Parkland Health & Hospital System (PHHS) facilities and hospital based clinics.

**Indications**

- Skeletal metastatic disease and staging (e.g., neuroblastoma or cancers of the prostate, breast, lung, or kidney)
- Primary bone tumors (benign and malignant)
- Occult or stress fractures and shin splints
- Osteomyelitis
- Avascular necrosis
- Arthritides
- Complex regional pain syndrome (formerly called reflex sympathetic dystrophy)
- Bone infarction
- Bone graft viability
- Bone pain that is otherwise unexplained
- Evaluation of distribution of osteoblastic activity before radionuclide therapy
- Accidental and nonaccidental trauma
- Further evaluation of skeletal abnormalities incidentally found on other types of imaging studies
- Prosthetic hardware complications
- Heterotopic ossification
- Paget disease
- Fibrous dysplasia
- Hypertrophic osteoarthropathy
- Bone manifestations of sickle cell disease
- Temporomandibular joint disorders
- Tissue viability for frostbite (*See optional maneuver*)

**Contraindications**

- For the pregnant or potentially pregnant and breastfeeding mothers, a pregnancy screening form must be administered. The attending physician must be notified of a positive pregnancy test result and will provide instruction on how to proceed.
- Patients who are breastfeeding should be instructed to pump and discard milk for 4-24 hours after injection

**Examination Time**

- Preparation and Injection: up to 30 minutes

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- Delay: 2 – 4 hours
- Imaging: 30 mins – 1.5 hours
  - SPECT/CT images may be required as determined by the interpreting physician

### Patient Preparation

- Focused history regarding the reason for examination (symptoms, diagnoses, treatments, implants, recent imaging examinations, surgeries, trauma, history of cancer etc.) should be noted and communicated to the reading physician/resident
- No dietary restrictions
- Instruct patient to stay hydrated and void frequently for at least 24 hours following administration of radiotracer to promote excretion and reduce radiation exposure.
- External attenuating (metal belts, jewelry, etc.) objects shall not be worn and should be removed if possible
- Void immediately prior to imaging to decrease radiation dose to the bladder and to maximize patient comfort

### Radiopharmaceutical, Dose, & Technique of Administration

- Radiopharmaceutical: Tc99m hydroxymethylene diphosphonate HDP (preferred method) or Tc99m methylene diphosphonate MDP
- Dose: faculty may decrease dose amount among shortages
  - Adult: 25 mCi, +/- 20%, (13 - 30 mCi is an acceptable range)
  - Pediatric: 6 mCi, +/- 20% (4 – 6 mCi is an acceptable range)
    - with a minimum of 0.5–1.0 mCi and maximum not exceeding the maximum for a healthy adult
- Technique of administration: Standard intravenous injection using a 3 way stop-cock
  - Flush 1 cc 0.9% sodium chloride to confirm patent line, inject the radiopharmaceutical and upon completion aspirate 5 cc 0.9% sodium chloride into the radiopharmaceutical syringe then in a pulsating motion infuse into patient, then flush with remaining 0.9% sodium chloride

### Equipment & Energy Windows

- Gamma camera: Large field of view, SPECT/CT
- Collimator: Low energy, high resolution, parallel hole.
- Energy window: 20% window centered at 140 keV.

### Patient Position & Imaging Field

- Three Phase Bone Scan
  - Patient position: Supine
  - Imaging field: Include area of interest on flow, blood pool and delay phases.
  - Include bilateral body regions, e.g. both legs or hands so that normal side can be used for comparison.
  - Perform whole body as directed by reading physician/resident on delayed images. (ie. history of cancer)
- Whole body Bone Scan
  - Patient position: Supine with arms by the side
  - Imaging Field: Entire Body

### Acquisition Protocol

- Have patients remove any metal objects before image acquisition.
- Patient should void immediately prior to the image acquisition

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- Any nonstandard position of the patient and any other deviation from the standard protocol (e.g., extravasation, movement of the patient, mobility issues, and premature termination of the scan) should be noted in patient's EMR.
- The acquisition time/counts will need to be increased for any patient receiving a decreased amount of radiopharmaceutical (due to shortages) to provide faculty/residents with optimal quality images required for proper interpretations.
- Routine imaging should begin 2 hours post injection.
  - Three Phase :
    - For extremities, be sure to clearly mark the right side with a low activity point source
    - Dynamic flow images :
      - Anterior & posterior unless otherwise specified by faculty
      - 2 seconds/frame for 60 seconds
      - 64 x 64 matrix
    - Blood pool images:
      - Anterior & posterior to match same FOV as flow , right and left lateral images
      - 3-5 minutes /image or 300K – 500K counts/image
        - 150k–200k counts per image may be adequate for the extremities
      - 128 X 128 matrix or greater
  - The whole body acquisition:
    - Start acquisition 2 – 4 hours post injection. Additional delay in imaging (6 – 24h) may be useful when longer times are needed for background washout such as in renal insufficiency or urinary retention.
    - Speed : 8 cm/min
      - patients whom are unable to lay comfortably, the scan speed may be adjusted to 12cm/minute
    - Matrix size : 1024 x 256 if available or 256 X 256
    - 1.5 million counts or greater
    - The scan should start at the top of the patient's head and should be terminated once the camera heads image the patient's feet. Bilateral spot views of the skull and pelvis are standard requirements. Bilateral oblique are to be included in patients with history of breast cancer.
  - Delayed Planars
    - 256 x 256 matrix
    - 500k – 1 million cts/image for thorax and abdomen
    - 250k – 400k for skull and pelvis
    - 150k – 250k for extremities
    - Oblique planars (RAO/LPO & LAO/RPO) of the ribs are required for a past medical history of breast cancer. Ensure the sternum is not overlapping the spine.
  - SPECT/CT may be performed at the request of reading physician/resident :
    - 10 - 40 seconds/stop depending upon patient compliance and region of interest
    - 128x128 matrix
    - radius of rotation : elliptical with patient body contouring
    - 180° degrees for each detector
    - 32 views
  - CT :
    - Care Dose 4D to modulate mAs

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- Quality reference: 100 – 200 mAs
- 120 kVp (ranging from 80 -130 kVp)
- Rotation time 0.5s
- Pitch: 0.5s
- 5 mm slices in 256 x 256 matrix

### Optional Maneuvers

- Delayed imaging may be performed up to 24 hours to improve quality for patients whom soft tissue clearance is impaired.
- Multi-phase bone scintigraphy for frostbite may be performed to evaluate the depth of injury after initial non-surgical and interventional treatment(s). Bone scintigraphy for frostbite provides essential information regarding microvascular and bone perfusion and can demarcate the level of bone necrosis for surgical planning (10).
  - **Acquisition Protocol:** 3 phase and SPECT/CT (on the delay phase)
    - Flow and blood pool phase: finger(s) and/or toe(s) are marked at the tips with a very small amount of Tc-99m activity or with the use of cobalt markers (100-300 uCi) so the physician/resident can identify the most distal level of flow
    - Additional markers applied to the heel of the feet when looking at lower extremities should also be utilized to improve localization of findings.
    - Fingers should be extended and spread out
    - Feet should be in plantar position but will depend on the patient's mobility and comfort
    - Zoom of 2
  - SPECT/CT:
    - 20 secs/stop
    - 64 views
    - Noncircular
    - 128 x 128 matrix
    - 3D OSEM, 5mm
    - Ensure Care dose is enabled to minimize radiation exposure to the patient
    - Hands are positioned over the abdomen to make sure they are completely in the field of view. Make sure to remove all metal including metal from pants, jewelry, etc.
    - Feet may be supported by pillows or cushions with a rolled up towel or sheet placed in-between the feet for adequate separation. Wrap the feet with tape or Coban to minimize movement depending on the patient's comfort.



## Data Processing

- Label all processed images in accordance to ACR standards
- Dynamic images are displayed in anterior and posterior projections for total of 30 frames for blood flow
- Blood pool and delay images are displayed in anterior and posterior, medial and lateral images for area of interest.
- Plantar and Palmer images right and left are clearly annotated on all image sets.
- Whole body images are displayed in anterior and posterior projections
- If applicable: reconstruct and fuse attenuated corrected images into transverse, sagittal, and coronal
- Send : raw and processed planar images, Topogram , Patient Protocol, Patient Dose Report, Statistics, AC CT, AC, NAC, recons, MIP/VRT (if applicable), and all planes fused files to Sectra PACS, verify
- Send AC/NAC files and recons to Syngo

## Principle Radiation Emission Data:

- Physical half-life = 6.01 hours
- Radiation: Gamma
- Mean energy: 140.5 keV

## Dosimetry – Tc-99m phosphates

SNMMI Practice Guideline for Bone Scintigraphy 4.0

**TABLE 1. Radiation Dosimetry in Adults**

Radiopharmaceutical	Administered activity (MBq)	Critical organ (bladder)	Effective dose
<sup>99m</sup> Tc-phosphates (intravenous)	500–1,110	0.047 (mGy/MBq)	0.0049 (mSv/MBq)
		34.8 (mGy/740 MBq)	3.6 (mSv/740 MBq)
		52.2 (mGy/1,110 MBq)	5.4 (mSv/1,110 MBq)

Values for normal bone uptake and normal renal function are from *Radiation Dose to Patients from Radiopharmaceuticals*. London, U.K.: ICRP; 1988:215. ICRP report 53. See also Weber DA, Makler PT Jr, Watson EE, Coffey JL, Thomas SR, London J. MIRD dose estimate report no. 13: radiation absorbed dose from technetium-99m-labeled bone imaging agents. *J Nucl Med*. 1989;30:1117–1122.

## Definitions:

- MDP- methylene diphosphonate
- HDP- hydroxymethylene diphosphonate
- SPECT- Single Photon Emission Computed Tomography
- CT- Computer Tomography
- LEHR- Low Energy High Resolution
- ALARA- As Low As Reasonably Achievable
- FOV – field of view
- RAO – right anterior oblique
- RPO – right posterior oblique
- LPO – left posterior oblique
- LAO – left anterior oblique

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### Applicable Forms:

- Pregnancy Screening form, if applicable

### References:

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5. [ACR–ACNM–SNMMI–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF SKELETAL SCINTIGRAPHY \(BONE SCAN\) \(2021\)](#)
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Review Date	Status	Name and Title	Approver; Date	Brief Summary
4/2/2025	Approved	Orhan Oz, MD, PhD, Daniel Lee, MD; Dr. Mi-Ae Park; Dr. Nima Kasraie; Trizzy Bui, Tech Sup (UT); Julie Eberting, Jacqueline Rolen (PHHS)	Dr. Orhan Oz; 4/23/2025	Adding frost bite protocol under optional maneuvers.
9/26/2024	Approved	Orhan Oz, MD, PHD, Daniel Lee, MD; Dr. Mi-Ae Park; Dr. Nima Kasraie; Trizzy Bui, Tech Sup (UT); Julie Eberting, Jacqueline Rolen (PHHS)	Dr. Orhan Oz; 2/19/2025	Formatting changes, addition of contraindications; Amendment to indications, prep, acquisition protocol; updated references
11/2022	Approved	Brooke Pipes, Tech Sup	11/2022	Dose range for HDP amended, pediatric doses added.
06/2020	Approved	Brooke Pipes, Tech Sup	06/2020	Oblique planar images added for patients with history of breast cancer
06/2019	Approved	Brooke Pipes, Tech Sup	06/2019	Seconds per stop amended
11/2018	Approved	Brooke Pipes, Tech Sup	11/2018	Formatting changes
11/2017	Approved	Brooke Pipes, Tech Sup	11/2017	Addition to alternative radiotracers