BONE SCINTIGRAPHY (BONE SCAN)

PURPOSE:

To establish a protocol for bone scan (3 phase, whole body, and/or SPECT) used to detect benign and malignant abnormalities of osseous structures.

SCOPE:

All Nuclear Medicine Technologists and Physicians must adhere to these guidelines when performing a Bone scan and Bone SPECT/CT scan.

PROCEDURE:

1) Indication (1-4)

    1) Detection of bone metastases.
    2) Diagnosis of osteomyelitis.
    3) Evaluation of musculoskeletal trauma.
    4) Occult or stress fractures and shin splints.
    5) Avascular necrosis.
    6) Bone infarction.
    7) Bone manifestations of sickle cell disease.
    8) Bone graft viability.
    9) Arthritides.
    10) Evaluation of primary benign and malignant bone lesions.
    11) Diagnosis of complex regional pain syndrome (formerly known as reflex sympathetic dystrophy).
    12) Evaluation of Paget’s disease and the response to treatment.
    13) Fibrous dysplasia.
    14) Hypertrophic osteoarthropathy.
    15) Evaluation of heterotopic ossification.
    16) Assessment for mandibular hyperplasia or other temperomandibular joint disorders.

17) Prosthetic hardware complications.

18) Bone pain that is otherwise unexplained.

19) Further evaluation of skeletal abnormalities found on other imaging studies

B. Examination Time

1) Initial: 15 minutes for injection of the radiopharmaceutical; 25 minutes for blood flow and blood pool imaging in three phase study.

2) Delayed: Patient should return 2-3 hours and expect the actual images to take at least 30 minutes

C. Patient Preparation

1) 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 results and will provide instruction on how to proceed.

2) Patients should drink at least 16 ounces of liquid before they return for delayed imaging. Patients should void frequently to decrease radiation dose to the bladder.

D. Equipment and Energy Windows:

1) Dual Head Gamma Camera: Large field of view

2) Collimator: Low energy, high resolution, parallel hole

3) Energy window: 20% window centered at 140 keV

E. Radiopharmaceutical, Dose and Techniques of Administration

1) Radiopharmaceutical: Tc99m methylene diphosphonate (MDP) or Tc 99m hexamethylene diphosphonate (HDP)

2) Dose: 25.0 mCi (925 MBq) [dose can be within +/- 20%. Note that in times of Tc99m shortage the medical director may authorize reduction in dose to as low as half the usual amount].

3) Technique of Administration: Intravenous Injection utilizing a three-way stop cock, aspirating into the radiopharmaceutical syringe a minimum of 5cc of 0.9% sodium chloride followed by 5 cc flush with the same.

F. Patient Position and Imaging Field

1) Three Phase Bone Scan

Patient position: Supine

Imaging field: Include area of interest on flow, 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 on delayed images.

2) Whole body Bone Scan

Patient position: Supine with arms by the side

Imaging Field: Entire Body

G. Acquisition Protocol

1) Have patient empty bladder immediately before imaging.
2) Ask patient to remove all objects that could cause artifacts on the images.
3) Position patient on imaging table with camera position over area of interest (start at head if whole body imaging). Make sure to remind patient to hold still during the acquisition. Acquire dynamic, whole body, static and/or SPECT imaging as specified by the nuclear medicine physician.
4) Dynamic images:
    a) Anterior and Posterior unless otherwise specified by faculty
    b) Acquire at 2 second/frame for a total of 60 seconds
    c) 64x64 or greater matrix
5) Blood Pool images:
    a) Change to blood pool images after dynamic
    b) Acquire 3-5 minutes/image and within 10 min after injection of tracer
    c) Acquire at a count density of 300k-500k counts/image, 150k-220k maybe adequate for the extremities.
    d) 128X128 or greater matrix.
6) The whole body acquisition:

a) Obtained 2 – 4h 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.

b) Count rate (usually of the anterior chest) should be determined before image acquisition, and the scanning speed adjusted so that the images contain more than 1.5 million total counts.

c) Should be performed with the LEHR collimators, typically at a speed of 12 cm/min but in conformance with 6b) above. A dual detector acquisition should be performed with heads A (anterior) and B (posterior) set to auto contour.

d) 256 x 1, 024 matrix or greater.

e) 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 lateral skull, lateral pelvis and in patients with breast cancer, bilateral oblique.

f) When spot views are used as the primary method of acquiring the delayed images the recommended counts are 500k – 1million counts for the thorax and abdomen, 250k-400k for the skull and large joints, and 150k-250k for distal extremities. More counts should be obtained when FOV is larger. A 128 x 128 or 256 x 256 matrix can be used.

g) A pinhole collimator may be used if very high resolution images of a specific area are necessary. This is more common in infants, children and small structures. Acquire 75k- 100k counts. Zoom magnification or a converging collimator may also be used to improve visualization.

7) SPECT/CT acquisitions are to be performed at the request of the Radiologist or Nuclear Medicine Physician.

a) A dual detector (LEHR) acquisition with 64 projections should be acquired.

b) Each projection should be acquired for 15-30 seconds in a step and shoot acquisition.

c) The radius of rotation is circular and 180° degrees for each detector.

d) A 128x128 matrix is used.

e) 3-dimensional iterative ordered-subsets expectation maximization is the typical reconstruction algorithm, with typically 3-5 iterations and 8-10 subsets.

f) Data is corrected for attenuation, scatter, and resolution recovery.

g) Post-processing should usually include application of a Gaussian filter (width at half-maximum 4-10mm) or a Butterworth filter (conventional parameters of 10.0.5).

h) For the CT acquisition please adhere to manufacturer recommendations, including the application of the CareDose and recommended scan times to be in compliance with ALARA.

H. Data Processing and Display

1) Dynamic images are displayed in anterior and posterior projections for total of 30 frames for blood flow.

2) Blood pool images are displayed in anterior and posterior, medial and lateral images for area of interest.

3) Plantar and Palmar images may be required by reading physician.

4) Right and Left should be clearly marked on all image sets.

5) Whole body images are displayed in anterior and posterior projections

6) SPECT processing and display

a) Process CT images with both a soft tissue kernel (B30 or 40) and bone kernel (60B-80B)

b) Fuse attenuation corrected data with CT and display in 3-orthogonal planes (axial, coronal, and sagittal).

I. Principle Radiation Emission Data (Tc99m)

1) Physical half-life: 6.01 hours

2) Radiation: Gamma

3) Mean % per disintegration: 89.07%

4) Mean energy: 140.5 keV

J. Dosimetry: As per (Table 1 from reference 1)

Table 1. Patient Radiation Dosimetry Technetium-99m Tc-Labeled Phosphonates[2] [9]:

Patient	Organ receiving the largest radiation dose	Effective dose
Adult	Bone surfaces 0.063 mGy/MBq (0.23 rad/mCi)	0.0057 mSv/MBq (0.021 rem/mCi)
15-year-old	Bone surfaces 0.082 mGy/MBq (0.30 rad/mCi)	0.007 mSv/MBq (0.026 rem/mCi)
10-year-old	Bone surfaces 0.13 mGy/MBq (0.48 rad/mCi)	0.011 mSv/MBq (0.041 rem/mCi)
5-year-old	Bone surfaces 0.22 mGy/MBq (0.81 rad/mCi)	0.014 mSv/MBq (0.052 rem/mCi)
1-year-old	Bone surfaces 0.53 mGy/MBq (2.0 rad/mCi)	0.027 mSv/MBq (0.10 rem/mCi)

DEFINITIONS:

1. MDP- methylene diphosphonate; HDP- hexamethylene diphosphonate
2. SPECT- Single Photon Emission Computed Tomography
3. CT- Computer Tomography
4. FOV- field of view
5. LEHR- Low Energy High Resolution
6. ALARA- As Low As Reasonably Achievable

APPLICABLE FORMS:

N/A

REFERENCES:

1. ACR–SPR Practice Parameter for the performance of Skeletal Scintigraphy (Bone Scan) 2017.
2. EANM practice guidelines for bone scintigraphy. Eur J Nucl Med Mol Imaging 2016. 43:1723-1738.
3. Society of Nuclear Medicine and Molecular Imaging Procedure Standard for Bone Scintigraphy version 4.0, approved June 21, 2018. J Nucl Med Technol 2018. 46:398-404.
4. Bone Scintigraphy SPECT/CT Evaluation of Mandibular Condylar Hyperplasia.Yang Z, Reed T, Longino BH. J Nucl Med Technol. 2016 Mar;44(1):49-51. doi: 10.2967/jnmt.115.158691.