BASIC IMAGING PROCEDURES IN NUCLEAR MEDICINE

CLIFTON
and
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Basic Imaging Procedures in Nuclear Medicine

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Basic Imaging Procedures in Nuclear Medicine

To my father,
W. T. Clifton,
to my brothers,
Keith and David,
and to the memory of my mother,
Mary Ann Clifton

N. C.

To my parents,
Richard and Marjorie Simmons,
to my sisters,
Bettye Simmons Crouch and Laura Simmons.

P. S.

Preface

This book was written to serve as a guide to major nuclear medicine imaging procedures. Although written primarily for nuclear medicine technologists and students, we feel it will be very useful to nuclear medicine physicians and residents.

We wish to emphasize two points:

A. Much of the material in this text is based on the authors' practice and may have to be modified for specific departments.

B. This book is designed to serve as a supplementary educational and study tool.

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Introduction and Procedure Divisions

It should be kept in mind that every nuclear medicine department is different. Although imaging procedures will be basically the same, each department will have their own adaptations according to physician's preference, availability of equipment, choice of nuclide, etc.

Explanation of Procedure Divisions

I. **INDICATIONS**
It would be impractical to attempt to list every possible indication for an imaging procedure; therefore, this section is a list of only the major indications for each study.

II. **CONTRAINDICATIONS**
As stated throughout the book, the manufacturers' product information should be consulted before administration of any radiopharmaceutical. This information should then be correlated with the patient's medical history.

III. **PATIENT PREPARATION**
This section is a description of the medication, dietary, and/or activity restrictions or recommendations required in pre- and/or post imaging.

IV. **NUCLIDE**

As stated throughout the book, the choice of nuclide may be based on such diverse factors as: type of pathology suspected, patient load, patient preparation, patient's medical history, nuclide availability and/or physician's preference. We have listed the nuclides most commonly used to date and no attempt was made to endorse the use of a particular radiopharmaceutical.

V. **DOSE**

The dose range listed in many of the sections are nonspecific (ex: 3-5 mCi). The final decision in regard to specific dose rests with the physician in accordance with license limitation, patient age, patient size, etc.

VI. **METHOD OF LOCALIZATION**

This section lists the means by which the radiopharmaceutical is concentrated or localized in a specific area of the body.

VII. **AREA OF LOCALIZATION**

This section lists the specific area or areas of the body in which the radiopharmaceutical is concentrated or localized.

VIII. **CRITICAL ORGAN**

The critical organ is the organ that receives the highest radiation dose after the administration of the radiopharmaceutical.

IX. **SCINTILLATION CAMERA COLLIMATION**

Listed in this section are the collimators that can effectively be used to perform the study. A brief explanation of each collimator is included. The actual choice of collimation will depend on availability, pathology suspected, patient load, and/or physician's preference.

X. **PROCEDURE**

This section is a step-by-step guide to the actual performance of the study.

XI. **POSITIONING/LANDMARKS**

One of the most important aspects in doing any procedure is to have the patient in the correct position every time. We have outlined each position for each study in accordance with body planes, angle of body parts, etc. in order that consistency of positioning may be achieved.

XII. **TECHNOLOGIST TIPS**

This section contains hints, ideas, pitfalls, common errors, etc. to help the technologist and/or physician when performing the procedure.

Basic Imaging Procedures in Nuclear Medicine

Contents

1 Central Nervous System Procedures

Cerebral Perfusion and Brain Imaging

I. INDICATIONS
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- B. Tumor evaluation
  1. Primary/metastatic neoplasm
  2. Benign neoplasm
  3. Meningioma
- C. Vascular disease
  1. Cerebrovascular accident (CVA)
  2. Arteriovenous malformation (AVM)
  3. Transient ischemic attack (TIA)
- D. Inflammatory disease
  1. Abscess
  2. Meningoencephalitis
- E. Evaluation of therapy
  1. Radiation therapy
  2. Chemotherapy
- F. Evaluation of patients with unexplained neurologic signs and symptoms

II. CONTRAINDICATIONS

There are generally no contraindications for this study. However, manufacturers' product information should be consulted before administration of any radiopharmaceutical.

III. PATIENT PREPARATION

A. Thirty to sixty minutes before I.V. administration of Tc-99m pertechnetate, the patient should be given an oral dose of 200–400 mg of potassium perchlorate to decrease normal uptake in the choroid plexus.

- Gastric irritation has been reported in therapeutic doses greater than 1 gm per day. There is the possibility of temporary local gastric irritation with the administration of subtherapeutic doses in capsule form. To prevent gastric irritation, $KClO_4$ should be administered with several ounces of water.

B. Glycopyrrolate, a synthetic anticholinergic agent, will also help eliminate pertechnetate activity in the choroid plexus and mouth, and helps reduce activity in the salivary glands. Fifteen to thirty minutes before I.V. administration of Tc-99m pertechnetate, the patient should be given glycopyrrolate either 0.2 mg I.V. or I.M., or 2.0 mg orally.

- Glycopyrrolate is contraindicated in glaucoma, some arrhythmias, CHF, coronary insufficiency, cardiospasm, pyloric stenosis and prostatism.

C. No patient preparation is required when using Tc-99m DTPA, Tc-99m glucoheptonate, or In-113m DTPA. These reagents will not normally localize in the choroid plexus.

IV. NUCLIDE

The choice of nuclide may be based on such diverse factors as type of pathology suspected, patient preparation, or physician's preference.

Tc-99m pertechnetate
Tc-99m GH (glucoheptonate)
Tc-99m DTPA (diethylenetriamine pentaacetic acid)
In-113m DTPA (diethylenetriamine pentaacetic acid) (see Table 1-1)

TABLE 1-1. Cerebral Perfusion and Brain Imaging

Nuclide	Energy	Half-life	Considerations
Tc-99m pertechnetate	140 kev	6 hours	1. No reagent preparation required. 2. Requires premedication of potassium perchlorate or glycopyrrolate, to avoid uptake in salivary glands and choroid plexus.
Tc-99m GH/DTPA	140 kev	6 hours	1. Requires reagent preparation. 2. Does not require patient preparation, because it does not accumulate in choroid plexus. 3. Has a higher lesion-to-brain ratio.
In-113m DTPA	393 kev	1.7 hours	1. Requires reagent preparation. 2. Does not require patient preparation, because it does not accumulate in choroid plexus. 3. Because of short half-life, delayed images after 1.7 hours not possible.

V. DOSE

Static study — 10–20 mCi
Dynamic study — 20–30 mCi

VI. METHOD OF LOCALIZATION

Alteration of the blood-brain barrier

VII. AREA OF LOCALIZATION

A. In a normal study, the vascular structures of the brain and the surrounding region will be visualized. These structures are superior sagittal sinus, lateral sinus, confluence of sinuses, cavernous sinus, and peripheral vasculature. Structures visualized will vary with the patient position.

B. In an abnormal study, the nuclide will diffuse through the blood-brain barrier into brain pathology.

VIII. CRITICAL ORGAN

The critical organ will vary with the nuclide used:
Tc-99m — colon
Tc-99m GH — kidneys
Tc-99m DTPA — kidneys
In-113m DTPA — kidneys

IX. SCINTILLATION CAMERA COLLIMATION

The choice of collimation may be based on such diverse factors as type of pathology suspected, patient load, or physician's preference.

A. *For use with Tc-99m - Tc-99m GH - Tc-99m DTPA*

Low energy-all purpose-parallel hole

Used to image large organs, this collimator offers good resolution and adequate sensitivity.

Low energy-High sensitivity-Parallel hole

Used to image large organs, this collimator offers good sensitivity and adequate resolution.

Low energy-High resolution-Parallel hole

Used to image large organs, this collimator offers optimal spatial resolution with decreased sensitivity.

B. *For use with In-113m DTPA*

High energy-Parallel hole

Used to image large organs, this collimator offers good spatial resolution with decreased sensitivity and a decreased field of view.

C. When using a large field of view (LFOV) imaging device, a parallel hole collimator of the appropriate energy level should be used.

X. PROCEDURE

A. *Dynamic imaging* — rapid sequence images obtained at preset intervals following a bolus injection of the nuclide.

1. Position the patient for type of view indicated. In most instances, an anterior view is implemented. A posterior view is often indicated in pediatric patients because of the high incidence of posterior fossa tumors. Other indications for a posterior view are trauma to the occiput, suspected vertebral artery involvement, or cerebellar signs or symptoms.

   A vertex view is indicated if visualization of all three cerebral arteries (anterior, middle and posterior) is desired.

2. Using either the direct or Olendorf method, inject a compact bolus into the basilic vein in the right arm.
3. Dynamic imaging usually begins 6–8 seconds after removal of pressure cuff or tourniquet. Because circulation time will vary with the patients, however, it is best to start the study when the flush of activity up the carotids is noted on the persistence scope.
4. Images are taken at 1–3 second intervals for at least 30 seconds.
5. Upon completion of the dynamic study, obtain an immediate static image without changing the patient's position.

B. *Static imaging*—images obtained 15 minutes–4 hours after the injection of the nuclide.

1.
   a. Immediate imaging—images obtained within 15 minutes postinjection.
   b. Routine imaging—images obtained 1–2 hours after injection.
   c. Delayed imaging—images obtained 3–4 hours after injection.
2. Anterior, posterior, and both laterals are the views usually obtained. A vertex view is often beneficial. At least 400,000 counts should be obtained for each view.

XI. POSITIONING/LANDMARKS

The brain is contained in the bony cranium. The brain consists of the cerebral hemispheres, the cerebellum, and the medulla oblongata. The spinal cord is a continuation of the brain stem (Figure 1-1).

A. *Anterior*

1. *Dynamic.* With the neck extended, the anterior aspect of the patient's skull is placed flat against the collimator face so that a line drawn through the external auditory meatus and the outer canthus of the eye is perpendicular to the detector. Position the skull so that the superior sagittal sinus is near the upper limit of the field of view. Adjust the median sagittal plane so that it is perpendicular to the detector. This allows maximum visualization of the carotid arteries as well as intracranial perfusion.
2. *Static.* The positioning for the static image is the same as for the dynamic image. However, the orbits should

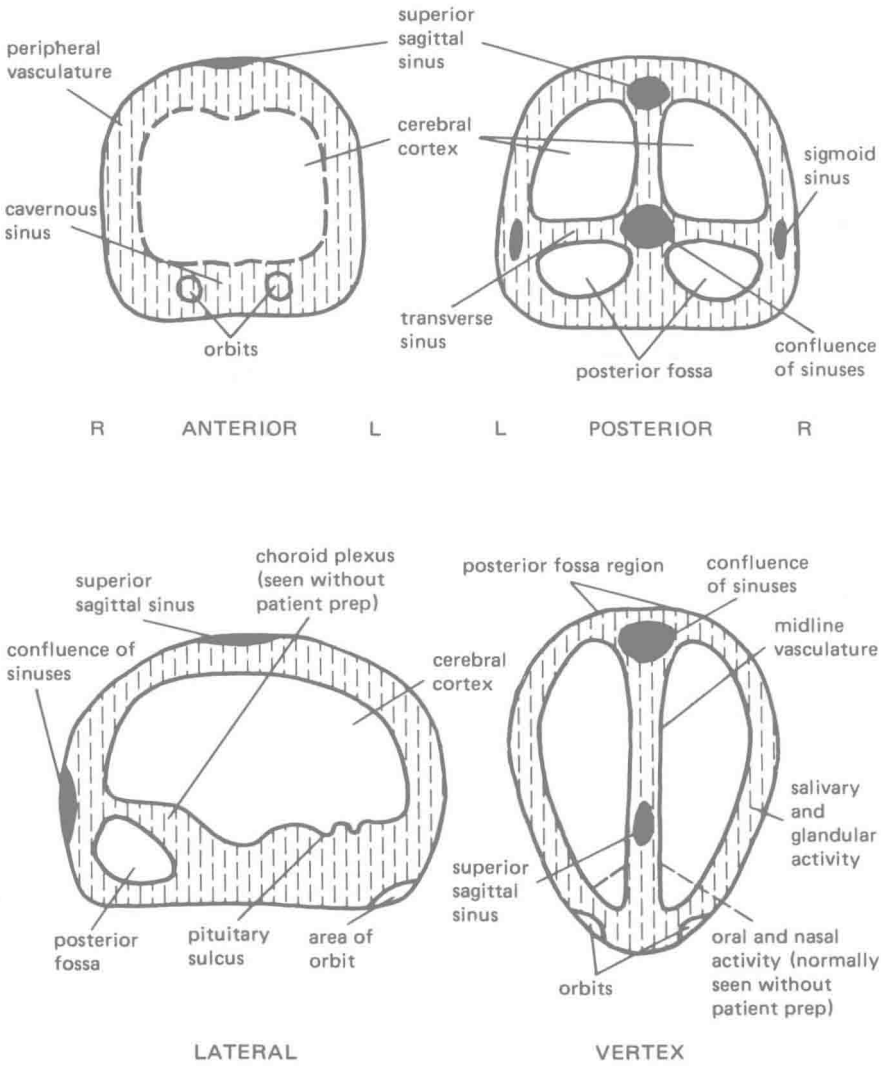

FIGURE 1-1. Normal brain scan.

be at the lower limit of the field of view.

B. *Posterior*

1. *Dynamic.* The posterior aspect of the patient's skull is placed flat against the collimator face. Adjust the median sagittal plane so that it is perpendicular to the detector. Position the skull so that the superior sagittal