

# British Nuclear Medicine Society Clinical Guideline for Parathyroid Scintigraphy

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**This guideline must be read in conjunction with the BNMS Generic Guidelines.**

## 1.Purpose

The purpose of this guideline is to assist specialists in Nuclear Medicine and Radionuclide Radiology in recommending, performing, interpreting and reporting the results of Parathyroid Scintigraphy. This guideline will assist individual departments to formulate their own local protocols. This does not aim to be prescriptive regarding technical aspects of individual camera acquisitions which need to be developed in conjunction with the local medical physics expert. These guidelines pertain only to adult patients.

## 2.Background

Parathyroid scintigraphy is an established method to identify abnormal parathyroid glands, usually in the context of primary hyperparathyroidism. Primary hyperparathyroidism is an endocrine disorder characterised by inappropriate production of parathyroid hormone (PTH) which results in a raised serum calcium.

There are normally two pairs of parathyroid glands, superior and inferior. These are usually located posterior and inferior to the thyroid gland respectively. A normal gland typically measures 6 x 4 x 2 mm and weighs 40-60 mg<sup>(1,2)</sup>. There can be more than 4 glands (in approximately 15% of cases), and their location can also be variable, anywhere from the carotid bifurcation to the mediastinum.

Most cases of primary hyperparathyroidism are caused by a solitary parathyroid adenoma (85%), other causes include glandular hyperplasia (10%), multiple adenomas (4%) and parathyroid carcinoma (<1%).<sup>(3)</sup>

Reported incidence of ectopic parathyroid adenomas is 5-16%<sup>(4,5)</sup>. Most parathyroid adenomas are sporadic but there are inherited causes, most commonly multiple endocrine neoplasia type 1 (MEN1).

Surgery is the mainstay of treatment to remove the offending parathyroid adenoma. Traditionally this involved a bilateral cervical exploration to identify all four glands and remove the abnormal gland, this involved a large incision across the neck. Parathyroid scintigraphy, particularly when combined with CT (e.g. SPECT/CT) enables localisation of the adenoma pre-operatively which allows minimally invasive operative techniques which reduces scar length, improves recovery time, reduces hospital stay and reduces complications.

These guidelines are not a substitute for local clinical support and parathyroid scintigraphy requires adequate, medical, physics and technical support to achieve the best results. A multi-disciplinary meeting is also recommended, particularly for challenging cases.

### 3.Scope

Imaging techniques used for the localization of Parathyroid adenomas include; <sup>99m</sup>Tc-sestamibi dual phase planar and/or SPECT/CT, dual isotope imaging in combination with <sup>123</sup>I-iodide, ultrasound, 4D CT, <sup>11</sup>C-Methionine PET/CT and <sup>18</sup>F-Fluorocholine PET/CT. All of these techniques have their pros and cons. These should be considered along with availability and expertise before agreeing a local imaging pathway. This guideline will describe the use of <sup>99m</sup>Tc-sestamibi dual phase imaging which may be used alone or in combination with other modalities.

### 4.Indications

Localisation of abnormal parathyroid glands in patients diagnosed biochemically with primary hyperparathyroidism.

### 5.Contraindications

Absolute: Allergy to Sestamibi. Allergy to iodine based intravenous contrast material (if giving intravenous contrast).

Relative: Pregnancy/Breast Feeding: If symptoms are mild then consideration should be given to delaying investigation until after the pregnancy or after breast feeding has ceased. Consider discussion of the risks from radiation balanced against the symptoms and risks from hyperparathyroidism with an Endocrinologist (and if possible at a parathyroid MDT).

### 6.Patient Preparation

No specific patient preparation required.

### 7.Radiopharmaceutical

The ARSAC Notes for Guidance gives a DRL for dual phase <sup>99m</sup>Tc-sestamibi as 900 MBq. This gives an effective dose of 8.1 mSv (additional dose will be given if CT is also used). This is administered intravenously <sup>(6)</sup>

### 8.Imaging Procedure

Images can be acquired with the patient supine with arms down. Early images can be acquired 10 – 30 minutes after injection with delayed images 1.5 – 2.5 hours after injection <sup>(7)</sup>. However some authors suggest that Sestamibi can

washout of parathyroid adenomas by 2 hours and suggest completing the delayed images by 2 hours <sup>(8)</sup>.

If SPECT imaging is unavailable then planar images can be acquired. Consider a broad field of view extending from the submandibular glands to at least the upper part of the myocardium to ensure visualisation of ectopic glands. This can be acquired using a 256 x 256 matrix using a low energy, high resolution, parallel hole collimator (5 mins).

For increased resolution around the thyroid a magnified image of the thyroid region can be obtained using a pin-hole collimator (10-15 min). An anterior oblique image is also useful to gauge the depth of a lesion seen in the thyroid region <sup>(9)</sup>.

SPECT/CT should be considered if available. Various combinations of early Planar or SPECT with late Planar or SPECT have been studied. Lavelly et al found an early SPECT/CT at 15 mins with any delayed imaging method (planar, SPECT or SPECT/CT) at 2 hours to have the highest accuracy <sup>(10)</sup>.

When possible, the SPECT data should be acquired over a 360 arc, using a body-contoured elliptic orbit, optimally obtaining 120 (minimum of 60) projections at 15–25 s per projection (every 3–6 angle), depending on the number of projections and sensitivity of the detector. The SPECT acquisition takes, on average, approximately 25 min. The images can be acquired into a 128 x 128 (16-bit) matrix, corrected for attenuation (if you have also acquired a CT) . SPECT reconstruction should be optimised as per manufacturer's instructions.

The CT component of the examination is performed for lesion localization and attenuation correction. The optimal slice thickness, acquisition time, and CT parameters (mAs and kVp) should be determined by individual laboratories or suggested by the manufacturer to maximize image quality and to minimize radiation exposure to the patient. Within these parameters, the highest possible spatial resolution should be sought in setting up the imaging protocol. Although the typical parameters are a tube current ranging from 100 to 200 mAs and a voltage of 120 kVp (ranging from 100 to 140 kVp), these may vary by manufacturer and in some systems may be automatically modulated, depending on the body part imaged <sup>(7)</sup>.

The CT study can be enhanced with intravenous contrast. A number of studies have shown reasonable results using contrast enhanced CT over 2 or 3 phases of enhancement (combinations of pre-contrast, arterial, delayed) <sup>(11)</sup>.

Albarano et al studied 122 patients with an early and delayed sestamibi SPECT-CT. They performed the early SPECT with an arterial phase CT (15-20 seconds) giving 75mls of Isovue 370, then performed a non-contrast CT with the delayed SPECT. They compared their results with the same protocol with intravenous contrast and found increased accuracy of localisation for adenomas less than 1 cm<sup>(12)</sup>.

There are logistical and dose implications in performing 2 SPECT-CT's.

Sims et al used planar early (10 minute) and delayed (2 hours) imaging with a SPECT-CT at 30 minutes using either a non-contrast and arterial phase CT or an arterial and venous phase CT. This yielded sensitivity, specificity, positive predictive value and negative predictive value of 85%, 97%, 96% and 88%<sup>(13)</sup>.

If following the Sestamibi study the parathyroid adenoma has not been localised, and depending on the clinical scenario, consider referral to a specialist PET centre for further imaging with C11 methionine or F18 choline.

## 9. Interpretation

On dual phase tc99m sestamibi images a parathyroid adenoma can appear as an area of increased or similar uptake to the adjacent thyroid. Often the tracer will washout of the thyroid and be retained in the adenoma making it more obvious on delayed images <sup>(7)</sup>. Washout from adenomas, is however variable and can have occurred prior to delayed imaging.

A detailed description of the precise anatomical location will aid surgical removal. This is particularly helped by SPECT-CT.

Images should be interrogated for the presence of a second adenoma or an ectopic gland (particularly within the anterior or posterior mediastinum). Correlation should be performed with any other relevant imaging investigations, such as ultrasound with comment made as to whether the findings are concordant.

## 10.Pitfalls

On planar imaging (dual phase) small adenomas that are located posterior to the thyroid can be difficult to appreciate – SPECT-CT can help with this. If SPECT is not available, anterior oblique images may be useful<sup>(7)</sup>. Breathing can lead to misregistration between the SPECT and CT even when preformed contemporaneously on the same machine. Account should be taken of this when reporting.

With the emergence of minimally invasive parathyroidectomy and an increased use of blood calcium testing, many departments have seen an increase in referral rate for parathyroid localisation studies. The number of parathyroidectomies in England and Wales rose from 3.3/100,000 population in the year 2000 to 5.8/100,000 in 2010 <sup>(14)</sup>. This has been associated with a trend towards patients with smaller and less functional active glands. Some centres have reported a consequent decreased pick up rate. Utilising technological advances such as combined SPECT-CT and use of intravenous contrast may help identify smaller lesions <sup>(12)</sup>.

Thyroid nodules can sometimes retain tracer on delayed images leading to difficult distinguishing these from intra-thyroidal parathyroid adenomas – ultrasound can sometimes help. If not consider thyroid imaging with Iodine or technetium.

If using contrast enhanced CT – ectopic thyroid tissue or nodules can mimic parathyroid adenomas.

## 11.Summary

Accurate localisation of parathyroid adenomas prior to surgery has increased in importance with the emergence of minimally invasive parathyroidectomy. A dual phase Sestamibi SPECT-CT with or without an ultrasound could be considered as first line investigations for this.

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### 13. Versions & Review

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