

Renal Cortical Scintigraphy (DMSA scan)

Clinical Guidelines

1. Purpose

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

The purpose of this guideline is to assist specialists in Nuclear Medicine and Radionuclide Radiology in recommending, performing, interpreting and reporting the results of renal cortical scintigraphy (DMSA scan). This guideline will assist individual departments in the formulation of their own local protocols.

These guidelines apply to studies on adults. For specific guidance for paediatric studies see the EANM guidelines on ^{99m}Tc -DMSA scintigraphy in children [1].

2. Background

After ^{99m}Tc DMSA is injected intravenously it slowly concentrates in the kidney where it mostly becomes bound to the proximal tubular cells. There is a low extraction efficiency by the kidneys, but 2 or 3 hours following injection there is sufficient uptake to obtain good images of the functioning renal cortex with low background. However some is excreted in the urine.

3. Common Indications.

3.1. Detection of focal renal parenchymal abnormalities

3.1.1 Assessment of the kidney in the acute phase of a Urinary Tract Infection (UTI) (Acute pyelonephritis) [1, 2, 3, 4, 5, 6, 7]

3.1.2 Assessment of the kidney for detection of scarring in the late phase, 4 to 6 months following a UTI [1, 4, 8, 9, 10, 11, 12].

3.1.3 For the recommended imaging strategy in children with UTI see the NICE algorithm at <http://www.nice.org.uk/nicemedia/pdf/CG54algorithm.pdf>

3.2. Differential renal function estimation – particularly when kidneys may be lying at different depths eg a low-lying or malrotated kidney.

3.3. Assessment of the horseshoe, solitary or ectopic kidney [13]

3.4. Localisation of the poor or very poorly functioning kidney [13]

3.5. Assessment of renal function in the presence of an abdominal mass

3.6. Detection of residual functioning renal tissue following direct trauma

4. Contraindications

None

5. Procedure

5.1. Patient preparation

5.1.1 No specific preparation is required

5.1.2 If relevant, the date of last UTI should be recorded and whether the patient is on prophylactic antibiotics.

- 5.2. Injection Technique
Simple intravenous injection

6. Radiopharmaceutical

^{99m}Tc DMSA (dimercaptosuccinic acid). The ARSAC diagnostic reference level for adults is 80 MBq [14]. For children, administered activity should be scaled according to body surface area [14] with a minimum activity of 15 MBq [15]ⁱ.

7. Image acquisition

7.1. Camera

Single or double headed gamma camera

7.2. Collimator

7.2.1 A low energy high resolution (LEHR) collimator is recommended [1, 4].

7.2.2 For children an ultra-high resolution (LEUHR) may be used [1].

7.3. Patient Position

7.3.1 Adults may be imaged supine. The seated or standing position is also acceptable as long as the patient can remain still.

7.3.2 Children should be imaged supine with suitable support to keep movement to a minimum. Very small children may be placed directly on the collimator surface if the camera allows this and there is no danger of them falling off [1].

7.3.3 It is important that the patient should be as close to the collimator face as possible in order to obtain the best resolution.

7.4. Views

7.4.1 The minimum data set is a posterior view and both left and right posterior oblique views.

7.4.2 The anterior view should always be acquired when there is an ectopic kidney, when spinal abnormalities with a scoliosis is present, or when tumours and / or an abdominal mass is present

7.4.3 The anterior view is also useful for calculating relative function when the kidneys may lie at different depths and so it should be acquired in adults whenever possible. Anterior and posterior views must both be obtained with the patient in the same position (ie both erect or both supine or both prone) in case the kidneys are mobile.

7.4.4 With a double headed gamma camera it may be possible to acquire two views simultaneously. This is usually the case for anterior and posterior views, but for the oblique views it may not be optimum as the distance from the collimator is often increased.

ⁱ The new EANM paediatric dosage card [16] gives a different scaling factor for administered activity to that in the current ARSAC Notes for Guidance [14]. ARSAC are considering whether to adopt the new EANM paediatric dosage card but have not published any recommendations at this time. The BNMS advise centres to continue to use the ARSAC schedule until further guidance is provided.

7.5. Computer Acquisition

7.5.1 The acquisition matrix used should ensure a pixel size of approximately 2 mm. This can be achieved either with a 256 x 256 matrix or a 128 x 128 matrix with zoom, depending on the size of the camera field of view.

7.5.2 Image acquisition should start between 2 and 4 hours post injection

7.5.3 Posterior image of both kidneys should be acquired with a total of 300,000 to 500,000 counts.

7.5.4 Both left and right posterior oblique images should be acquired with approximately 150,000 - 200,000 counts each

7.5.5 The anterior view should be acquired with a total of 150,000 to 200,000 counts.

7.6. Interventions

Nil

8. Data Analysis

8.1. Percent differential renal function (DRF) should be calculated from the posterior view by drawing regions of interest (ROI) around each kidney. A background ROI should also be drawn in any nearby non-renal area. The position of the background ROI makes very little difference except with very poorly functioning kidneys. Counts in the background region are used to subtract background counts from each kidney ROI (scaled for the relative size of the ROIs). DRF of each kidney should then be calculated from the percentage of background subtracted counts in each kidney. This DRF may not be accurate if the two kidneys lie at significantly different depths, but this is less likely to be a problem in children

8.2. If an anterior view has also been obtained, background subtracted kidney counts should also be calculated from this image. The geometric mean of the posterior and anterior background subtracted counts in each kidney should then be calculated.

$$\text{Geometric Mean Count} = \sqrt{\text{Posterior Count} \times \text{Anterior Count}}$$

The geometric mean DRF should be calculated using these geometric mean counts. This gives an approximate correction for the fact that kidneys may lie at different depths. It is particularly important for ectopic or malrotated kidneys.

8.3. Displayed results should include all acquired images. Each image must be labelled to show the projection and with left and right sides marked. DRF should also be stated together with the method used (posterior view only or geometric mean).

9. Interpretation

9.1. Reporting format:

9.1.1 The position, relative size and overall morphology of the functioning renal tissue should be described.

9.1.2 The number, size and location of any areas of cortical loss should be noted.

9.1.3 Diffuse reduced uptake may be seen in a kidney with a UTI.

9.1.4 The DRF should be stated together with the method of calculation (posterior view only or geometric mean).

10. Pitfalls

- 10.1. Acute and chronic pyelonephritis cannot be distinguished on the cortical scan. If a defect is present 6 months after the last UTI then this is a scar [17]
- 10.2. A recent UTI may cause temporary reduced uptake or focal defect and a follow-up DMSA scan should be undertaken [17]
- 10.3. The diagnosis of renal scars is difficult in the infant under 3-6 months of age because of renal immaturity. If appropriate the scan should be delayed.
- 10.4. There is a wide range of normal variants which should be recognised [1, 18]
- 10.5. Hydronephrosis may cause tracer retention in the collecting system which can affect image interpretation and overestimate DRF [4]

11. Controversies

- 11.1. To obtain the highest resolution, some centres recommend the use of a pin-hole collimator, but this can give distorted images [4]
- 11.2. Currently there is no consensus on the routine use of SPECT to delineate focal defects in children [1, 4, 19].

12. References

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These guidelines are not supposed to constitute a formal protocol but rather the protocol in your department should fit within these guidelines. They are meant to highlight the aspects of a study where variation in practice may significantly affect the quality of outcome of the study.