Whole Body Gamma Camera

Whole body mechanical scanning speed

1. Introduction and rationale
During recording, the camera moves relative to the table. If there are deviations in speed, the duration of the investigation will either increase or decrease, resulting in more or fewer counts than expected in the recording. This test checks whether the actual speed is equal to the set scanning speed.

2. Frequency
This test must be carried out upon acceptance and after major maintenance of the transport mechanism

3. Method
A check of the set scanning speed can be achieved by having the camera travel a fixed distance and registering the time required.

4. Required equipment, phantoms and sources
To check the scanning speed, a tape measure and a stopwatch are needed.

5. Procedure
Check the scanning speed at the minimum and maximum speeds and at the speeds used clinically. Mark two points at a known distance apart and measure the time difference. Note visually whether the movement is smooth.
This test can be combined with 'Whole body uniformity' or 'Whole body spatial resolution' checks.

6. Analysis and interpretation
The scanning speed can be calculated by dividing the distance travelled by the time. Compare the set speed with the measured scanning speed.

7. Action thresholds and actions
If, during clinical use, a difference of more than 20% is noted, repairs should take place (see the Sensitivity protocol). On acceptance, a stricter requirement may be set, although there is usually no specification available. A deviation of more than 5% from the set speed may be considered unacceptable.

8. Pitfalls and comments
The mechanical scanning speed is our concern here: avoid the area where the detector is opened electronically.

Whole body uniformity

1. Introduction and rationale

The uniformity of a whole body image is not only dependent on the uniformity of the detector. If the scanning speed is not constant, the "exposure" of an image will not be constant over the entire length of the recording area and the uniformity of the image will be adversely affected in the longitudinal direction. This could occur if there is slip in the drive system or if the free movement of the system is hampered during recording.
At the beginning and at the end of imaging, certain cameras use an electronic window which is opened or closed whilst no mechanical movement of the system takes place. The speed with which this window is opened and closed must be equal to the mechanical speed at which the camera moves along the table.

2. Frequency

Differences in uniformity are usually only present after installation. Therefore, this test must be carried out on (re)acceptance and after major maintenance of the transport system.

3. Method

Variations in scanning speed during a recording can be checked by making an image of the entire scan range with a uniform planar source on the detector. Local variations in scanning speed will lead to a different count density in the relevant areas. In addition, the transmission of the scanning table is determined.

4. Required equipment, phantoms and sources

A planar source of ^{57}Co or ^{99m}Tc with a minimum source intensity of 75 MBq (maximum count rate 20 kcps).

5. Procedure

Turn the detector so the collimator faces upwards and place a planar source directly onto the collimator (not on the scanning table, but leave that in place). Record an image with both detectors over a total length which is at least 4,5 times the width of the detectors. Check the uniformity at the minimum and maximum speeds and at the speeds used clinically. Repeat the test with both detectors in the lowest position. This test may be combined with the 'Whole body mechanical scanning speed' test.

6. Analysis and Interpretation

Generate a profile in the longitudinal direction of the image and with equal width to the field of view of the gamma camera. Calculate the average and standard deviation of the mean for this profile.
In a system using an electronic window, deviations at the beginning and end of the profile indicate a difference between the electronic and mechanical speed.
As an additional diagnostic test, a recording can be made of a few point sources in the border area or a line source at 45°. The point sources should not appear double or deformed and the line source may not display a kink (see also the following tests: 'Whole body spatial resolution' and 'Whole body image size').
Do a further visual check of the image made. For non-rectangular detectors, deviations in

width may be seen. One may have opted for giving the camera a higher sensitivity at the centre and accepting limited reduction at the sides. This makes sense because the majority of abnormalities to be detected will be centrally located, and a higher sensitivity in this area is more important than a uniform profile.
One of the recordings of the uppermost detector can be used to calculate the transmission of the scanning table.

7. Action thresholds and actions
Compare to the specifications if available.
More than 4% deviation from the average profile height is not acceptable (see 'Uniformity' protocol), apart from the potential decay at the edges as discussed above. Choosing a uniform profile for non- rectangular detectors, can result in a slight increase in noise at the edges.
The transmission of the scanning table must be compared to the specifications, if these are available. The user must be informed of any inhomogeneities in the transmission of the scanning table.

8. Pitfalls and comments
In all whole body systems, the position of the table relative to the camera is measured and translated to a position in the image on the film or in the acquisition matrix. If the determination of this position is wrong, it will lead to inhomogeneity in the longitudinal direction of the recording. In some systems, the position is measured by a small wheel that rotates during the recording. In one direction, it is pushed ahead and in the other direction, it is pulled along. Thus, inhomogeneities may arise in one direction but not the other. Therefore, the measurements must be done in both directions if this is applicable.

9. Additional checks
Compare the ratio of length and width of the field of view with the actual proportions. In a dual-head system, both detectors must produce the same size of images.

Whole body spatial resolution

1. Introduction and rationale
A camera's spatial resolution during movement will be different to the spatial resolution for stationary images due to vibrations and other movement artefacts.

2. Frequency
This test is recommended at (re)acceptance.

3. Method
Make a whole body image of a point and/or line sources

4. Required equipment, phantoms and sources
Point sources (^{57}Co) or a line source of 500 mm length filled with ^{99m}Tc, approx 100 MBq/ml.

5. Procedure

Mount the LE(HR) collimator(s).
Place a line source or several point sources on the table 10 cm from the collimators.
Place line sources both parallel and perpendicular to the direction of movement.
Make recordings with the source(s) at both ends of the electronic scanning area, in the field of mechanical scanning of the scanning area and on both sides in the transitional area.
Use an energy window of 15%.
Register the images from both detectors in the largest possible matrix.
Perform the test at the minimum and maximum speeds and at the speeds used clinically.
The test may be combined with the 'Whole body mechanical scanning speed' test.

6. Analysis and Interpretation

Use the images to calculate the FWHM and FWTM. (For a description of the method, see 'Planar gamma camera: spatial resolution'). In practice, it is almost impossible to meet the requirements set for the maximum pixel value and the number of pixels within the FWHM, thus a less accurate measurement must suffice.
All point sources must be displayed in their entirety and as a single focus.
Problems may occur, especially during starting and stopping and during the transition from the electronic to the mechanical window (if applicable). If the table and camera are incorrectly aligned, the start and stop positions noted on the table will not correspond to the mechanical start and stop positions of the system. A stop error may occur either because the table or the camera shifts during deceleration at the end of the recording area. This occurs especially at high scan speeds. Such start and stop errors affect the image size and may cause parts of the image to fall outside the area displayed. Counts obtained during the opening and closing and during the movement of the detector are displayed in these areas. Point sources can then be displayed as thin lines or even as double points.

7. Action thresholds and actions

Compare to the manufacturer's specifications if available.
As a rule of thumb, the resolution at clinical speeds may not be more than 10% worse than the stationary value. Ensure the results of the whole body measurements are compared to measurements made under the same conditions as a stationary gamma camera i.e. with the same distance, the same collimator and the same shielding material (table and mattress).
Double images or missing images are obviously unacceptable.
Also pay attention to the influence of the table and make sure the user is informed about any variations in the spatial resolution in whole body scans.

8. Pitfalls and comments

When recording the images, it is assumed that the table is horizontal and therefore parallel to the detector during the entire recording. Some tables are constructed so they are only horizontal when a patient is lying on them. While performing these tests, there is only a phantom on the table. Thus the distal end of the table will remain (partially) elevated. Hence, the distance between the phantom and the detector will not be the same everywhere. This results in an apparent difference in resolution between different locations in the recording area.