Routine quality control tests for breast tomosynthesis (Radiographers)
NHSBSP Equipment Report 1406

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Contents

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Executive Summary

Guidance is provided on routine quality control tests for tomosynthesis systems in mammography. These should be carried out in addition to the 2D tests described in NHSBSP Equipment Report 1303. The tests are used to ensure that the equipment performs as expected and meets the appropriate NHSBSP standards.

The tests covered comprise:

- system checks with Perspex blocks

- weekly image quality test

- tests and calibration required by the manufacturer

1. Introduction

Tomosynthesis systems are beginning to be used for assessment in breast screening services. It is essential to ensure that the equipment performs as expected and meets NHSBSP standards for routine quality control (QC). This guide describes the recommended routine QC tests which should be undertaken by radiographic staff. It is based heavily on the radiographer QC protocol developed for the TOMMY trial[1] and on current knowledge and understanding of tomosynthesis systems.

This guidance has been approved by the NHSBSP QA Coordinating Group for Radiography, Physics and Equipment. Both the tests and the remedial levels may be revised in the light of further experience and developments in technology.

Guidance on testing of mammography tomosynthesis systems by physicists is given in NHSBSP Equipment Report 1407[2]. Baseline values will be established at installation by radiographic staff in conjunction with the local physicist, and revised if conditions are changed.

These tests should be performed in addition to the routine tests performed on 2D mammography systems, described in NHSBSP Equipment Report 1303[3]. All quantitative and qualitative data generated by routine tests and observations should be recorded.

The routine QC tests for tomosynthesis systems are summarised in Table 1.

Table 1. Recommended routine QC tests for tomosynthesis systems

Frequency	Test	Section
Daily	System check	2.1
Weekly	Check of contrast to noise ratio (CNR)	2.2
Weekly	Image quality check	3
Monthly	Automatic exposure control (AEC) thickness check	2.3
As required	Tests and calibrations required by manufacturer	4

2.   System checks with Perspex blocks

These tests will detect changes in the performance of the X-ray set or the image receptor. Full size Perspex blocks are preferable for these tests so that the uniformity of the whole field of view can be checked. The test object for 2D testing described in NHSBSP Equipment Report 1303 should be used for these tests. A local test protocol must be developed in conjunction with the local physicist to suit the particular equipment. It should define the equipment configuration and settings (for example, acquisition mode, AEC settings, paddle, compression force) to enable the test exposures to be carried out in a consistent manner. As far as possible, test exposure settings should mimic clinical exposure settings. Any image containing abnormal artefacts should be saved to help with the investigation of the fault.

2.1   Daily system check

This test is an extension of the existing 2D daily system test. On some systems it may be possible to carry out the two tests together.

Method

- place the test object on the breast support table

- expose under AEC in tomosynthesis mode according to the local protocol

- record relevant post exposure factors (for example, kV, mAs, detector dose indicator)

- inspect the reconstructed image slices (not the projections) on the X-ray unit using a narrow window setting (high contrast). Whilst scrolling through the tomosynthesis slices, look for any abnormal artefacts or variations in the noise pattern

- if a region of interest (ROI) facility is available for the reconstructed slices, determine the signal-to-noise ratio (SNR) using the method described in NHSBSP Equipment Report 1303. For consistency, use a reconstructed slice at a fixed height, or the one which contains the sharpest image of the aluminium foil in the phantom

Remedial level

mAs	baseline ± 10% (provided kV and target/filter are the same as for the baseline measurement)
Detector dose indicator	baseline ± 10%
SNR	baseline ± 20%

Any abnormal artefacts

If any of the above levels are exceeded, the necessary action must be taken to correct the problem. If the problem persists after checking, action must be taken, in line with local protocols, before the equipment is put back in use.

2.2   Weekly check of CNR ratio

This test is only possible if a region of interest (ROI) facility is available for the reconstructed slices. It is an extension of the existing 2D CNR test and, on some systems, it may be possible to carry out the two tests together.

Method

- use the image of the test object from the daily test (see 2.1)

- determine the CNR using the method described in NHSBSP Equipment Report 1303. Make the measurement in the plane which contains the sharpest image of the aluminium foil in the phantom

Remedial level

CNR	baseline ± 20%

If this level is exceeded, the necessary action must be taken to correct the problem. If the problem persists after checking, action must be taken, in line with local protocols, before the equipment is put back in use.

2.3   Monthly AEC thickness check

This test is an extension of the existing 2D monthly thickness test and, on some systems, it may be possible to carry out the two tests together. The same Perspex blocks that are used for the 2D thickness test are used for this test.

Method

- place each thickness of Perspex in turn on the breast support table

- expose under AEC in tomosynthesis mode according to the local protocol

- record relevant post exposure factors (for example, kV, mAs, detector dose indicator)

- inspect the reconstructed image slices (not the projections) on the X-ray unit using a narrow window setting (high contrast). Whilst scrolling through the tomosynthesis slices, look for any abnormal artefacts or variations in the noise pattern

- if a region of interest (ROI) facility is available for the reconstructed slices, determine the SNR and CNR using the method described in NHSBSP Report 1303, selecting the slice which contains the cleanest, sharpest image of aluminium foil in the phantom

Remedial levels

mAs	baseline for that thickness ± 10% (provided kV and target/filter are the same as for the baseline measurement)
Detector dose indicator	baseline for that thickness ± 10%
SNR	baseline for that thickness ± 20%
CNR	baseline for that thickness ± 20%
Any abnormal artefacts	

If any of the levels are exceeded, the necessary action must be taken to correct the problem. If the problem persists after checking, action must be taken, in line with local protocols, before the equipment is put back in use.

3.   Weekly image quality check

Dedicated test objects for routine image quality checks on tomosynthesis systems are not currently available. Image quality should, therefore, be tested using a test object already available in the department such as Leeds Test Objects TOR(MAS) or TOR(MAM). A local test protocol must be developed in conjunction with the local physicist to suit the particular equipment. It should define the equipment configuration and settings (for example, acquisition mode, AEC settings, paddle, compression force) to enable the test exposures to be carried out and evaluated in a consistent manner. As far as possible, test exposure settings should mimic clinical exposure settings.

Method

- place the test object on the breast support table, with the appropriate total amount of Perspex. 2cm of Perpex should be under the test object

- expose in tomosynthesis mode according to the local protocol

- inspect the reconstructed image slices (not the projections) on the X-ray unit

- find the slice at which the image of the test object appears sharpest and record that slice number

- send the image to a reporting workstation

- evaluate the image according to the local protocol, using the slice recorded as having the sharpest image

- compare the image with a baseline image and look for significant changes in the appearance of the in-focus and out-of-focus slices

Remedial levels

Number of sharpest slice   baseline ± 2 slices

Significant change of score
compared with baseline

Significant change of
appearance compared with

baseline

CNR

Any abnormal artefacts

baseline

CNR

Any abnormal artefacts

4. Tests and calibrations required by the manufacturer

Any tests and calibrations required by the manufacturer should be added to the local QC protocol. Some of these may be crucial to ensure the correct operation of the equipment; others may be a means of demonstrating that the equipment is working correctly. To avoid duplication, the local physicist should advise whether any built-in QC tests are suitable for use in place of the tests described in this document.

References

1.   *Radiographer QC protocol for TOMMY trial – Version 2*. National Coordinating Centre for the Physics of Mammography, 2011.

2.   Burch A, Loader R, Rowberry B, Strudley C, Whitwam D*. Physics QC protocol for breast tomosynthesis* (NHSBSP Equipment Report 1407). Sheffield: NHS Cancer Screening Programmes, 2014.

3.   *Routine quality control tests for full field digital mammography systems - Fourth Edition* (NHSBSP Equipment Report 1303). Sheffield: NHS Cancer Screening Programmes, 2013.