QUALITY CONTROL FOR THE MAMMOGRAPHY SCREENING PROGRAM IN SERBIA: PHYSICAL AND TECHNICAL ASPECTS

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Abstract

Breast cancer is the major cause of mortality among female population in Serbia. It is presumed that the introduction of screening programme will reduce mortality and therefore, 47 new mammography units were installed for the purpose of population-based screening program in 2011. In parallel, Quality assurance and Quality control (QC) in mammography has received increasing attention as an essential element of -the successful breast cancer campaign that is for the first time initialed in Serbia. The purpose of this study is to investigate the need for and the possible implementation of the comprehensive QC programme for the mammography screening in Serbia, with special focus on physical and technical aspect. In the first phase, a QC protocols containing list of parameters, methodology, frequency of tests and reference values for screen-film, computed radiography and full-filed digital mammography) units, were developed. The second phase is focused on the initial implementation of these protocols. The paper presents results of tests of the selected parameters in 35 mammography units, with special emphasis on patient dose and image quality descriptors. After initial implementation at the beginning of the population-based breast cancer screening campaign, it is essential to establish system of regular and periodic QC equipment monitoring and to ensure high quality mammograms with minimal possible radiation dose to population included in the screening.

Introduction

Breast cancer is the major cause of mortality among female population in Serbia. Mammography is an extremely useful non-invasive imaging technique for early detection of breast cancer and for detection and diagnosis of cancer in any stage of the disease. Introduction of screening programme along with better oncology care has reduced mortality considerably in many countries [1]. It is presumed that the introduction of screening

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programme will reduce mortality in Serbia as well, and therefore, 47 new mammography units were installed for the purpose of population-based screening program in 2011.

Quality Assurance (QA) in mammography has received increasing attention as an essential element of a successful clinical mammography and breast cancer screening programme. QA requires multidisciplinary approach, continuous education, evaluation, effectiveness and detriment minimization [1-3]. In Serbia, the use of ionizing radiation in medicine is framed by national regulation, however, this legal framework does not cover sufficiently the area of QA in medicine, including clinical mammography and mammography screening [4,5]. In addition to legal documents, there is a lack of national guidelines for Quality Control (QC), whereas operating staff commonly do not have sufficient knowledge about equipment and their responsibility in optimizing daily practice. Performance of mammography centers is evaluated by licensed external technical services annually. These activities frequently do not include internal QC that should encompass more frequent tests performed by local staff.

The purpose of this study is to investigate the need for and the possible implementation of a comprehensive QC programme for the mammography screening in Serbia, with special focus on physical and technical aspect of both screen-film and digital mammography units.

Materials and Methods

This work consisted of two phases. In the first phase, a QC protocols containing list of parameters, methodology, frequency of tests and reference values for screen-film (SF), computed radiography (CR) and full-filed digital mammography (FFDM) units, were developed. The second phase is focused on the initial implementation of these protocols. The paper presents results of tests of the selected parameters, with special emphasis on patient dose and image quality descriptors. Detailed recommendations for the implementation of the QA programme in mammography are given in the "European Guide lines for Quality Assurance in Breast Cancer Screening and Diagnosis" [1]. Daily and weekly test are to be performed by local staff, while six-monthly and annual tests are performed by medical physicists.

For the evaluation of the mammographic practice, the developed QC protocol was implemented in 35 mammographic units of different technological properties: 22 digital mammography units with CR as image receptor, 11 mammography units with SF combination as image receptor and two FFDM units. All hospitals using SF were equipped with a same model of mammography unit (Lorad IV, Hologic) and same film-screen combination (Agfa Mamoray HDR-C). Those that used CR detector were equipped with

mammography units from two manufacturers (Lorad IV, Hologic-15 units and Mammomat 1000, Siemens-7 units), whereas CR detector and reader in all cases was Agfa CR MM 3.0 Mammo Cassette and AGFA CR 35-X, respectively. Both FFDM units were Hologic Selenia, with a-Se detector. As a part of QC tests, image quality was evaluated using images of the TOR (MAS) test object (Leeds Test Object, Leeds, UK). Test object TOR MAS, containing structures for the assessment of low and high contrast resolutions, as well as those for the visualization of small details such as micro-calcifications and low contrast sensitivity, was used in this survey [3]. Sensitometry and densitometry tests were performed with calibrated sensitometer and densitometer (X-Rite, Germany). For the assessment of the parameters of X-ray tube and generator multimeter Barracuda (RTI Electronics, Mölndal, Sweden) with a calibrated solid-state detector Multi Purpose Detector. Additional tool for QC test implementation as PMMA plates, spacers, Al filters and other tools were also used.

Results

Results of the measurement of selected parameters of mammography units' are presented in Figures 1-7. For two FFDM units, all parameters of detector and x-ray tube and generator were satisfactory, while a selected image quality and dose parameters contrast to noise ratio (CNR) and mean glandular dose (MGD) are presented in Figures 8 and 9.

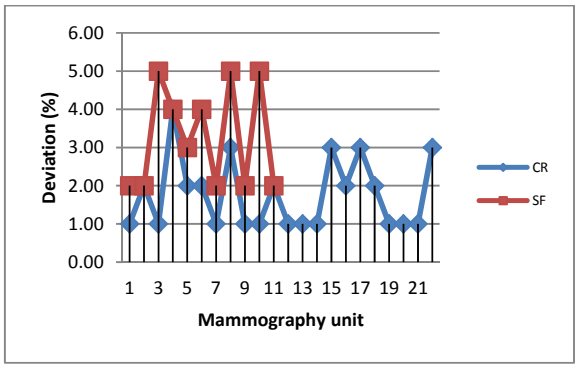

Figure 1. Tube voltage accuracy measure at 28 kV for screen-film and CR mammography units

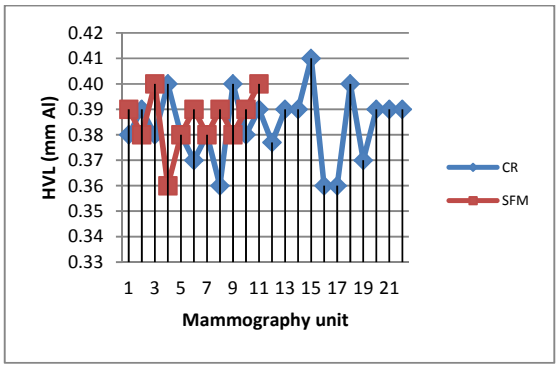

Figure 2. Half-value layer for Mo/Mo target/filter combination for screen-film and CR mammography units

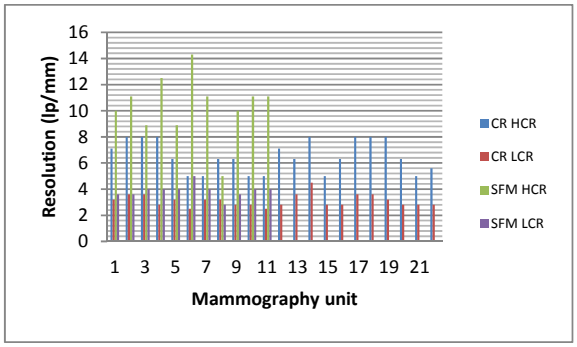

Figure 3. High and low contrast resolution for screen-film and CR mammography units

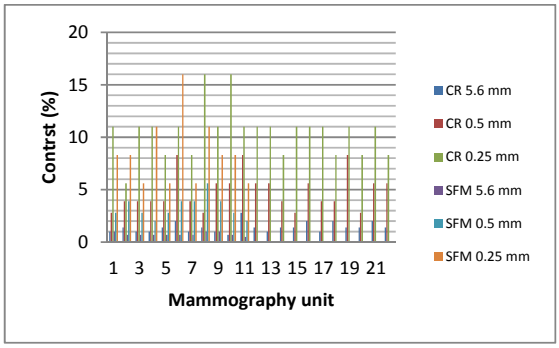

Figure 4. Contrast for details 5.6 mm, 0.5 mm and 0.25 mm size for screen-film and CR mammography units

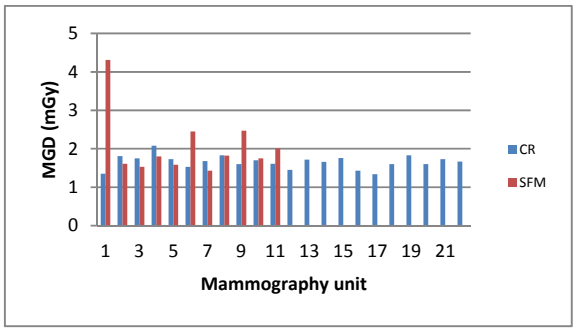

Figure 5. Mean glandular dose for standard breast for screen-film and CR mammography units

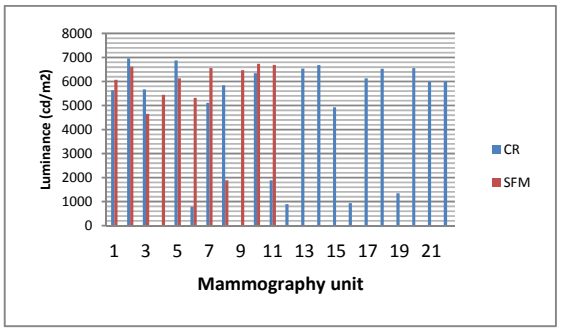

Figure 6. Light box luminance in mammography units equipped with screen-film and CR detectors

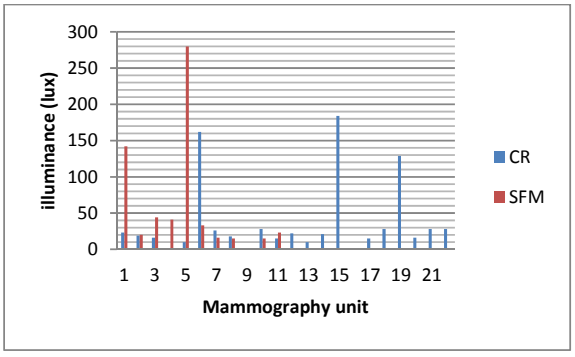

Figure 7. Ambient light level in viewing environment in mammography units equipped with screen-film and CR detectors

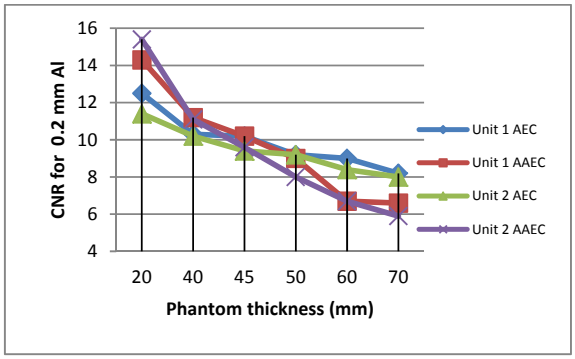

Figure 8. Contrast to noise ratio (CNR) for two FFDM units

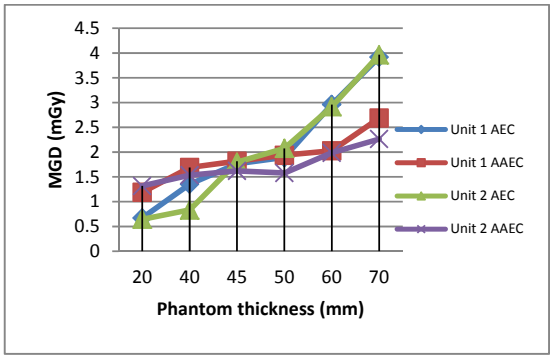

Figure 9. Mean glandular dose (MGD) for two FFDM units

Discussion

As demonstrated in previous studies [4,5], parameters of x-ray tubes and generators were among the most stabile elements of mammography units. However, compared to previous studies, the performance of image receptors, film processors and viewing conditions has been significantly improved [4-6].

Image quality and dose are the most important indicators of mammography practice and important components of a quality control programme. Quantitative assessment of dose is well defined and straightforward as there are well developed dosimetry protocols [1]. Although it is difficult to establish correlation between clinical and physical image quality [?], the results of image quality assessment using test object presented here were of importance for comparison of different mammography units, different technologies and for establishment of minimal standards in mammography [3,7].

The presented results are the first efforts to implement comprehensive QC in the mammography, in particular in DR (direct radiography) and FFDM units. While implementation of test in SFM and FFDM (groups of parameters related to detector and x-ray tube and generator)…., there were difficulties related to inabilities of workstations in CR mammography units for extraction of basic statistics of selected region of interest, as mean pixel value and standard deviation. Also, there were problems with import of DICOM QC test images for monitor and printer QC test. Such problems highlighted a need to carefully analyze technical specification of the purchased equipment and establish close cooperation with manufacturers.

Conclusion

After initial implementation at the beginning of the population-based breast cancer screening campaign, it is essential to establish system of regular and periodic QC equipment monitoring and to ensure high quality mammograms with minimal possible radiation dose to population included in the screening.

References

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