Technical and clinical breast cancer screening performance indicators for powder based computed radiography versus direct digital radiography

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Purpose

In 2003, the European Council recommended mammography screening in women aged 50 to 69 years in accordance with European Guidelines [1]. These guidelines determine the whole process, from the invitation of the women to epidemiological evaluation of screening data. They use acceptable and achievable levels for both the technical screening indicators and the clinical screening performance parameters. In 2006, these Guidelines were updated to cope with newer insights and technical evolutions [2]. A new chapter was dedicated to digital mammography systems. The main idea of the additional physical tests was to guarantee that at least the same quality could be obtained with the new technology as obtained with film-screen mammography (FSM). Contrast detail analysis was proposed to evaluate image quality; as with film-screen technology, mean glandular dose was used to assess the stochastic radiation induced risk of the procedure.

In Flanders we have implemented the Guidelines for both film-screen and digital detectors in a systematic way.

In most papers, screening results for programs using digital radiology (DR) technology only are reported. Examples are reviewed in [3]. Screening performance parameters for programmes with a mixed use of powder computed radiography (CR) and DR technology are scarce and as there is some concern about the use of powder CR for selected purposes such as detection of subtle clusters of microcalcifications [4], we have extended our annual evaluation of our screening parameters with an extra evaluation to find eventual differences between these technologies.

Purpose of this study to compare technical and clinical screening performance parameters between CR and DR systems in the Flemish breast cancer screening program.

Methods and Materials

Present study is a retrospective analysis of data from the population-based Flemish breast cancer screening program. The period of investigation was fixed from January 2008 until December 2010. Screening mammograms were taken in 171 mammographic units.

Between 2008 and 2010, 73,008 women were screened with CR (17,855 women at their first screening (first round) and 55,153 in subsequent rounds). In parallel to this, 116,945 women were screened with DR (25,032 in the first round and 91,913 in subsequent rounds).
Physico-technical data for present study were collected in a subset of the mammographic units controlled by the medical physics experts of either the university of Ghent or the university of Leuven. This made a total of 62 digital mammography units involved, with 25 CR systems and 37 DR systems.

Following our legislation, mean glandular doses have to be calculated annually for at least 50 successive patients (4 mammograms per patient). The patient dose sample used in present analysis had 5,623 cases with CR and 22,122 cases with DR. We calculated first the mean value of the mean glandular doses of all the mammography systems and then separately for CR and DR.

Contrast threshold values were obtained from acquisitions of the CDMAM test object (Artinis, The Netherlands). Manual reading of the CDMAM was performed at acceptance along with an automated approach that is then continued afterwards if the results of the first automated reading had been in line with the manual reading. Automatic evaluation was performed with the software cdcom1.5 (downloadable from the Euref website) and Erica\(^2\) (available from www.qaelum.com).

The following screening indicators were calculated for CR and DR technologies and for both the initial and the subsequent screening rounds: recall rate (RR), cancer detection rate (CDR), the percentage of DCIS, the percentage of tumors with size < 1cm and positive predictive value (PPV).

The results of CR and DR technologies for the investigated period were compared using the Fisher test and a p-value less than 0.05 was regarded as statistically significantly different.

Remark: For the total group of patients scanned in the period investigated, 12.5% of the follow-up results of the recalled cases was not available. As missing follow-up results are homogeneously spread over the cohort, our CDR may therefore be underestimated by 12.5%.

Results
The mean and median doses of CR and DR systems were respectively 2.16 ± 0.36 mGy and 1.35 ± 0.32 mGy. These values are significantly different (p-value < 0.0001). **The mean dose was for CR 60% higher than for DR.**

Figure 1 visualizes the dose data, allowing an easy comparison of the data with the limiting values of the European Guidelines. The averaged values remain below the acceptable dose levels.

Physico-technical characteristics in terms of threshold gold thickness at the associated clinical dose setting are shown in figure 2.

The CR and DR systems show up as 2 groups in the graph, with DR presenting clearly better performance parameters. Contrast threshold value for the 0.1mm disk of the DR systems had an average value of 1.20µm (SD 0.13µm). The same value for the CR systems was 1.43µm (SD 0.13µm). These values were obtained at the following doses: 2.26mGy (mean) with SD 0.44mGy for CR and 1.26mGy with SD 0.27mGy for DR.

The screening performance parameters are summarized in table 1 (Fig 3). None of the parameters showed statistically significant differences between CR and DR technology.

**Images for this section:**

![Graph showing dose data comparison](image-url)
**Fig. 1:** Fig 1. Mean Glandular Dose (MGD) as a function of compressed breast thickness for a large patient dose sample examined with DR, resp. CR technology. On top of this graph, the achievable and acceptable dose levels for PMMA acquisitions (all of them corresponding to a specific compressed breast thickness) are plotted on top of this.

**Fig. 2:** Fig 2. Overview of contrast detail data, plotted as a function of mean glandular dose. This graph shows powder CR and DR 2 separate groups of systems in terms of their performance.
**Fig. 3:** Table 1: Overview of the screening performance parameters for CR versus DR and first round screening versus subsequent rounds. *CDR values have not been corrected for recalled cases without follow-up results. CDR values may therefore be underestimated by typically 12.5%. **Values between brackets represent the percentage of DCIS in the total group of cancers.

<table>
<thead>
<tr>
<th></th>
<th>CR</th>
<th>DR</th>
<th>p-value (tot)</th>
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<tbody>
<tr>
<td></td>
<td>N = 72692</td>
<td>N = 116435</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>17855</td>
<td>55153</td>
<td>25032</td>
</tr>
<tr>
<td>RR</td>
<td>5.48%</td>
<td>2.52%</td>
<td>5.61%</td>
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<tr>
<td>CDR</td>
<td>0.52%*</td>
<td>0.53%*</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.64%*</td>
<td>0.48%*</td>
<td></td>
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<tr>
<td>DCIS</td>
<td>0.08% (15.6)%**</td>
<td>0.11% (19.8)%**</td>
<td></td>
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<tr>
<td></td>
<td>0.03% (20.2)%**</td>
<td>0.05% (13.6)%**</td>
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<tr>
<td>T score &lt; 1cm</td>
<td>0.11%</td>
<td>0.12%</td>
<td>0.13%</td>
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<tr>
<td>PPV</td>
<td>18.45%</td>
<td>18.64%</td>
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<td>114/818 (13.94%)</td>
<td>265/1236 (21.44%)</td>
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</table>
Conclusion

From physico-technical point of view, DR performs better than powder based CR in terms of dose and image quality. In the Flemish screening program we could not see a difference in clinical screening indicators obtained with CR and DR.

References


Personal Information