Comparison of 2.3 & 5 mega pixel (MP) resolution monitors when detecting mammography image blurring.

Borgen R, Ma V, Kelly J, Scrogg B, Aspin R, Millington S, Luca C and Hogg P

ABSTRACT

Background
Image blurring in Full Field Digital Mammography (FFDM) is reported to be a problem within many UK breast screening units resulting in significant proportion of technical recall/rates. Our study investigates monitors of differing pixel resolution, and whether there is a difference in blurring detection between a 2.3 MP technical review monitor and a 5 MP standard reporting monitor.

Methods
Simulation software was created to induce different magnitudes of blur on 20 artifact free FFDM screening images. 120 blurred and non-blurred images were randomized and displayed on the 2.3 and 5 MP monitors; they were viewed by 28 trained observers. Monitors were calibrated to the DICOM Greyscale Standard Display Function. T-test was used to determine whether significant differences exist in blurring detection between the monitors.

Results
The blurring detection rate on the 2.3MP monitor for 0.2, 0.4, 0.6, 0.8 and 1 mm blur was 46, 59, 66, 77% and 78% respectively; and on the 5MP monitor for 44, 70, 85, 96 and 98%. All the non-motion images were identified correctly. A statistical difference (p<0.01) in the blurring detection rate between the two monitors was demonstrated.

Conclusions
Given the results of this study and knowing that monitors as low as 1 MP are used in clinical practice, we speculate that technical recall/true rates because of blurring could be reduced if higher resolution monitors are used for technical review at the time of imaging. Further work is needed to determine monitor minimum specification for visual blurring detection.

INTRODUCTION

Image blurring due to motion unsteadiness in Full Field Digital Mammography (FFDM) is a widely recognised problem and various explanations exist about how it occurs [1, 2]. One explanation is breast/paddle movement whilst the exposure is being made [3-4]. Technical recalls due to blurring also has the potential to increase false negative and false positive results. Repeat imaging increases client radiation dose, overall examination time and can raise client anxiety.

In 2000 Seddon et al. reported that over 50% of their screening mammogram technical recalls were due to blurred images [5]. More recently blurred images were found to be a major source of technical recall [6]. Audit in one of our breast screening units found that 0.86% of clients were recalled due to image blur; this contributed approximately one third (29%) of the 3% maximum permissible recall rate in the National Health Breast Screening Programme (NHISBP) [7].

For some images blurring could only be detected when they were displayed on 5 mega pixel (MP) reporting grade monitors at the time of reporting. Blurring was missed when the images were checked for technical accuracy on the lower specification technical review monitors.

Our study aims to investigate whether there is a difference in visual detection of blurring between a 2.3 MP technical review monitor and a 5 MP reporting grade monitor; and to propose an observer standard for the visual detection of blurring on reporting grade 5 MP monitors.

METHODS

Twenty eight radiographers qualified in mammography imaging from two breast screening units were invited to review 120 blurred and non-blurred images on a 2.3 MP technical review monitor and a 5.0 MP reporting grade monitor.

Selection of FFDM Images
Using published quality criteria [8], two experienced image readers independently reviewed several hundred images to identify an initial set of 100 normal artifact free FFDM images. Mathematical simulation software [9] was used to simulate the effect of motion in 20 FFDM images, thereby creating simulated blur. Simulated blurring was imposed from 0.2 to 1.0 mm at 0.2 mm increments. In total 120 images were used, comprising 20 with no blur and 100 with varying levels of simulated motion and therefore blurring (0.2mm (20), 0.4mm (20), 0.6mm (20), 0.8mm (20) and 1.0mm (20)). Figures 1 and 2 show examples of FFDM images with and without simulated blur imposed.

RESULTS

The average blurring detection rate for the 2.3 and 5 MP monitors are shown in Figure 3.

- All the non-motion images were identified correctly.
- Blurring detection rate increases with simulated motion and monitor resolution.
- The 5 MP monitor has a higher average blurring detection rate.

Figure 3: Blurring detection rate against level of motion, the error bars represent the standard deviation

- For 0.2 mm motion, there is no significant difference (p>0.20) in blurring detection between the 2.3 and 5 MP monitors.
- For motion larger than 0.2 mm there is significant difference (X2 = 547, p<0.001) in blurring detection between 2.3 and 5 MP monitors.

The technical recall rate for 2.3 and 5 MP monitors at each level of motion were calculated and summarized in Tables 1 and 2.

- Technical recall rate appears directly related to the level of motion and inversely related to monitor resolution.
- The technical recall rate for the 2.3MP monitor varies from 3.6% to 9.7% and for the 5 MP it varies from 0.3% to 5.4%.
- The 2.3MP monitor has a higher overall technical recall rate (29.5%) compared to SMP monitor (19.5%).

Table 1: Technical recall rate for 2.3MP monitor

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<tr>
<th>Level of motion (mm)</th>
<th>Technical recall rate (%)</th>
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<tr>
<td>0.2</td>
<td>0.6</td>
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<tr>
<td>0.4</td>
<td>1.8</td>
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<tr>
<td>0.6</td>
<td>3.4</td>
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<tr>
<td>0.8</td>
<td>5.6</td>
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<td>8.0</td>
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Table 2: Technical recall rate for SMP monitor

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<tr>
<th>Level of motion (mm)</th>
<th>Technical recall rate (%)</th>
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<tr>
<td>0.2</td>
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<tr>
<td>0.4</td>
<td>0.3</td>
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<tr>
<td>0.6</td>
<td>0.7</td>
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<tr>
<td>0.8</td>
<td>1.4</td>
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<td>1.0</td>
<td>2.3</td>
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For 0.2 mm motion, there is no significant difference (p>0.20) in blurring detection between the 2.3 and 5 MP monitors.

CONCLUSION

- Monitors equal to or below 2.3 MP are probably not suitable for technical review of FFDM images for the detection of blurring.
- Further research is needed to identify the minimum monitor specification for technical review in clinical norms for blurring.
- Using our image dataset, minimum standards for blur detection at 0.4, 0.6, 0.8 and 1 mm level of simulated blurring are 96, 100, 100 and 100% respectively.

This information could be used to help inform competence assessment standards of radiographers in training programmes and routine practice.

REFERENCES

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