Hull and East Yorkshire Hospitals NHS Trust

Investigating the use of an anti-scatter grid in digital CR chest radiography

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Introduction

- Radiography of the chest is one of the most frequently performed diagnostic X-ray examinations in the UK so optimisation of radiation dose *and* image quality in chest radiography is therefore an important re-search area.
- One such technique to optimise image quality is to use an anti-scatter grid.
- The benefit of using an anti-scatter grid with film has been recognised for decades, but one had to increase patient dose by a factor of 2-6 to ensure adequate optical density.
- There are clear guidelines recommending the use of grids for film, but none for digital imaging, such as computed radiography (CR).
- With modern CR receptors the image quality is restricted by noise, not optical density, so we need to ensure the signal-to-noise ratio is sufficient for the clinical task, but there is no consensus as to what in crease in dose (if any) there should be.

Methods

- A computer simulation was used to quantify the benefit of using a grid
- The computer simulator has been produced and validated by our group [1]
- It can simulate chest radiographs (examples in figure 1) acquired with various tube voltages, doses and scatter rejection techniques, by projecting virtual x-rays through real CT data
- 'Gridded' images were simulated with various levels of receptor dose as well as a corresponding 'grid-less' image.
- Gridded images were compared quantitatively to the grid-less image of the same patient by expert im-age evaluators
- Image evaluators used a 'visual graded analysis score' (VGAS) to quantify typical clinical quality criteria.
- For example (see table 1a and 1b below): if the quality of lung is definitely inferior in the gridded image compared to the grid-less image, give this a score of –3 and so on…..
- Eighty simulated patients were scored in total

GRADING	VISIBILITY OF STRUCTURE
-3	Definitely inferior to the reference image
-2	Reasonably inferior to the reference image
-1	Slightly inferior to the reference image
0	Equal to the reference image
+1	Slightly better than the reference image
+2	Reasonably better than the reference image
+3	Definitely better than the reference image

Table 1a: Scoring criteria

CRITERIA	GRADING			
	IMAGE 1	IMAGE 2	IMAGE 3	IMAGE 4
Overall quality compared to reference				
Quality of lung				
Quality of hilar/mediastinum				
Quality of spine				
Quality of ribs				
Quality of diaphragm/ retrodiaphragmatic				
Quality of lung nodule/abnormality				

Table 1b: Scoring criteria used for VGAS

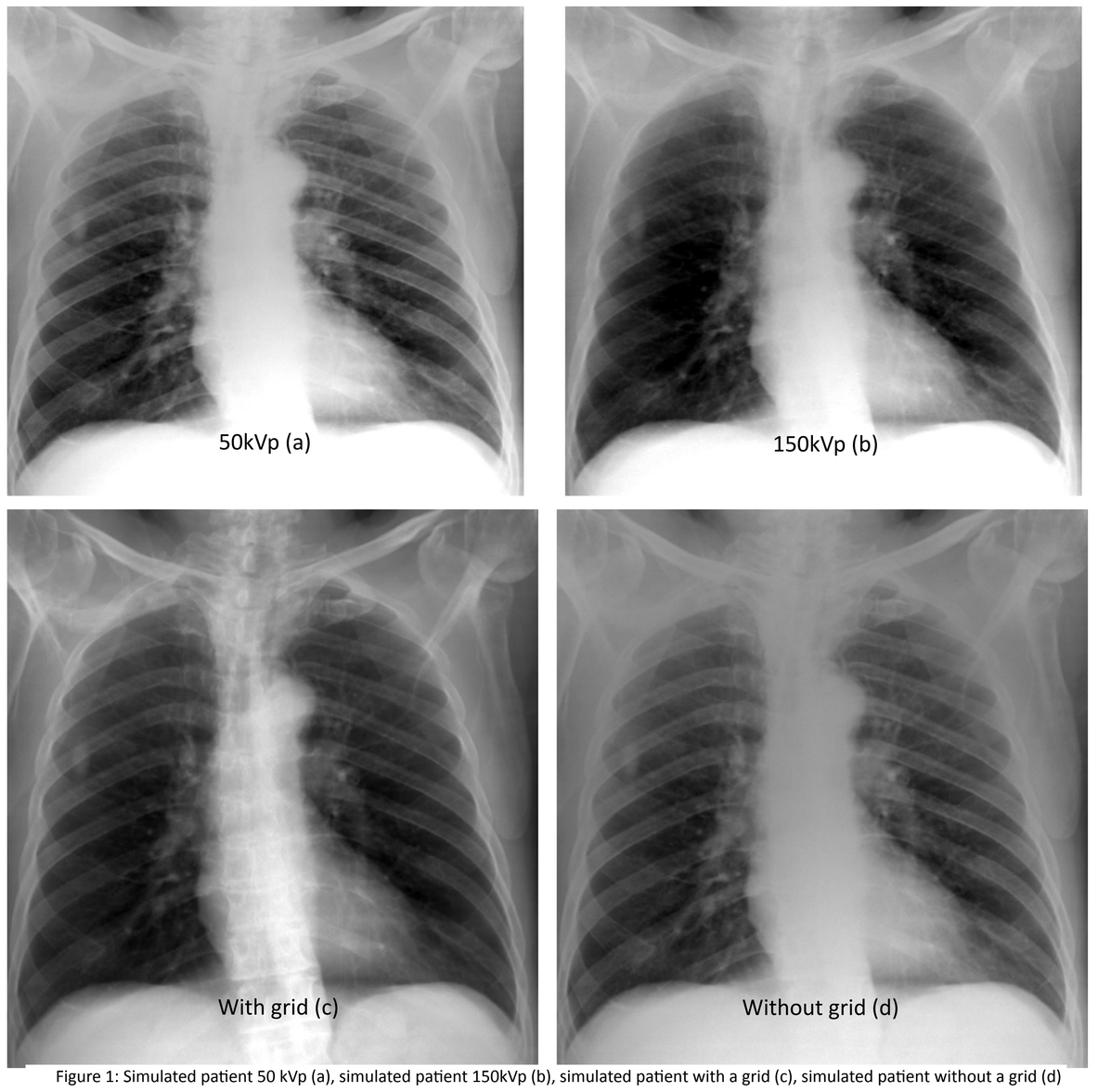

Figure 1: Simulated patient 50 kVp (a), simulated patient 150kVp (b), simulated patient with a grid (c), simulated patient without a grid (d)

Results & Discussion

- Figure 2 shows clear evidence that image quality (VGAS) improves with a grid with *no increase in dose, irrespective of tube voltage*
- It is probable that decrease in 'scatter noise' outweighs the increase in quantum noise when a grid is used
- It is also clear from the results that increasing dose to the level required for film-screen (i.e. an increase in proportion with the grid factor) is not required
- Based on the overwhelming evidence found during this research, we adopted this technique. Figure 3 demonstrates an example of real clinical impact

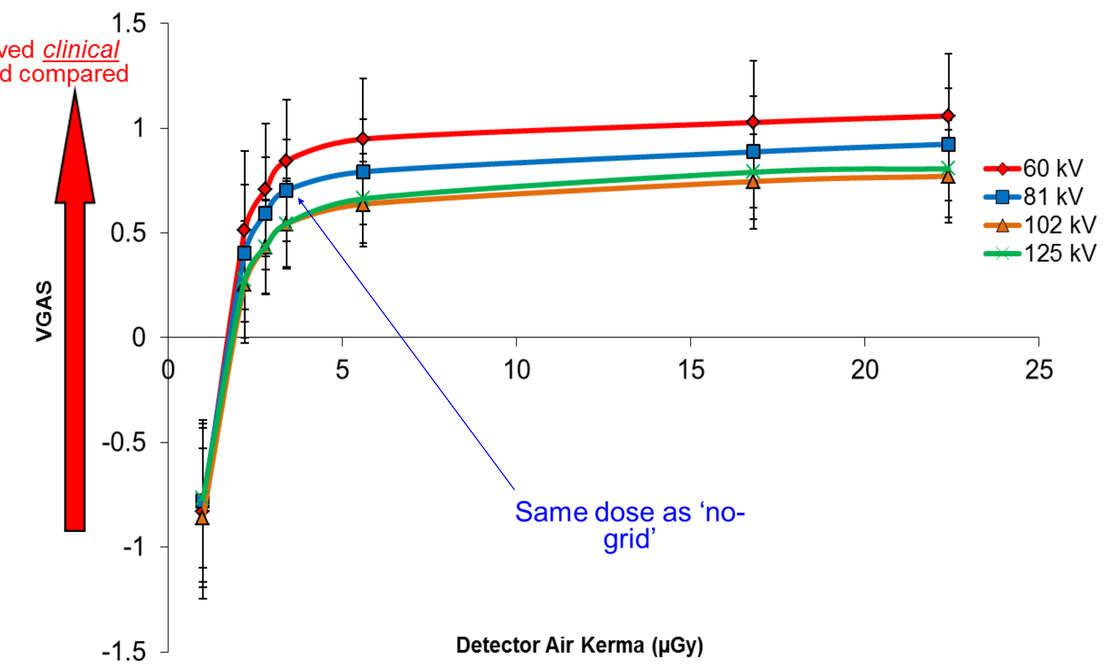

Figure 2: VGAS as a function of receptor dose for each tube voltage investigated

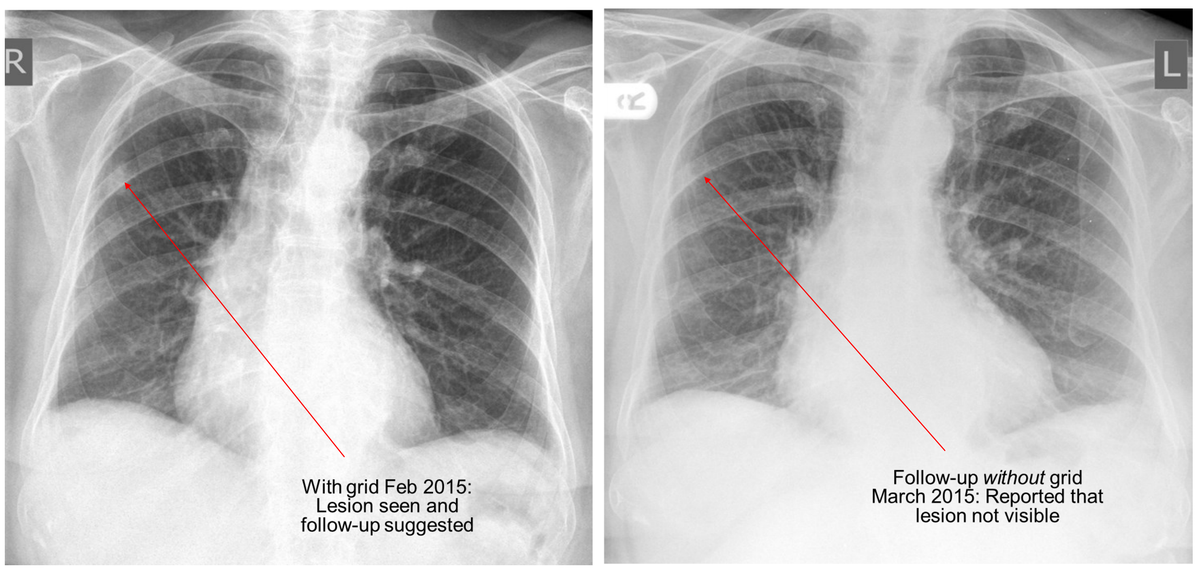

Figure 3: Real patient image acquired with a grid (a), real patient image acquired without a grid (b). Both images were acquired with same factors

Conclusions

- We have demonstrated that it is possible to use an anti-scatter grid for chest CR imaging without having to increase patient dose, irrespective of tube voltage. There is no justification for increas-ing dose to levels required for film imaging
- We have changed clinical practice by using anti-scatter grids routinely with no increase in expo-sure factors. Image quality has improved which has led to real improvements in patient care

- [1] **CS Moore**, **TJ Wood**, **G Avery, S Balcam, L Needler, A Smith**, **JR Saunderson** and **AW Beavis**, "A method to produce and validate a digitally reconstructed radiograph (DRR) based computer simulation for optimization of chest radiographs ac-quired with a computed radiography (CR) imaging system *Br J Radiol* ;84:890-902 2011
- [2] **CS Moore**, **TJ Wood**, **G Avery, S Balcam, L Needler, A Smith**, **JR Saunderson** and **AW Beavis**, Investigating the use of an antiscatter grid in chest radiography for average adults with a computed radiography imaging system, *Br J Radiol 2015;88:20140613*

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