Quantification of optical density and latitude requirements in mammography

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Introduction
Objective: to develop tools to quantitatively assess image quality in mammograms. Ultimate aim: to optimise imaging procedures and improve cancer detection.

Two studies are presented, which investigate the requirements of film optical density and latitude in screening mammography.

Study 1 - Optical density and latitude measurements
• 120 Mammograms (92 oblique views and 28 cranio-caudal views) of 46 women recorded on a single day of screening were studied.
• X-ray unit was an IGE 600 TS SENIX. the film / screen combination was Sterling Microvision C / detail screen. Films were processed using a Sterling T6 processor operating at 34°C on extended cycle.
• Films were digitised (at 110 µm resolution) using a Lumixys 150HR laser digitiser, together with density calibration strips to facilitate the conversion from image pixel value to optical density (OD).

Results - Study 1
• Each image was divided into three mutually exclusive regions of interest (ROI), representing the pectoral muscle, skin edge, and the main breast region (Figure 1).

• Images were median filtered before a threshold technique was used to select the ROI.
• Measurements included the maximum, minimum, and mean OD for each ROI on each image.
• The relative exposures of the film (log10E) corresponding to each film OD were calculated using the measured characteristic curve for the film screen system (Figure 2).
• The dynamic range of log10(E) in the main breast ROI (DR) was then calculated for each film:
  \[ DR = \log_{10}(E_{\text{upper OD limit}}) - \log_{10}(E_{\text{lower OD limit}}) \]

• The DRmax defined below and shown in Figure 2 represents the DR for an ideal OD range, and from which it is possible to approximate how many mammograms may be imaged in an ideal manner with this system.

CONCLUSIONS

Study 1
• Study has demonstrated how film OD and latitude requirements for clinical mammograms can be assessed quantitatively.
• Where film ODs for all tissues in the main breast region were within the range 0.8 to 2.9 even relatively dense glandular tissue could be adequately displayed.
• An analysis of the latitude requirements showed that about 17% of the breasts could not be ideally displayed with the high contrast system used.
• The current target density of 1.6 (including base + fog) appeared suitable for this imaging system.

Study 2
• Skin edges were better visualised with the Agfa HDR film.
• Ideally for good skin edge visualisation:
  – OD of the skin edge should be < about 3.8.
  – There should be a large difference between the OD of the skin edge and the OD of the “black part” of the film near the skin line.