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An Assessment of Image Quality of Radiographs in a Nigerian Teaching Hospital by Film Densitometry

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Abstract

3000 radiographs covering chest, upper limb, lower limb, lumbar spine (AP) and skull (PA) from the University of Calabar teaching hospital (UCTH) were retrospectively studied by densitometry to assess the degree of variation in radiographic contrast over a ten year period (1999 – 2008). The results show that variation in mean radiographic contrast from year to year was statistically insignificant ($p < 0.05$) for the respective projections studied. This result implies a relatively basic standardisation in image quality arising from consistency in technique acquired over time. The results would serve as a baseline for developing a more robust quality assurance programme in the hospital.

Introduction

The end product of the radiography process is the production of an image of diagnostic quality, that is, the image must sufficiently aid in the diagnosis of a patient's condition. A good quality radiographic image is one in which the amount of anatomical information displayed is maximised while distortions are minimised[1]. The acquisition of good quality radiographs require that the factors involved in the image formation are properly understood[2].

Although image quality is defined with respect to the task[3], the search for the optimum radiographic image quality has generated studies which have revealed the need for standardisation of technique and procedure in many places[4-6]. Efforts towards optimisation of image quality are often lost through poor quality control

(QC) methods or the lack of equipment for, and any defined quality assurance (QA) programmes. This is most evident in non automated x-ray departments such as is found in most developing economies. It has been shown that poor quality radiography images and poor standardisation in procedure is related to inadequate film processing techniques in manual processing[7-8]. In addition to this, the use of different brands of x-ray films and processing chemicals, with the attendant variation in film speed, film contrast or base-plus fog density[7,9], makes the process of standardisation of images quality difficult in a non automated setting.

This work is a review, by the most basic method of image quality assessment, using Radiographic contrast, of image quality in radiographs produced at the University of Calabar Teaching Hospital, Calabar to ascertain the level of image standardisation in the absence of standard QA facility and programmes. Findings in this study will provide a basis for future reference in the development of QA/QC criteria in the hospital.

Materials and methods

3000 radiographs, 600 each for chest, upper limb, lower limb, lumbar spine and skull radiography, respectively, were studied with a Sakura PDA 81 model portable digital densitometer (Konica Corporation, Japan). The radiographs used covered the period from1999 to 2008. Six to ten arbitrarily selected spots on each radiograph were chosen for measurement of the optical density (OD), as described in Egbe[10]. The number of points used was chosen with respect to film size. Mean values of OD were computed for respective radiographic projections for each year. From these, the mean radiographic contrast was determined from the OD differences obtained from selected adjacent points on the radiographs. The Mann-Whitney test of differences was used to assess statistical variation at the 95% confidence interval, between the image quality (radiographic contrast) between the respective years.

Results

Mean contrast values for respective projections studied for the years 1999 to 2008 are presented in Figures 1 – 5. Figure 1 shows a relatively stabilized image contrast with no statistical differences ($p < 0.05$) observed between the contrast over the y/ears, except in 2002 and 2007 – 2008, where significant differences ($p > 0.05$) were observed. Similar consistency in contrast was observed for upper limb radiographs for which no statistically significant differences were observed, although slightly lower values in contrast were obtained in 2007 and 2008, respectively.

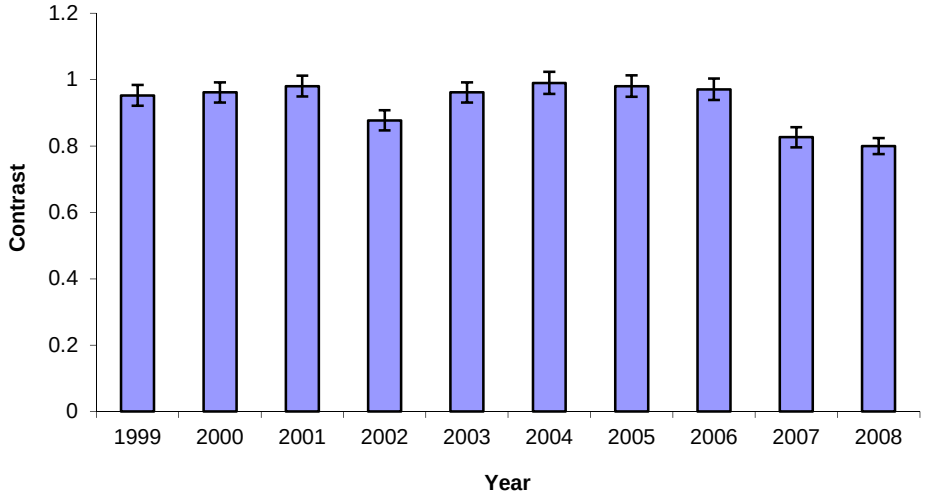

Figure 1: Chest radiography contrast between 1999 – 2008. Error bars are 1 SD of mean.

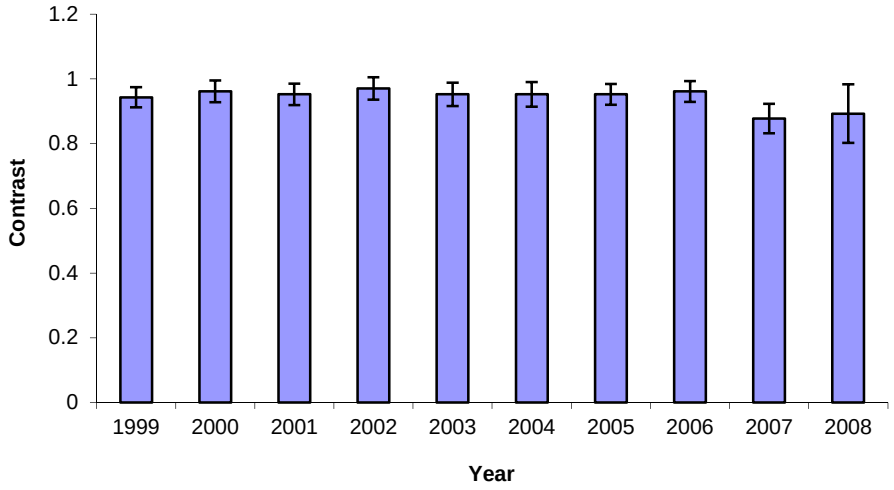

Figure 2: Upper limb radiographic contrast for the study period. Errors are 1SD.

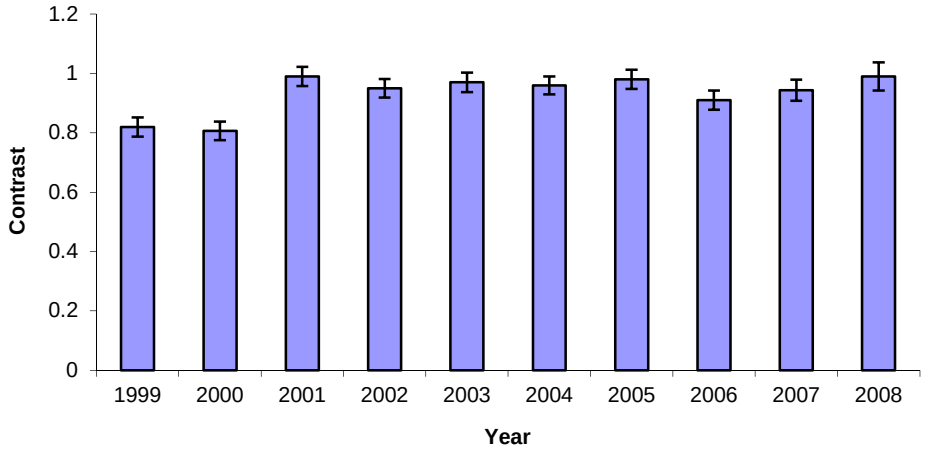

Figure 3: Radiographic contrast for lower limb radiographs. Errors are 1SD of mean values.

Radiographic contrast improved significantly from 0.8 (1999 and 2000) to close to unity in the years following. Results show no statistically significant difference in contrast obtained in the years from 2001 to 2008. Mean values of contrast for lumbar spine radiography and skull (Figures 4 and 5) show periodic breaks in the consistency of image quality obtained. These differences were not statistically significant for lumbar spine radiographs, but significant differences were observed in skull radiography, particularly in 2001/2002 and 2007/2008 periods.

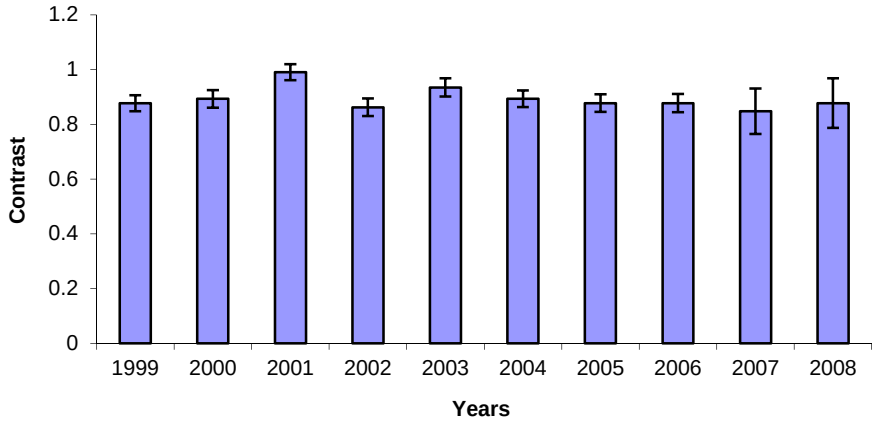

Figure 4: Radiographic contrast for lumbar spine (AP) films over the period. Error bars are 1SD of the mean values.

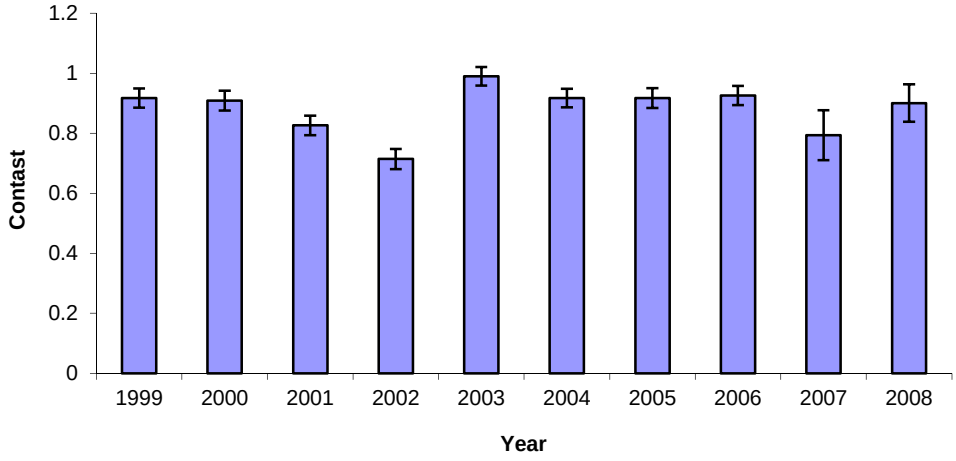

Figure 5: Radiographic contrast for Skull radiographs. Error bars are 1 SD of mean.

Discussion

The results from this study reveal a relatively consistent radiographic image quality over the period of study. Small but statistically insignificant ($p < 0.05$) variations observed between the years could be attributed to the use of different brands of film products from different manufacturers. Films from different manufacturers have been reported to have varied response to x-rays, producing differences in image quality for the same objects[11]. The use of different x-ray generator types or machines over the period under review could also account for variation in image quality (Holm 2000). Up until sometime in 2001, a GEC R501 x-ray generator was in use in the hospital, alongside a GEC MX-4 unit. Following the breakdown of the R501 unit, a much smaller poly-mobile generator was put to use. In 2007, a digital Philips Practix 300 x-ray unit, was introduced. The utility of these multiple generator types, with different tube outputs and variation in age and wear due to use, would partially explain the small differences observed between the years. In addition, the use of old cassettes and intensifying screens, without any manifest quality control measures for performance, could also account for the observed slight variation in image quality.

The foregoing suggests some degree of consistency in radiographic contrast or image quality for the respective projections studied. Considering the current lack of facilities for development and adoption of modern image optimisation techniques, the results demonstrate the most basic of standardisation of radiographic procedure within the hospital. These results might have been achieved as a result of staff strength developing consistency in technique over time, in both radiographic procedure and darkroom or film processing techniques.

It needs to be stated that the above does not preclude the need for a more elaborate quality assurance programme for the hospital, especially with regards to optimising the quality of radiographs with respect to patient dose and the use of different imaging facilities. The issue of patient dose, not considered in this study, is critical to achieving acceptable optimised radiographic conditions and is being studied using the results in this study as a reference.

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