

Assessment of the diagnostic quality of the digital display monitors at the dental clinics of a university hospital



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ABSTRACT

Background: In contemporary health care, monitor displays are important devices that help clinicians in reading and understanding diagnostic images including radiographs. Image quality and observer performance could be compromised if the performance of monitor is below the known standards.

Objectives: To estimate the parameters of diagnostic quality of digital display monitors (using AAPM TG-18 criteria) installed at the dental clinics of a university hospital.

Materials and methods: A survey was carried out on a convenience sample of forty-four diagnostic monitor displays currently being used for radiographic interpretation at dental clinics of a university hospital. A calibrated photometer (BARCO V950-180, USA) comprising of different test patterns and reference standards developed by the AAPM TG18 and DICOM part 14 GSDF were used on the monitors to assess their diagnostic image quality. It is a scale which consists of five parameters that labels monitors into two categories: primary grade or secondary grade. Data was reported as frequencies of the five parameters of imaging.

Results: Of the 44 monitors assessed, none fulfilled the primary grade criteria. All monitors fulfilled the parameters for secondary grade display except the luminance response for which only 16/44 monitors passed the criteria. There was an excellent agreement between the assessors for the image quality parameters; kappa: 0.92.

Conclusions: Within the limitations of this study, it is concluded that all monitors at dental clinics were of secondary grade and the only parameter in which majority of the monitors failed, was the luminance response.

1. Introduction

In dental practice, radiography is an integral component in the process of diagnosis and treatment planning [1,2]. In last two decades, the improvement in the digital radiography has virtually replaced the conventional film based dental radiographs [3]. Those film based images had the drawbacks of longer processing time, increased radiation dose, image quality variability and difficult manipulation of images after processing etc. [3,4] The digital imaging has the advantage of offering minimal exposure of radiation to the patient, elimination of chemical processing, ease in image modification by operator and improved accuracy of the image [3,5]. This has made digital radiography popular among dentists [6–8].

Computers are essential part of healthcare establishments including

dental offices [2,4]. Computer monitor is a crucial device in digital imaging and represents an important element in optimizing the quality of the digital radiographs [4]. However, it was reported that the information seen on the monitor display degrades over time because of progressive ageing [7].

To identify that display performance can affect image quality and diagnostic outcomes, there are different guidelines which can assess and optimize the performance of these devices. The American Association of Physicists in Medicine- Task Group 18 (AAPM TG18) and the National Electric Manufacturers Association (NEMA) have developed recommendations regarding the appropriate operating characteristics of the displays used for the purpose of diagnostic radiology. They have classified monitor displays into primary and secondary display systems [8].

Primary display systems are used for interpretation of medical

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Table 1
Acceptance criteria for display monitor performance adapted from AAPM TG 18.

Operating Parameter	Acceptance criteria	Acceptance criteria	AAPM TG 18 Test patterns used
	For primary grade displays	For secondary grade displays	
Geometric distortion	Straight Horizontal and vertical line pairs Each grid should be square	Straight Horizontal and vertical line pairs Each grid should be square	TG 18-QC
Luminance response	$L'_{max} \geq 170 \text{ cd/m}^2$ $LR' \geq 250$	$L'_{max} \geq 100 \text{ cd/m}^2$ $LR' \geq 100$	TG18-LN8-01 to TG18-LN-18
Luminance dependency	Non-uniformity $\leq 30\%$	Non-uniformity $\leq 30\%$	TG 18-UNL10 & TG 18-UNL80
Display resolution	$0 \leq Cx \leq 4$	$0 \leq Cx \leq 6$	TG 18-QC
Display Noise	All targets visible except the smallest	Two largest sizes visible	TG 18-AFC

images, as in radiology. They have to fulfill strict performance criteria [1, 8,10]. On the other hand, secondary display systems are used in disciplines other than radiology [8–10]. Despite the widespread availability of advanced color and gray-scale monitors, the quality of the final displayed image is often insufficient for diagnostic purpose. This is mainly attributed to improper configuration and poor maintenance of the display monitors [2,9,11]. Therefore, the purpose of this study was to assess the diagnostic quality of the display monitors used in the dental clinics of a university hospital by using AAPM TG18 criteria.

2. Materials and methods

Exemption from the Institutional Ethics Review Committee was obtained to use monitor displays installed at the dental clinics for the data collection. A survey was carried out on a convenience sample of forty-four diagnostic monitor displays currently being used for radiographic

interpretation at dental clinics of a university hospital, Karachi. All displays were cleaned, warmed up for a period of 30 min and the optimum display resolution was set before testing. Monitor displays were assessed using appropriate software package and calibrated photometer (BARCO (V950-180)) comprising of different test patterns and reference standards developed by the AAPM TG18 [2,9] (Table 1).

Assessment was performed by two researchers after being trained with a senior medical physicist experienced in the display performance assessment. Installation and operation of software was done on computer utilizing a dedicated graphics card capable of supporting 32-bit color or 10-bit gray scale images, as recommended by the AAPM TG18. Before assessment, the TG18-QC test pattern was used to check the horizontal and vertical alignment of the active display field. Display performance was measured according to the primary and secondary acceptance criteria of the AAPM TG18 utilizing different test patterns (Fig. 1).

The operating parameters that were taken into consideration were geometric distortion (TG 18-QC), luminance response (TG18-LN8-01 to TG18-LN-18), luminance dependency (TG 18-UNL10 & TG 18-UNL80), resolution (TG 18-QC) and noise (TG 18-AFC). Data was recorded using a proforma on which individual monitor performance was scored as either a ‘pass’ or ‘fail’ according to the AAPM TG18 criteria.

3. Results

Of the forty-four monitor displays assessed, none of them fulfilled the primary grade criteria. All monitors fulfilled the parameters for a secondary grade display except the luminance response for which only sixteen out of forty-four (36.3%) monitor displays passed the criteria (Table 2). There was an excellent agreement between the assessors for the image quality parameters; kappa: 0.92.

4. Discussion

Medical imaging displays are expected to provide the maximum

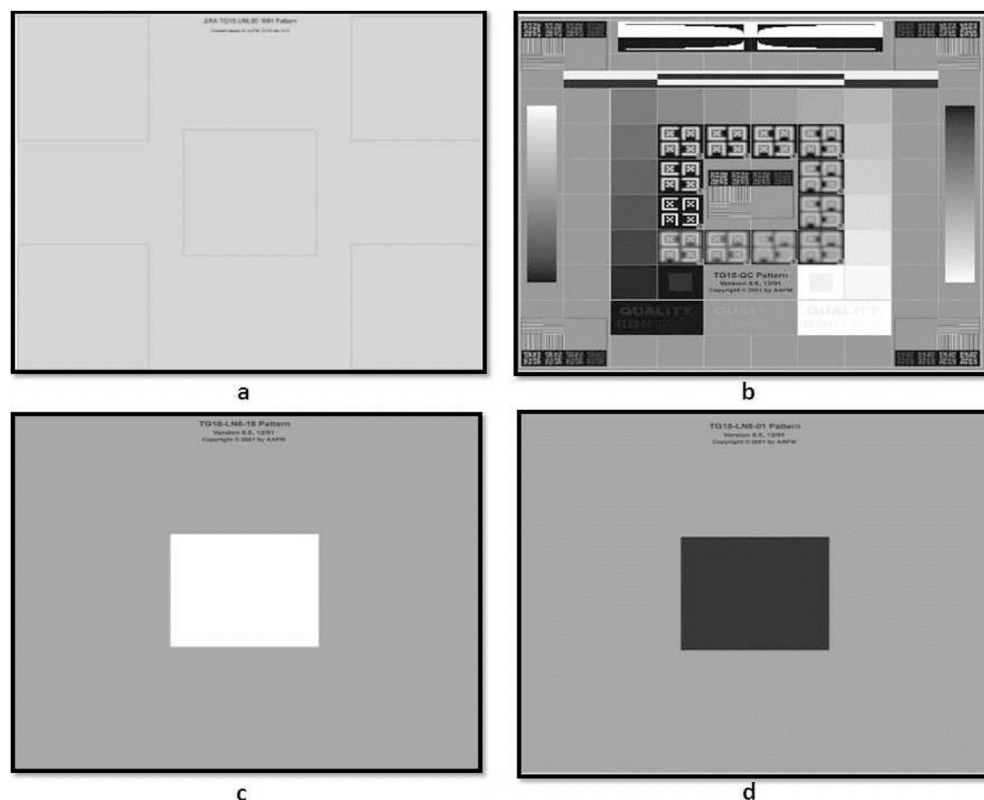


Fig. 1. AAPM TG18 test patterns (a) TG 18-UNL10 & TG 18-UNL80 (b) TG 18-QC (c, d) TG18-LN8-01 to TG18-LN-18.

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