
INFLUENCE OF PIXEL SIZE DIFFERENCE ON IMAGING PLATE COMPUTED RADIOGRAPHY ON THE QUALITY OF DIGITAL IMAGES IN INTRAORAL DENTAL RADIOGRAPHY EXAMINATION

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ABSTRACT

This research aims to determine the assessment of digital image quality from 18 x 24 cm Imaging Plates of the ST (Standard) and HR (High-Resolution) types by engineering the dimensions on intraoral dental radiographic examinations so that we can determine the differences in image quality for each type of imaging. Plate Computed Radiography. The research method took the form of an experiment using the subjective quality assessment method of digital images in intraoral dental radiographic examinations using the object of patients who carried out the examination and brought a referral letter for 60 patients. Analyze image quality by measuring MSE (Mean et al.), PSNR (Peak Signal to Noise) and PIQE (Perception-based Image Quality Evaluator) score. The results of the research show that the analysis of differences in IP FCR ST and HR types with the Mann-Whitney Test shows the significance values of all digital images (< 0.05), namely: MSE (0.041), PSNR (0.041), PIQE score (0.012), meaning that there is a difference in digital image quality between IP FCR ST and HR, while with subjective analysis the respondents gave IP FCR HR results of 57.14% and IP FCR ST 42.86%. The difference in the results of the two types shows that IP FCR HR can be used as the main alternative in selecting IP FCR in intraoral dental radiographic examinations).

Keywords: Imaging Plate, Pixel, PIQE Score, Mean Square Error, Peak Signal to Noise Ratio.

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INTRODUCTION

Developments The development of digital radiography technology has had a significant impact on the field of radiology (Ma, 2019). The use of digital radiography has been proven to be more effective and useful in diagnosing organ diseases and diagnosing diseases (Alshqaqeeq et al., 2020) ; (Mun et al., 2021). The use of Image Plate (IP) as a Computed Radiography (CR) component is a material used in digital radiography, apart from being able to store and capture latent X-ray images, IP can also increase the accuracy of radiographic images (Setyawan & Suryono, 2014). The use of digital radiography has also led to the development of digital intraoral dental radiography techniques, such as X-ray, panorama, and X-ray spectroscopy (Gigi & Padang, 2015). In 2018, 90% of Belgian radiologists used digital radiography, with 70% using digital detectors and 30% using sensors (Gijbels et al., 2005).

CR tools designed explicitly for intraoral dental examinations have been widely used in dental health, including in Indonesia (Nuraisyah, 2023). However, in reality, the results displayed by a unique CR dental tool from one of the brands circulating in Indonesia during a demonstration of the tool at the Pramita Main Clinic, Martadinata Bandung branch, were not yet able to provide a digital image display that could be processed such as 100% and 200% image enlargement. The image processing

parameters on the CR console are not many compared to the CR they already have, so management still wants intraoral radiographic dental examinations to use the existing CR tool to fulfil the request of several dentists to get comparative digital radiographic image results of 100% and 200%. The image can be processed in more detail with the help of various tools during intraoral dental examinations at the Pramita Main Clinic. The existing use of CR does not produce cassettes and IPs with dimensions as large as films for intraoral dental examinations. There are 2 types of IP CR, namely the ST type with dimensions: 35 cm x 43 cm, 35 cm x 35 cm, 24 cm x 30 cm, 18 cm x 24 cm, and 15 cm x 30 cm and there is also the HR type with dimensions: 24 cm x 30 cm, 18 x 24 cm (Kashima et al., 1994). The choice of IP, often not paid attention to and can affect image quality, often occurs due to limited knowledge in selecting IP, so information is needed regarding the IP type and firmness in selecting the IP to be used (Amtha et al., 2020).

Based on this background, the aim of this research is to assess the quality of digital images from 18 x 24 cm Imaging Plates of the ST (Standard) and HR (High-Resolution) types by engineering the dimensions on intraoral dental radiographic examinations, so that quality differences can be identified—images on each type of Imaging Plate Computed Radiography. The benefit of this research is knowledge of the IP FCR's ability to obtain digital images of intraoral dental radiographs, where the IP FCR has differences. Dimensional engineering is carried out so that it can fit into the mouth. It can provide information about how much influence different types of IP FCR have on the resulting digital image so that it can be used in intraoral dental radiology examinations by fellow radiographers as a medical support tool.

METHOD

This type of research is experimental using the subjective quality assessment method of digital images in intraoral dental radiographic examinations using IP FCR ST and HR. The current research population is all data in digital images of intraoral dental radiographs examined at the Pramita Main Clinic, Matraman branch, Jakarta. 2. This research sample was taken from a portion of the research population that met the inclusion and exclusion criteria. The criteria are a) Inclusion of patients with an explicit diagnostic record in the dentist's introduction and images with sufficient collimation (not cut or superposed) so that the desired object is achieved. b) Exclusion of patients whose image does not show the object of interest and also has an unexposed area around it (clear at the top/bottom/right/left), the object is cut off and there is superposition. The instruments required in this research are Planmeca Promax dental X-ray aircraft, IP FCR (ST and HR), digital image processing (FCR), and data processing (laptop, Matlab/MathWorks, SPSS IBM).

RESULTS AND DISCUSSION

Digital Image Data Analysis of Intraoral Dental Radiography

Kappa Test

The research involved two respondents filling out a questionnaire, respondents practising in the same location, different ages, and dental graduates. The results of the two doctors' assessments were analyzed using the kappa test, shown in Table 1. Respondents assessed the image in terms of whether it appeared clearly or less clearly.

Table 1. Kappa Test for Respondent 1 and Respondent 2

		Value	Asymptotic Standard Error ^a	Approximate T ^b	Approximate Significance
Measures of Agreement	Kappa	,618	,167	2,868	,004
N of Valid Cases		14			

a. I am not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Bivariate Analysis

1) Normality test

Table 3 displays the initial steps in the analysis before proceeding to the next stage, namely the normality test of the variables presented in this research.

Table 2. PIQE, MSE and PSNR Score Normality Test.

IP ST and HR	Kolmogorov Smirnov ^a			Shapiro-Wilk		
	Statistics	df.	Sig.	Statistics	df.	Sig.
PIQE Score.	.109	60	,072	,984	60	,598
Error Value.	,257	60	,000	,840	60	,000
Ratio Signal Value.	,202	60	,000	,872	60	,000

*. This is a lower bound of the true significance

a. Lilliefors Significance Correction

It can be seen from Table 3 that the Shapiro-Wilk Sig value. PIQE score sig value. 0.598 (> 0.05) normal distribution, MSE value sig. 0.000 (< 0.05) non-normal distribution, PSNR value sig. 0.000 (< 0.05) non-normal distribution, one normal distribution (PIQE Score) and two other data non-normal distributions (MSE and PSNR).

2) Mann-Whitney Difference Test

The results of the normality test show that the results are not normally distributed, so the Non-Parametric test is continued. Because the two materials were tested with different samples, the difference test was continued with the Mann-Whitney test. Table 4 displays the results of the Mann-Whitney Test on these four variables.

Table. 3 Mann-Whitney Test PIQE, MSE and PSNR scores between Pixel 10 and Pixel 20 Test Statistics

	PIQE Score	Error Value	Ratio Signal Value
Mann-Whitney U	280,000	312,000	312,000
Wilcoxon W	745,000	777,000	777,000
Z	-2,513	-2,040	-2,040
Asymo. Sig. (2-tailed)	.012	.041	.041

a. Grouping Variables: ST and HR

Hypothesis table 3

H0 = Both Populations are Identical (Digital et al. of Both IPs Influence Image Quality but Are Not Significantly Different)

H1 = The two populations are not identical (the digital image results of both IPs influence image quality but are significantly different)

Asymp value. Sig (2-tailed) PIQE score 0.012 (< 0.05), MSE 0.041 (< 0.05) and PSNR 0.041 (< 0.05), so all values are < 0.05 . This value is based on decision-making in the Mann-Whitney Test, it is stated that IP FCR ST and IP FCR HR have different image quality. H0 = REJECTED.

Steps for Testing the Quality of Digital Images of Intraoral Dental Examination Radiographs at the Paramita Main Clinic, Matraman branch

Testing involves direct patient samples on the basis that the IP used has been tested to provide good results for all radiographic examinations other than intraoral dental examinations by engineering the dimensions to suit the dimensions of conventional dental film, namely 3.1 x 4.1 cm, so it can fit into the mouth. The patient being examined also brings a referral letter from the dentist for an intraoral dental examination according to the doctor's and patient's needs so that the cover letter can be used as a consent form for taking dental images. Patient data and patient safety can be guaranteed because the Laboratory Information System (LIS) system owned by the research site is excellent, and K3 patient handling is running well.

Testing involving researchers in collecting and processing data must have a good and correct basis and reference. This is done so that the results obtained are maximum so that conclusions and suggestions are not doubtful and precise when making decisions. With the help of applications, consultations and media, constructive input and output can be accounted for.

Testing involving respondents as assessors of the image displayed is sufficient to provide options for making decisions other than existing applications. Although this assessment is based on the respondent's experience, it can at least represent the many respondents in this study.

The data in the form of digital dental images is displayed in the form of a selection of the best data for both ST and HR based on the researcher's observations without any intervention from other parties. This selection is carried out so that no element of favouring one of the instruments studied exists.

The application used in this research is also a standard for medical digital imaging purposes, namely the Fuji System and PACS, which can provide output and input in the form of DICOM. External image processing also uses the Matlab application (Yudha et al., 2023). Researchers also use the best application from IBM (SPSS) for statistics.

The use of the PIQE score which has the ability to provide a score on digital images without the need for intervention on the original image, MSE and PSNR are also digital image quality parameters that can be obtained after intervention on the original digital image (Gaussian filter).

Digital Image Quality Testing of Intraoral Dental Examination Radiography at the Pramita Main Clinic, Matraman branch.

The results of assessing digital image quality parameters based on the selection of images taken provide a variety of numbers that are directly calculated from the Matlab application, both online and offline. The commands used are standardized to make it easier to process all data. The

PIQE Score value taken directly from the image has been converted to grayscale; for the MSE and PSNR values, additional intervention was given to get the value out; the researcher used the Gaussian filter command. The MSE and PSNR values are obtained after taking a digital image given a filter.

The data is then processed statistically, starting with a normality test, which produces a non-normal distribution, so the next test step is the Mann-Whitney test. Test results p value sig. All below 0.05 (PIQE Score 0.012, MSE 0.041 and PSNR 0.041).

The images displayed as attachments to the questionnaire are separated between sheets one and 2, where the code is given randomly; respondents have to choose whichever image seems less clear. After being given the attachment, both respondents stated that the appearance was good enough to be evaluated. However, because the aim was to compare the image quality between the two IPs with different pixel sizes, the respondents were willing to give clear, unclear and unclear values to the image displayed.

The results of respondent 2's assessment were that the percentage of "Clear" scores on ST was 42.86% and HR was 57.14%, "Not Clear" on ST was 42.86% and HR was 28.57%, the score was "Not Clear", ST and HR have the same value, namely 14.29%.

Digital Image Data Analysis of Intraoral Dental Radiography

For respondent consistency, it can be seen from the accumulated assessments using the Kappa test that Respondent 1 and Respondent 2 have a p-value of 0.004. Kappa value 0.618. Differences in MSE, PSNR, and PIQE score when using ST and HR, a different test must be carried out, previously a normality test for MSE, PSNR, and PIQE Score must be carried out. It can be seen from Table 4.6 Shapiro-Wilk Normality Test that the Sig value. Of the 6 data, one has a Normal distribution (Signal et al. on ST), and the other 5 have a non-normal distribution. So, the normality test is not normally distributed, so non-parametric tests are an option in the next test.

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Selection of 2 types of IP FCR ST and HR, two gradations to ordinal with test results for three image quality parameters not normally distributed, then non-parametric test using Mann Whitney Test, test results p value sig. All below 0.05 (PIQE score 0.012, MSE 0.041 and PSNR 0.041) means that H_0 is rejected, meaning that the IP FCR types ST and HR types have differences in image quality between ST and HR.

The IP FCR HR used for mammography has almost the same characteristics as the IP FCR ST for other radiology applications. However, there are some differences to note. One of the most striking differences is pixel size. IP FCR HR has a smaller pixel size, namely 75 x 75 microns. This smaller pixel size allows the FCR IP to capture more image details, resulting in better image quality. Another difference to note is sensitivity. IP FCR HR has a higher sensitivity, namely 1500 mJ/mm².

This higher sensitivity allows IP FCR HR to produce images with better contrast, even in dense breast conditions. The following is a comparison table of pixel characteristics between IP FCR HR and IP FCR ST for other radiology applications:

The following is a comparison table of pixel characteristics between IP FCR HR and IP FCR ST for other radiology applications:

Table 4 . Characteristics of P FCR HR and ST

Characteristics	IP FCR HR	IP FCR ST
Pixel size	75 x 75 microns	100 x 100 microns
Resolution	500dpi	500dpi
Sensitivity	1500 mJ/mm ²	1000 mJ/mm ²

There is no difference in the possibility that the type of IP used has almost the same characteristics as both ST and HR; even though the IP product code provides names for ST (10 pixels) and HR (10 pixels), the coding provided by the product is limited as a differentiator, between IP specifically for mammography (HR) and non-mammography (ST). This may also occur because the control variables are not appropriate, so HR and ST should be the same regarding the results of calculating digital parameters, but there is no difference.

In research (Sudin et al., 2015) using a CR system using step wedge samples, the aim was to determine the effect of different IP pixel sizes (0.168 mm, 0.115 mm and 0.097 mm) on the quality of digital radiographic images, with the results obtained being greater. The pixel size used, the greater the density and contrast values in the digital radiographic image, so that the values obtained improve the quality of the digital radiographic image.

In research (Ningtias et al., 2016) using a CR system and a sample in the form of a phantom made of copper measuring 15 x 15 cm with a thickness of 1 mm, the aim was to determine the quality of digital images by using spatial resolution calculations with the Matlab-based MTF method. The results are that the higher the voltage used, the better the image quality with an optimal current in the 4-8 mAs range with an average spatial resolution value of 7.26 lp/mm.

In research (Kuramoto et al., 2020), the phantom as the object used in this research is a self-made step phantom which consists of 12 steps with a thickness interval of 1.0 mm. Each step has seven holes with a diameter of 1.0 mm drilled at sequentially increasing depths from 0.05 to 0.35 mm. This phantom is used for visual evaluation in research. This research also uses three types of PSP pixels, namely High Speed (HS), High Resolution (HR), and Super High Resolution (SHR), and evaluated with Modulation Transfer Function (MTF) and Normalized Noise Power Spectrum (NNPS) to show that the pixel size of a digital intraoral radiography system has a significant influence on the characteristics of the resulting image. The smaller the pixel size, the higher the resulting image resolution, but the larger the image file size, the longer the scanning time.

In research (Watanabe et al., 2022) using a CR and PSP system in the form of a Dual Imaging Plate (DIP) and Conventional Single Imaging Plate (CSIP) with samples using a Porcine Mandible Embedded in Acrylic Resin phantom, aiming to evaluate the CNR, spatial resolution and subject quality of the DIP. The results are that the CNR value on DIP is higher when compared to the CNR value on FIP, the decrease in spatial resolution is limited on DIP, and the subjective image quality on DIP is higher than on FIP.

(Kamburoğlu et al., 2022) this study aims to compare the performance of CMOS and PSP intraoral detectors in terms of digital image quality of dental radiography, measuring the patient's radiation dose, and the length of time carrying out intraoral dental examinations. This study also aims to evaluate patient preferences and levels of satisfaction with CMOS and PSP. The results show that the CMOS intraoral detector has advantages in terms of time efficiency and patient comfort, while the PSP detector provides better digital radiographic image quality. However, there was no significant difference in patient radiation dose between CMOS and PSP.

The novelty of the research is an attempt to manually engineer conventional IP CR dimensions into dimensions that can be used for intraoral dental research, without using a special scanner. When using real objects, namely patients, comparisons between different sizes give almost no difference. Both can display an image that can be assessed by respondents.

CONCLUSION

Based on the research results, it can be concluded that the effect of different pixel sizes on digital image quality can be proven that: 1) Manual dimensional engineering can provide digital images that are readily accepted for IP ST and HR, even though IP HR has a value of "Clear" (57.14 %) and IP ST (42.86%). 2) Significance analysis test related to image quality <0.05 on the PIQE score (0.012), MSE (0.041), and PSNR (0.041) shows that there is a difference in quality between the two IPs. 3) significant differences exist between the two IPs, which could be the best choice between the FCR IP and the FCR HR IP.

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