

# Comparing Raw Data and DICOM Data According to Use Duration of Digital Radiography System

Sung-Hun Jeoung, Chung-Hwan Lim, Kil-Soo Ra

**Abstract**—With changes in diagnostic radiation generating apparatus, digital radiography (DR) systems are continuously increasing. The objective of this study was to compare Raw data and DICOM data according to the use period of DR system. In addition, this study conducted a constancy experiment in Korea for the first time. Based on measured value of the consistency test, it was measured after calibration for 1 month and 4 months.

Image quality change with time was then observed. A analysis of MTF curve was carried out with spatial resolution intersection of MTF 10% and the curve was evaluated. Sharpness ratings were evaluated at the intersection of MTF 50% and the curve. Information transmission ability was measured up to 1.0-3.0lp/mm. Constancy test results showed that the Raw data information transmission ability was 1.0lp/mm 92%, 2.0lp/mm 79%, 3.0lp/mm 63%, MTF 10% 5.4lp/mm, and MTF 50% 3.9lp/mm. DICOM data information transmission ability was 1.0lp/mm 94%, 2.0lp/mm 74%, 3.0lp/mm 63%, MTF 10% 5.1lp/mm, and MTF 50% 3.7lp/mm. In results of calibration after 1 month and 4 months, based on constancy test value, the image quality decreased with time. It was measured higher than 1 month and 4 months after calibration. Radiologists responsible for medical imaging will be able to improve the quality of life of patients as well as the quality of medical service if they can fully understand the evaluation method according to change of image and maintain medical image consistently.

**Index Terms:** Constancy test, Raw data, DICOM data, MTF, Calibration

## I. INTRODUCTION

Image evaluation in an analog system is performed by evaluating the image and characteristics of the film using gamma value and tolerance based on characteristic curve.

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However, in the modern age, where digital image devices take up the majority, there is no need for image measure[1], [2]. Simple image measurement using a computer is possible. The evaluation of image quality in Digital Radiography System (DRS) is a very important aspect. When examining a patient in DRS, various image files are generated. Digital Imaging and Communications in Medicine (DICOM) files will be generated and passed to Raw data of Picture Archiving and Communication System (PACS)[3], [4]. When image evaluation of DRS is performed, it is performed using Raw data [5]. However, when Raw data are converted into a DICOM file, various parameters are applied to the original data to form an image. The evaluation of images using Raw data has various limitations. Thus, many researchers have performed image evaluation with DICOM files. In addition, the format of the file is different for each equipment company. It is still not enough to measure the quality of image using Raw data. In addition, Raw data are amplified by various parameters. Thus, Raw data suffer some losses during the amplification of image. However, there is still little research that compares Raw data with DICOM data. By comparing and analyzing Raw data and DICOM data according to the usage period in the DR system, this study aims to observe the performance change of the detector and identify the timing of the degradation of image quality to suggest change of image quality and the timing of calibration of the detector. Results of this study can be utilized as basic data to improve image quality in DR system.

## II. MEASURING INSTRUMENT AND METHOD

### A. Measuring Instrument

The equipment used in this study was a diagnostic radiation generator (Gemss Medical, Apollon, R-800-150, Korea) installed in hospital A in area A. An indirect detector (FXD 4343R, TOSHIBA, Japan) was used for image acquisition. For modulation transfer function (MTF) measurement, TX5 Tungsten Edge Filter (IBA Dosimetry, USA) was used. For editing and measurement of images in this study, Image J Ver. 1.46 developed by the US National Institutes of Health (NIH) for research purposes and engineering software Matlab R2014 that could provide numerical analysis and programming environment developed by Math Works were used.

### B. Method of Measurement

The period of this study was from September 2



015 to April 2016. Five-day constancy test was performed at 1 month after measurement, 4 months after measurement, and after calibration. Constancy test was carried out daily for 5 days in order to calculate the initial average power value according to the recommendation of IEC 61223-2-11[6]. The number of measurements was once. Measured average values for 5 days were used to calculate an average value. The measured value was set as a reference value of each equipment. To observe changes of measurement values according to the use of equipment, the measurement was performed with the same method after 1 month, 4 months, and after calibration. Five measurements were made for each time point and compared with their initial setting values[7]. MTF measurement was made by aligning the tungsten edge portion of the edge filter with the center line of the X-ray tube using many pixel values. The tungsten edge portion was measured at 3°[Fig 1].

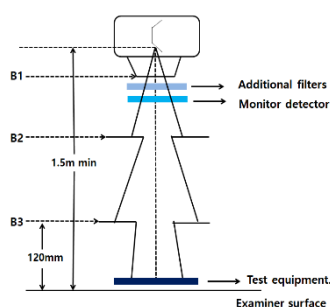


Fig. 1: Constancy Test

## C. Image Evaluation

The equipment used in this research produced a Tiff file as Raw data and a DCM file that was passed to PACS. IEC 62220-1 recommends the use of Raw data without parameters. However, images used in this study selected both. They were compared and analyzed by measuring MTF[Fig 2]. Analysis of the MTF curve was carried out by performing a spatial resolution evaluation at a value where MTF 10% and the curve intersected. Sharpness evaluation was performed at a point where the curve intersected with MTF 50%. The information transmission ability was also measured from 1.0 to 3.0lp/mm[Fig 3].

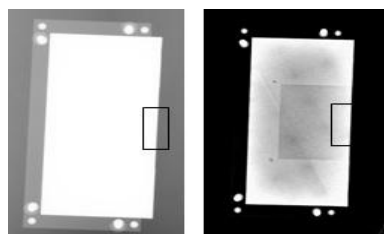


Fig.2: Analyzed by measuring MTF

## III. Results

### A. Comparative Analysis of Raw Data and DICOM Data of Constancy Test

Constancy test was performed for 5 days to set MTF reference value. Results were analyzed in three ways. Overall information transmission ability was evaluated at 1.0lp/mm 2.0lp/mm and 3.0lp/mm Sharpness was evaluated at

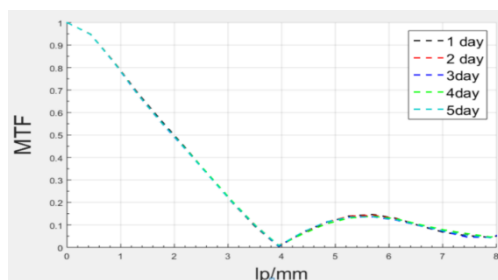


Fig.3:MTF curve

50% MTF and Resolution was evaluated at 10% MTF. Regarding information transmission ability in this study, Raw data showed an average of 1.0lp/mm 92%, 2.0lp/mm 94%, and 3.0lp/mm 63%. In MTF 50% representing sharpness, it showed 5.0lp/mm on day 1, 4.0lp/mm on day 2, 3.9lp/mm on day 3, 3.3lp/mm on day 4, and 3.3lp/mm on day 5 with an average of 3.9lp/mm MTF 10% representing Resolution showed 5.2lp/mm on day 1, 5.2lp/mm on day 2, 5.0lp/mm on day 3, 5.8lp/mm on day 4, and 5.8lp/mm on day 5, with an average of 5.4lp/mm Also, DICOM data information transmission ability showed an average of 1.0lp/mm 94%, 2.0lp/mm 74%, and 3.0lp/mm 59%. In MTF 50%, it was 4.3lp/mm on day 1, 3.8lp/mm on day 2, 3.8lp/mm on day 3, 3.8lp/mm on day 4, and 3.0lp/mm on day 5 with an average of 3.7lp/mm In MTF 10% representing Resolution, it was 5.2lp/mm on day 1, 5.2lp/mm on day 2, 5.0lp/mm on day 3, 5.8lp/mm on day 4, and 5.8lp/mm on day 5, with an average of 5.4lp/mm[Table.1].

Table. Comparative Analysis of Raw Data and DICOM Data of Constancy Test(unit: lp/mm)

Constancy Test MTF Evaluation										
Information Transfer Ability							Resolu		Sharp	
	1.0		2.0		3.0		10%		50%	
Day	Raw	DCM	Raw	DCM	Raw	DCM	Raw	DCM	Raw	DCM
1	95	97	85	85	75	72	5.2	6.5	5.0	4.3
2	93	95	80	80	68	65	5.2	6.5	4.0	3.8
3	93	95	80	80	63	60	5.0	6.3	3.9	3.8
4	90	95	75	65	55	50	5.8	3.2	3.3	3.8

5	90	90	75	60	55	50	5.8	3.0	3.3	3.0
Aver	92	94	79	74	63	59	5.4	5.1	3.9	3.7
DCM:DICOM, Resolu: Resolution, Sharp: Sharpness										

### B. Comparative Analysis of Raw Data and DICOM Data After 1 month

Based on Constancy test, results of measurement in identical experiment after 1 month were as follows. In case of Raw data, information transmission ability showed an average of 1.0lp/mm 85%, 2.0lp/mm 71%, and 3.0lp/mm 59%. In case of DICOM files, it was 1.0lp/mm 96%, 2.0lp/mm 83%, and 3.0lp/mm 68%, higher than Raw data. Also, in MTF 50%, Raw data showed an average of 3.7lp/mm while DICOM data showed an average of 3.9lp/mm. These two were similar. In MTF 10%, Raw data and DICOM data both showed 7.0lp/mm. Compared to the Constancy test, as time passed, information transmission ability, resolution, and sharpness were found to be decreased [Table II].

Table II. Comparative Analysis of Raw Data and DICOM Data after 1 month (unit: lp/mm)

Constancy Test MTF Evaluation										
Information Transfer Ability							Resolu		Sharp	
	1.0		2.0		3.0		10%		50%	
Day	Raw	DCM	Raw	DCM	Raw	DCM	Raw	DCM	Raw	DCM
1	85	97	70	83	58	70	5.0	7.0	3.5	4.0
2	85	95	68	80	53	62	4.0	6.0	3.2	3.8
3	85	95	75	85	65	72	9.0	8.0	4.2	3.8
4	85	97	75	88	65	75	9.0	8.0	4.2	4.8
5	85	95	68	80	55	65	6.0	6.0	3.2	3.0
Aver	85	96	71	83	59	68	7.0	7.0	3.7	3.9
DCM:DICOM, Resolu: Resolution, Sharp: Sharpness										

### C. Comparative Analysis of Raw Data and DICOM Data after 4 months

Based on Constancy test, results of the measurement in the identical experiment after 4 months were as follows. In case of Raw data, information transmission ability showed an average of 1.0lp/mm 80%, 2.0lp/mm 50%, and 3.0lp/mm 20%. In case of DICOM files, it was 1.0lp/mm 85%, 2.0lp/mm 50%, and 3.0lp/mm 22%, identical to Raw data. Also, in MTF 50%, Raw data and DICOM data both showed 2.0lp/mm. In MTF 10%, both Raw data and DICOM data showed

identical 3.0lp/mm. Compared to Constancy test, as time passed, information transmission ability, resolution, and sharpness were all found to be decreased [Table III].

Table III. Comparative Analysis of Raw Data and DICOM Data After 4 months (unit: lp/mm)

Constancy Test MTF Evaluation										
Information Transfer Ability							Resolu		Sharp	
	1.0		2.0		3.0		10%		50%	
Day	Raw	DCM	Raw	DCM	Raw	DCM	Raw	DCM	Raw	DCM
1	80	85	50	52	20	22	3.5	3.5	2.0	2.0
2	80	85	50	52	20	22	3.5	3.5	2.0	2.0
3	80	85	50	52	20	22	3.5	3.5	2.0	2.0
4	80	85	50	52	20	22	3.5	3.5	2.0	2.0
5	80	85	50	52	20	22	3.5	3.5	2.0	2.0
Aver	80	85	50	52	20	22	3.5	3.5	2.0	2.0
DCM:DICOM, Resolu: Resolution, Sharp: Sharpness										

### D. Comparative Analysis of Raw Data and DICOM Data after Calibration

Results of the identical experiment after calibrating the detector showed the following results. In case of Raw data, information transmission ability showed an average of 1.0lp/mm 90%, 2.0lp/mm 75% and 3.0lp/mm 70%. In case of DICOM files, it was 1.0lp/mm 96%, 2.0lp/mm 90%, and 3.0lp/mm 84%. In case of RAW data and DICOM data, it was higher than the constancy test, showing improvements in image quality. Also, in MTF 50%, both Raw data and DICOM data showed an average of 5.0lp/mm. In MTF 10%, Raw data and DICOM data both showed an identical 9.8lp/mm. As a result of calibrating the detector, image transmission quality, resolution, and definition were all improved compared to those of the Constancy test [Table IV].

Table IV. Comparative Analysis of Raw Data and DICOM Data after Calibration (unit: lp/mm)

Constancy Test MTF Evaluation										
Information Transfer Ability							Resolu		Sharp	
	1.0		2.0		3.0		10%		50%	
Day	Raw	DCM	Raw	DCM	Raw	DCM	Raw	DCM	Raw	DCM
1	90	98	75	90	70	85	9.8	10	5.0	6.0
2	90	88	75	88	70	80	9.8	9.0	5.0	5.2

3	90	98	75	90	70	85	9.8	10	5.0	6.0
4	90	98	75	90	70	85	9.8	10	5.0	6.0
5	90	98	75	90	70	85	9.8	10	5.0	6.0
Aver	90	96	75	90	70	84	9.8	9.8	5.0	5.8
DCM:DICOM, Resolu: Resolution, Sharp: Sharpness										

## IV. DISCUSSION

Due to development of science and medical technology, equipment of imaging is rapidly changing. It is a crucial part in the diagnosis and treatment of diseases. Such imaging equipment must be accurate because only the equipment with accurate quality control can predict correctly and adequately for patient care. Patient testing using equipment that is not properly quality controlled can increase the likelihood of misdiagnosis, thereby increasing the cost of testing and increasing the patient's exposure dose [8], [9]. Kang Byeong-Sam has reported that in the case of clinics and educational institutes, there is nonconformity occurring in tube voltage test, irradiation dose reproducibility test, irradiated dose linearity test, half-value layer test, and light field difference test. In addition, non-compliance occurred in the general hospital in the radiation dose reproducibility test, the light field difference test, and the survey period reproducibility test. Moreover, it has been reported that performance tests should be carried out in order to carry out the quality management efficiently and plans should be established in the setting range of items and the inspection cycle [10]. Park Jung-Gyu has reported that many nonconforming items have been measured. In order to improve this, it is necessary to revise the periodic inspection cycle to 1~2 years for older equipment [11]. Therefore, in this study, the Constancy test recommended by IEC 61223-2-11 was performed to set the reference value of the equipment and degradation of image quality of the equipment with time was observed with this reference value. In information transmission ability, Raw data showed an average of 1.0lp/mm 92%, 2.0lp/mm 94%, and 3.0lp/mm 63%. In MTF 50%, the average was 3.9lp/mm. In MTF 10%, the average was 5.4lp/mm. For DICOM data information transmission ability, the average was 1.0lp/mm 94%, 2.0lp/mm 74%, and 3.0lp/mm 59%. In MTF 50%, the average was 3.7lp/mm. In MTF 10%, the average was 5.4lp/mm. Through this constancy test, it is very important to measure the reference value of the equipment. By setting the reference value, it is easy to see change of image quality. This study also examined the change of image quality of 1 month and 4 months based on the reference value set by the Constancy test. As a result, it was confirmed that the image quality deteriorated with time. As a result of measurement using detector calibration, the quality of image was improved. This is an important result in that it shows change of quality control according to change of image and timing of calibration which is the time of initializing the detector.

## V. CONCLUSION

This study performed a comparative analysis between Raw data and DICOM data according to the period of use of digital diagnostic radiation generator. The following conclusions were obtained.

1. In the result of the Constancy test, Raw data information transmission ability was 1.0lp/mm 92%, 2.0lp/mm 79%, and 3.0lp/mm 63%. In MTF 10%, it was 5.4lp/mm. In MTF 50%, it was 3.9lp/mm. DICOM data information transmission ability was 1.0lp/mm 94%, 2.0lp/mm 74%, and 3.0lp/mm 63%. In MTF 10%, it was 5.1lp/mm. In MTF 50%, it was 3.7lp/mm. It can be seen that the constancy test can provide important data to easily recognize change of equipment.
2. Based on the Constancy test value, in measurements after 1 month, 4 months, and after calibration, the image quality decreased with time. After calibration, all were measured higher than those at 1 month and 4 months.
3. As a result of comparison between Raw data and DICOM data, there was not much difference. Image quality of both Raw data and DICOM data decreased with time.

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