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Examination of The specific spatial frequency of An analog image system for Diagnosis by Monochromatic X-ray

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1 Introduction

The degree of sharpness of an analog image system for diagnosis is estimated by the result of MTF measurement of a physical estimation of image quality method.

At the clinical spot, although the image is created based on the evaluation result of MTF, it was presupposed that the evaluation result of a visual evaluation (ROC analysis) was also important, and eventually the optimal picture for diagnosis is decided from both sides of a physical image evaluation method and a visual evaluation.

Spatial frequency which sharpness degree evaluation usually united with the resolution of man's eye since a MTF value changed with spatial frequency: It is carrying out by 2.0 Lp/mm.

This spatial frequency (2.0Lp/mm) is called "Specific spatial Frequency", and let it be a valuation basis in MTF of an analog image system for diagnosis.

This examination, it inquired for the purpose of setting up specific spatial frequency with spatial frequency higher than 2.0 Lp/mm in monochromatic X-ray from the MTF measurement result of the monochromatic X-ray of an analog image system reported at "28th PF symposium".

2 Equipment

i station : BL-14C
ii intensifying screen : HR-4 (FUJI FILM)
iii X-rays film : SuperHR-30s (FUJI FILM)
iv square wave chart
material : Pb
thickness : 0.05 mm
spatial frequency : 0.0,0.5,1.0,1.5,2.0,2.5,3.0, 4.0,5.0,6.0,8.0,10.0 Lp/mm
(Type1,KASEI OPTONIX)
v densitometer
diffusion : 301RS (FUJI FILM)
specular(microdensitometer) : PDM-7 (KONICA MINOLTA)

3 Method

i X-rays energy : 33 keV
ii distance : 110 cm
iii field : 40 mm × 40 mm
iv exposure
The quarter cassette was divided into two and the exposure time (10sec) from which spatial frequency :0.0Lp/mm (with no Pb) diffusedensity becomes about 1.50 was set up.
Two images were created in the X-ray film of one sheet.
By the same exposure time (10sec), two images were created also about spatial frequency:3.0, 4.0, 5.0,6.0,8.0,10.0 Lp/mm.
v density measurement
Density measurement was performed using the microdensitometer.
aperture width : 10 μ m
aperture height :100 μ m
stage movement speed : 0.05mm/sec
vi display
horizontal : spatial frequency
vertical : density
0.0Lp/mm : Fig.2a, 3.0～10.0Lp/mm : Fig.2b
vii calculation
The square wave MTF was computed from contrast (spatial frequency:0.0 Lp/mm standard).
The sine wave MTF (sine wave response function) was computed by having used the Coltman's correction formula for the square wave MTF.
viii display
horizontal : spatial frequency
vertical : MTF
ix visual evaluation of the square wave chart image
Observation distance (film～eyeball) : It was referred to as 30cm and the square wave chart image was observed.
x A setup of the specific spatial frequency
MTF value : The spatial frequency in the range of 0.600～0.400 was read from on the graph.

4 Result and Discussion

i The MTF value,monochromatic X-ray,it was set to 1.000～0.081and diagnostic X-ray:1.000～0.059, and fell from near spatial frequency:6.0Lp/mm (Table.1, Fig.1).
ii The specific spatial frequency, It was admitted that the MTF value in 2.0 Lp/mm became about 0.5 through about 0.6 (point estimate) and the diagnostic X-ray, and that of the direction of monochromatic X-ray was high through monochromatic X-ray.
iii In visual evaluation, it was judged that spatial frequency:3.0Lp/mm of a square wave chart image (Fig.3) could be decomposed (discernment).
iv In the specific spatial frequency in the diagnostic X-ray, if the spatial frequency in monochromatic X-ray is read in on a graph (Fig.1) in the MTF

value:0.600 ～ 0.400 based on the MTF value becoming about 0.5, it will be set to 2.5～3.5 Lp/mm.

v The spatial frequency : 2.5～3.5 Lp/mm resolution was set to about 0.20～0.14 mm by the following resolution formulas.

resolution : R mm

chart line width : d (2.5～3.5 Lp/mm)

$$R = \frac{1}{2d} \quad (\text{mm})$$

Spatial Frequency (Lp/mm)	Diagnostic X-ray MTF	Monochromatic X-ray MTF
0.0	1.000	1.000
0.5	0.906	
1.0	0.779	
1.5	0.656	
2.0	0.546	
2.5	0.452	
3.0	0.373	0.498
4.0	0.262	0.345
5.0	0.191	0.245
6.0	0.144	0.148
8.0	0.083	0.091
10.0	0.059	0.081

Table.1 MTF value

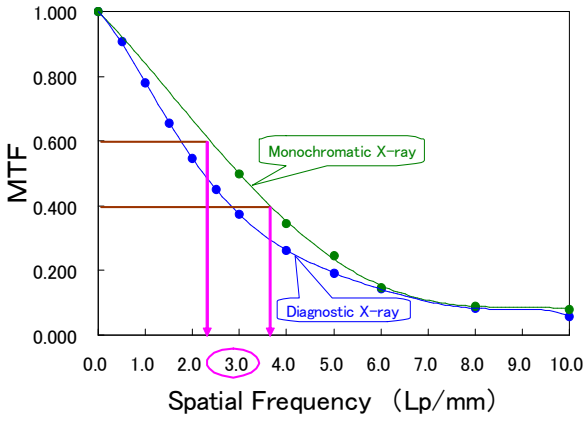

Fig.1 Graph of MTF

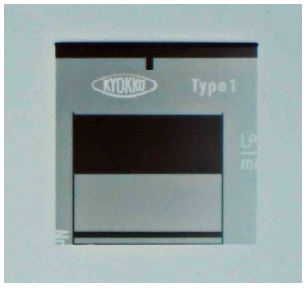

Fig.2a
Image of Square Wave Chart
Spatial Frequency：0.0Lp/mm

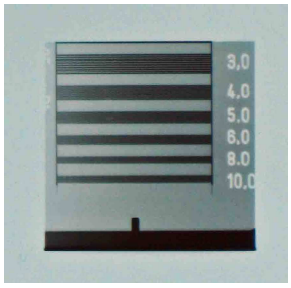

Fig.2b
Image of Square Wave Chart
Spatial Frequency：3.0～10.0Lp/mm

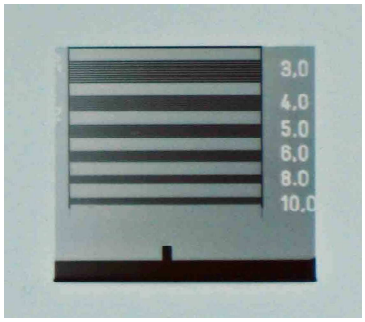

Fig.3
Image of Square Wave Chart
Spatial Frequency：3.0～10.0Lp/mm

5 Conclusion

Since the calculation result of resolution is a value lower than the resolution (0.2～0.3 mm) of an eye, the resolution of monochromatic X-ray can be said to be high compared with the resolution of an eye.

And, I think that the specific spatial frequency in monochromatic X-ray can be set as 3.0 Lp/ mm about.

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Reference

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