Medical Applications

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The study compare Diagnostic X-ray with Monochromatic X-ray on MTF measurement

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Introduction

X-ray imaging for medical purposes is the most essential type of imaging for diagnostic imaging. The sharpness of an x-ray image is important for physical evaluations when interpreting the minute details of diagnostic imaging.

The evaluation on the sharpness of an image is generally judged by modulation transfer function (MTF) measurements. X-rays of x-ray machines used for diagnostic purposes are continuous spectrums, and it is impossible to avoid deterioration in sharpness since MTF values are low because of the spread of the tube focal point and flux.

Comparisons and the study of MTF for x-rays used for diagnostic purposes and MTF of monochrome x-rays were conducted in this experiment.

Experiment

<Diagnostic X-ray MTF>

(1) The characteristic curve for x-ray intensity conversion was prepared using the range method.
(2) A rectangular wave chart image was prepared to measure the density using a microdensitometer.
(3) The obtained density value was converted into x-ray intensity using the characteristic curve to calculate the contrast and MTF value.

<Monochromatic X-ray MTF>

(1) A characteristic curve for an x-ray intensity conversion was prepared using the time scale method.
(2) A rectangular wave chart image was prepared to measure the density using a microdensitometer.
(3) The obtained density value was converted into x-ray intensity using the characteristic curve to calculate the contrast and MTF value.

Results

X-rays for diagnostic purposes were found to have an input contrast of 0.165 and an output contrast between 0.157 and 0.014. Furthermore, MTF values were found to be between 1.000 and 0.059, whereas the spatial frequency showed a significant decline from the boundary at 5.0 Lp/mm. (Fig.1, Fig.2)

Monochrome x-rays were found to have an input contrast of 0.656 and an output contrast between 0.327 and 0.053. Furthermore, MTF values were found to be between 1.000 and 0.081, whereas the spatial frequency showed a significant decline from the boundary at 6.0 Lp/mm. (Fig.1, Fig.2)

It is possible to verify from a comparison of the results for both cases that the contrast is higher and the response is higher with monochrome x-rays with higher spatial frequencies. It is therefore possible to expect sharper images using monochrome x-rays.

It became evident that the principal reason behind the overall deterioration of the MTF values with x-rays for diagnostic purposes was in the tube focal point and flux. In order to inhibit these causes in capturing x-ray images for clinical purposes, it is considered desirable to use long range imaging, in which flux can be made almost parallel and a smaller focal point can be obtained.

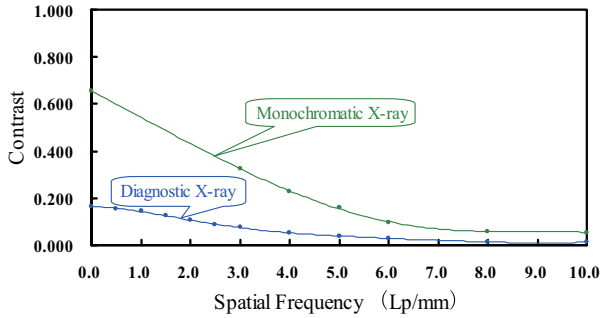

Fig.1 Contrast

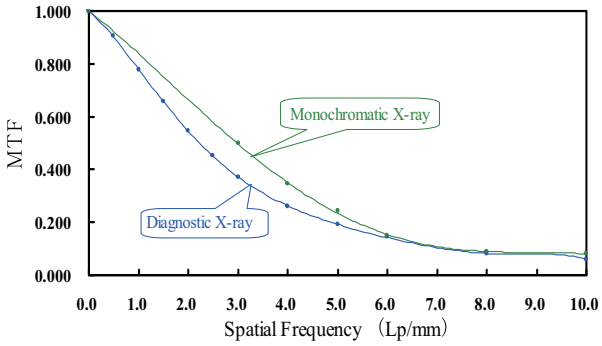

Fig.2 MTF

Discussion

In this experiment, long wavelength portions of diagnostic x-rays were eliminated using additional filters, but the contrast and MTF values were reduced. This implies that in order to improve the sharpness of x-ray images for diagnostic purposes, it is necessary to get as close to short wavelengths as possible.

Conclusion

With a consideration for the results of this experiment, it was concluded that the conversion of x-rays to monochrome x-rays is a useful means for improving the sharpness of clinical imagery for diagnostic purposes.