

Purpose: Patient dose from daily CBCT positioning has been much concerned. Decreasing the dose, however, results in lower image quality because of the increased relative noise. In this study, we build a simple model for the stochastic, and apply the result to improving the image quality.

Methods: Assume the photon fluence from the source is governed by truncated Gaussian. We derived the expression of CBCT numbers as summation of a noiseless part and a stochastic part. The standard deviation(SD) of the later term was derived. On the other hand, we measured the SDs of CBCT numbers in the water equivalent region of a CatPhan phantom scanned by our Varian OBI system with various mAs values. Fitting the SD in our expression by using the measured, we then applied it to simulating low dose CBCT patient images from the normal dose CBCT image, and to improving low dose image quality.

Results: The SD from our model changes with mAs in a very similar way to those measured. This may indicate the usefulness of our model. The magnitude of the truncated Gaussian is thus the only parameter that needs to be fitted in our model by comparing the value of SD with that from measured at a certain mAs. Our model produced low dose CBCT images stochastically equivalent to those from real scans. This would be useful for the study of low dose CBCT of patient. Finally, the image quality of low dose CBCT is significantly improved by applying our model. Thus, patient dose would be decreased without loss of image quality.

Conclusions: A stochastic model for low dose CBCT image is proposed. The model is used to simulate low patient dose CBCT image and to improve the image quality. It is possible to acquire equivalent CBCT with significantly lower patient dose.