Purpose: To develop a synchronized moving grid (SMOG) system to enhance the contrast-to-noise ratio (CNR) and correct image lag in cone-beam CT (CBCT).

Methods: The SMOG system uses a rapidly oscillating, synchronized moving grid attached to the kV source. Multiple exposures are taken at each gantry angle with the grid offset by a distance equal to the grid interspace width after each exposure, before the gantry moves to the next position during a scan. In each projection image, patient image data are acquired within the grid interspace area and scatter is measured under the area blocked by the grid for post-scan scatter correction. The grid provides direct scatter reduction by blocking part of the beam, which enhances CNR in the reconstructed CBCT images. Image lag was also estimated from the blocked area and used for lag correction in the image area since both areas have similar radiation history during SMOG acquisition. Experimental studies were performed to evaluate the CNR enhancement for different numbers of exposures (1, 2, and 4) taken at each gantry angle using an enlarged CATphan. Simulation studies were performed to evaluate the lag correction using a lag model.

Results: Experimental results showed that SMOG enhanced the CNR by 16% and 13% when increasing exposure number from 1 to 2 and from 2 to 4, respectively. This enhancement was more dramatic for large phantoms. The gain in CNR by increasing the exposure number gradually diminished as the exposure number became large. The CNR values from 4-exposure SMOG were similar to those from the quasi-fan beam scan. Simulation results showed that image lag was reduced from 19% to 0.6% using 4-exposure SMOG.

Conclusions: SMOG has the advantages of substantially enhancing the CNR and correcting image lag while removing the scatter artifacts in CBCT with similar scanning time and imaging dose as conventional CBCT.