Purpose:To develop a cone-based modulation transfer function (MTF) measurement technique for tomosynthesis using a sphere phantom.

Methods:Projections were simulated for a voxelized breast phantom with 12 mm sphere inserts using a fluence modeled from 28 kVp beam and incident upon an indirect flat-panel detector with 200 um pixel size. Characteristic noise and blurring for each projection were added using cascaded systems analysis. The projections were reconstructed using standard filtered backprojection techniques, producing a 3D volume with an isotropic voxel size of 200 um. ROIs that completely encompassed single spheres were extracted, and conical regions were prescribed along the three axes extending from the centroids. Pixels within the cones were used to form edge spread functions (ESF), from which directional "raw" MTFs were calculated. Binning size and conical range were considered for maximizing accuracy and minimizing noise of the MTF. A method for removing out-of-plane artifacts of the ESFs in x and y directions was investigated and yielded an “effective” MTF.

Results:Comparisons of the cone-based MTF along the different axes and the true 3D MTF yielded good agreement. A 30 degree angle was found to provide ideal trade-off between measurement noise and accuracy. Drop-off frequencies in the x- and y-directional "raw" MTFs were 1.5 cycles/mm and 2.5 cycles/mm, respectively. As expected, the z-directional MTF had a much lower drop-off due to the lack of angular sampling. The removal of artifacts in ESF yielded a “modified" MTFs which enabled a novel characterization of in-slice resolution for tomosynthesis.

Conclusion:The directional MTF of tomosynthesis reconstruction with FBP was determined by using the cone-based MTF technique. The presented method of separating the effective resolution and artifacts from the measured ESF is expected to facilitate the interpretation of MTF measurements in tomosynthesis.