Purpose:
Spectral CT was used to investigate the feasibility of detection of plaque vulnerability using gold nanoparticles. Calcium concentration in a plaque has been proposed as a marker for plaque vulnerability to rupture. A new method for quantification of calcium concentration was introduced in presence of iodine and gold.

Methods:
Single-slice spectral CT from the photon counting Cadmium-Zinc-Telluride detector was simulated for different mixture solutions of iodine, gold, and calcium. A 120 kVp spectrum was generated to produce photon fluxes sufficient for detecting contrast materials above the k-edges of iodine (33.2 keV) and gold (80.7 keV). The concentrations of both iodine and gold were determined by material decomposition based on the maximum likelihood method. Furthermore, calibration curves of Hounsfield units with respect to the concentrations of different mixtures were used to eliminate signal from contrast material and different tissue from the mixtures while simultaneously assessing the calcium concentration.

Results:
The described method yielded reliable estimates of calcium mixed with water, blood, and muscle. The average relative errors were approximately 6%. Only in a few cases the uncertainty reached up to 15%, which was due to the 5-10% uncertainty in measurements of iodine and gold concentrations.

Conclusions:
The study showed that it is possible to quantify calcium concentration in the presence of iodine and gold. This demonstrated the potential feasibility of the method for assessing plaque vulnerability.