Metallic alloys for use in radiographic phantoms

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Iodine contrast agent is problematic as a phantom material because of its tendency to leak, dry out, and form bubbles. Metal alloys were investigated as a surrogate material. The key constraint was that the alloys have the same radiographic contrast as an iodine solution when used in the same volume, from 60 to 120 kVp and for a typical range of coronary artery diameters (up to 3 mm) Based on material density, metallic solubility, and the dependence of the photoelectric effect on atomic number, attention was focused on MgCd and LiMgCdHo. Composition was determined by searching for the minimum modeled difference in contrast between the alloy and a specified iodine solution. Iodine concentrations of 350 mg I/mL and 175 mg I/mL, corresponding to full and half-strength Iohexol, were specified in the search. At our request, MgCd and LiMgCdHo wires were fabricated by a commercial vendor in five diameters, ranging from 0.5-mm to 2.8-mm. Wire contrast was measured from 60-120 kVp using acrylic phantoms to mimic a cardiac patient.

Based on the composition and density of the manufactured wires an experiment was designed to compare the contrast of the alloy wires to the measured contrast of tubes filled with iodine contrast diluted to 170 and 345 for MgCd, and 190 and 387 mg-I/mL for LiMgCdHo. The measured contrasts were compared to the contrasts predicted by the model, which included measured corrections for scatter fraction and system blurring. Two-thirds of the differences between the contrast of the alloy wires measured in the imaging experiment and the corresponding modeled iodine solution contrasts were less than 2%, and only one exceeded 4%. Comparison of the measured contrasts of iodine solution and alloys using ANCOVA was performed at each of 6 kVps. All the resultant F-statistics save for one were less that the 0.05 confidence level critical value.