Identifying prostate brachytherapy seeds at MRI: A study in phantom

CT and MRI images of prostate gel phantom containing five inactive seeds (Advantage-I-125™) were collected. Both original MR magnitude (Fig. 1C) and phase images were constructed (Fig. 1A). The optimum TE for maximum contrast to noise ratio (CNR) in filtered phase images theoretically was determined according to:

\[
\frac{dCNR}{TE} = \left( e^{-\frac{TE}{T_2^*}} - \frac{1}{T^2} \times TE \times e^{-\frac{TE}{T_2^*}} \right) = 0 \rightarrow TE = T_2^* \quad [1]
\]

The original phase images were unwrapped by using 64 x 64 central homodyne high pass-filter (Fig. 1A). And finally, the areas of brachytherapy seeds were correlated with CT and SWI filtered phase images (Fig. 2).

The dipole effect, surrounding seeds, causes blooming in filtered phase images. This explains why seed area appears larger on SWI filtered phase images compared to CT. Although both CT and MRI suffer from partial volume effects the blooming effect is not related. **The correlation between CT and MRI shows better confidence in our interpretation that SWI does not only replicate CT findings but also shows the effect is from brachytherapy seed.** The presence of background field variations and dipole effect as a result of the paramagnetic nature of seeds are the major source of phase image artifacts. This can be reduced using simple high pass filtering to remove low spatial frequency phase variation [2]. Using 64 x 64 central homodyne filter (Fig. 3) generates the best estimate of seed area (3.7 mm²) as a result of minimal phase image artifacts. With the improved resolution, SNR and proper filtering on high field MRI systems, SWI phase images can be used to confirm prostate brachytherapy seeds on conventional MRI without using CT.

References:
