

Effects of Iodinated Contrast and Field Strength on Gadolinium Enhancement: Implications for Direct MR Arthrography

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Introduction

Following intra-articular injection of gadolinium for MR arthrography, we have occasionally observed suboptimal contrast on T1-weighted images and low signal of synovial fluid on T2-weighted images, both on high-field and low-field scanners; we postulated that mixture of gadolinium with iodinated contrast might affect image quality. Contrast interaction and optimal concentration for MR arthrography is controversial in the literature (1-4). We sought to optimize direct MR arthrography by determining the effect of dilution of gadolinium in iodinated contrast, saline or albumin on T1w, T2w and GRE images, and to evaluate the effect of scanner field strength on this interaction.

Methods

Gadopentetate dimeglumine was diluted into normal saline, albumin, or iodinated contrast (0.625 mmol/L to 40 mmol/L). Samples were scanned at 1.5T and 0.2T; signal intensity was measured using T1w spin echo (SE), T2w SE and 2D and 3D GRE (flip angle 20 to 75 degrees) sequences. Graphical analysis of signal intensity versus gadolinium concentration was performed.

Results

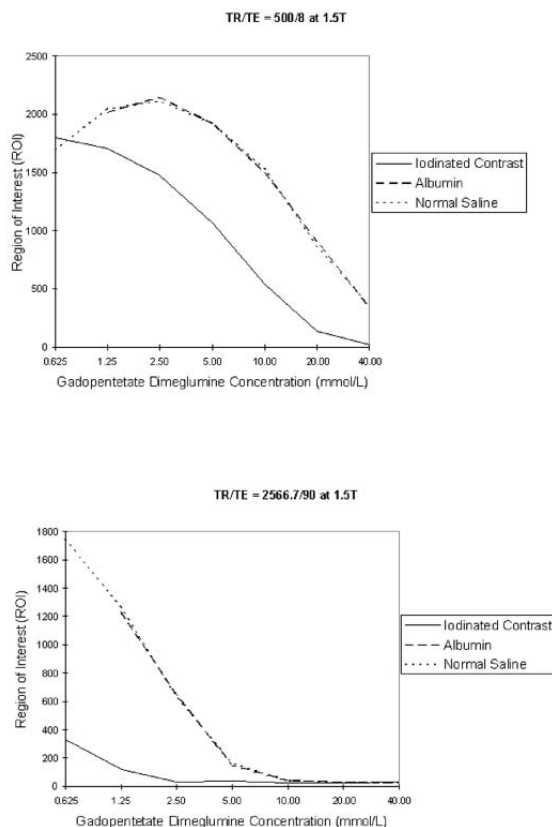
Albumin had no effect on gadolinium contrast. Dilution of gadolinium in iodinated contrast decreased signal intensity on all sequences compared to samples of identical concentration diluted in saline at both 1.5T and 0.2T. Using a 1.5T scanner, the T1w SE sequence (TR/TE = 500/8) demonstrated a peak signal amplitude at a gadolinium concentration of 2.1 mmol/L diluted in normal saline versus a peak signal amplitude of 0.625 mmol/L when diluted in iodinated contrast; at a gadolinium concentration of 2.0 mmol/L (which is a common concentration used for direct MR arthrography), signal amplitude decreased by 26.1% when diluted in iodinated contrast compared to normal saline. This effect was demonstrated on the GRE sequences tested as well. The peak signal amplitude on GRE (TR/TE = 24/13, flip angle 20 degrees) was produced at a gadolinium concentration of 2.5 mmol/L when diluted in saline compared to a peak signal amplitude of 1.25 mmol/L when diluted in iodinated contrast; using TR/TE = 33.3/13 and flip angle of 45 degrees, peak signal was demonstrated with normal saline dilution at a concentration of 2.5 mmol/L versus 1.25 mmol/L with iodinated contrast dilution. On the T2w SE sequence (TR/TE = 2566.7/90), at a gadolinium concentration of 2.0 mmol/L, signal amplitude decreased by 92.9% when diluted in iodinated contrast versus normal saline.

Using a 0.2T scanner, the T1w SE sequence (TR/TE = 500/18) demonstrated a peak signal amplitude over a broad range of gadolinium concentration (0.625 to 2.5 mmol/L) when diluted in normal saline versus 1.25 mmol/L with dilution in iodinated contrast. At a concentration of 2.0 mmol/L, signal intensity decreased by 23.5% with dilution in iodinated contrast compared to dilution in normal saline. On GRE (TR/TE = 50/16, flip angle 45 degrees), dilution in normal saline resulted in peak signal at a gadolinium concentration from 0.625 to 5.0 mmol/L versus 1.25 mmol/L with dilution in iodinated contrast. On GRE (TR/TE = 30/12, flip angle 65 degrees), peak signal was achieved over a range of gadopentetate dimeglumine concentrations from 2.5 mmol/L to 10.0 mmol/L with dilution in normal saline compared to a range of 1.25 mmol/L to 5.0 mmol/L with dilution in iodinated contrast. GRE (TR/TE = 400/16, flip angle of 75 degrees) resulted in peak signal from 1.25 mmol/L to 5.0 mmol/L with dilution in normal saline and 0.625 mmol/L to 1.25 mmol/L with dilution in iodinated contrast.

Peak signal was also seen at different gadolinium concentrations on different sequences and field strength: at 1.5T, peak in saline/iodinated contrast was 2.5/0.625 mmol/L on T1w, 2.5/1.25 mmol/L on GRE20 and GRE45 sequences. At 0.2T, peak in saline/iodinated contrast is 0.625-2.5/1.25 mmol/L on T1w, 0.625-2.5/1.25 on GRE45, 2.5-10.0/1.25-5.0 mmol/L on GRE65, and 1.25-5.0/0.625-1.25 mmol/L on GRE75 sequences.

Discussion

Dilution of gadolinium in iodinated contrast results in decreased signal on T1w, T2w and GRE images compared to dilution in saline or albumin for both 1.5T and 0.2T scanners; if gadolinium is diluted in iodinated contrast for MR arthrography, a lower concentration should be used because the peak is shifted to the left. Optimal gadolinium concentration for MR arthrography is dependent on scanner field strength and a broader range of gadolinium concentration can be used to provide maximal signal at low field strength.



References

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