Timing of the interstitial post-gadolinium phase for T1 imaging of focal liver lesions: What is the incremental benefit of 3 and 5 minute phases over 2 minutes?

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Target Audience:

Radiologists specialized in abdominal and liver MRI, abdominal MRI fellows, radiology residents, MRI technologists.

Background:

The timing of arterial and portal venous phase T1-weighted sequences post-injection of extracellular gadolinium-based contrast agents (GBCAs) in liver MRI has been well studied, but the optimal timing and number of delayed ("interstitial" or "equilibrium", non-hepatobiliary) phase sequences is not precisely known [1, 2]. Despite considerable variation in this timing (generally acquired between 1.5 and 5 minutes post-injection) and number [3, 4], interstitial phase post-GBCA MRI to distinguish benign from malignant focal liver lesions (FLLs) has been shown to be valuable [5], even with GBCAs which do not have a high rate of hepatobiliary excretion. Performing numerous interstitial post-GBCA sequences increases the length of the MR examination, but may not contribute a significant amount of additional diagnostic information. If delayed sequences beyond 2 minutes post-GBCA do not provide extra useful information in most cases, it may be justifiable to omit them from a routine protocol. This would in turn decrease the time per examination, and ultimately increase patient access to MR imaging.

Purpose:

To evaluate the change in categorization and diagnostic confidence of FLLs imaged with post-GBCA T1-weighted MRI at 3 and 5 minute interstitial phases, compared with a 2 minute interstitial phase.

Methods:

This study was approved by our institutional review board with a waiver of informed consent. The images of 72 consecutive patients with 145 FLLs undergoing liver MRI were retrospectively reviewed independently by 2 abdominal radiologists. Axial MRI of each FLL were reviewed sequentially in four assessments as follows: first with T1 GRE in/opposed phase, T2 SS TSE +/- FS, DWI b=750, ADC map, T1 GRE FS; second by adding arterial, portal venous and 2 minute phase 3D T1 GRE FS post-GBCA images; third and fourth by adding 3 and 5 minute phase 3D T1 GRE FS post-GBCA images, respectively. The GBCA used was gadobenate dimeglumine (Gd-BOPTA). Following each assessment, the 2 readers each categorized the FLL as either non-aggressive, benign with malignant potential, indeterminate, or aggressive. Each reader also rated their confidence of each FLL categorization on a 5-point scale (1 = unsure of category with other possible diagnoses equally possible; 3 = confident in categorization, with other categories less likely but still possible; 5 = 100% sure that the FLL falls in this category). The data for each reader were analyzed independently. Changes in lesion categorization were evaluated using percent agreement as well as the simple kappa statistic for observer agreement [6] with 95% confidence intervals.

Results:

Concordance between FLL categorization at the 3 and 5 minute phase assessments respectively compared to the 2 minute phase was 94.5% and 93.1% (κ 0.91 and 0.89) for reader 1, and 97.2% and 95.9% for reader 2 (κ 0.95 and 0.94), indicating near perfect agreement. Concordance between lesion characterization following the 2 minute phase assessment versus pre-GBCA imaging alone was 70.1% for reader 1 and 74.4% for reader 2 (κ 0.55 and 0.65) indicating moderate agreement for reader 1 and substantial agreement for reader 2. The proportion of FLLs characterized as indeterminate for readers 1 and 2 was 24.8% (36/145) and 17.9% (26/145) pre-GBCA, decreasing significantly to 11.7% (17/145; p=0.0003) and 3.4% (5/145; p<0.0001) at the 2 minute phase, and decreasing insignificantly to 9.7% (14/145; p>0.05) at 3 and 5 minutes for reader 1, with no change at 3 and 5 minutes for reader 2. FLL categorization by reader is shown in Figure 1. There was a significant increase in reader confidence between pre-GBCA and 2 minute phase assessments for both readers (p<.0001) with a small but significant increase at 3 and 5 minutes for reader 1 (p<.006 and p<.001), and at 5 minutes for reader 2 (p<.035), shown in Figure 2.

Discussion and Conclusion:

3 and 5 minute post-GBCA interstitial phase T1 sequences do not change FLL categorization in the majority of cases, and the rise in reader confidence is small but significant. Therefore, they may not add significant additional information beyond 2 minute post-GBCA interstitial phase T1W imaging in the routine MRI evaluation of FLLs. There is moderate agreement between FLL categorization pre-GBCA versus post-GBCA imaging up to 2 minutes, with a significant rise in confidence of categorization in the latter. As a result, unenhanced liver MRI is often still diagnostic in patients who cannot receive IV GBCAs.
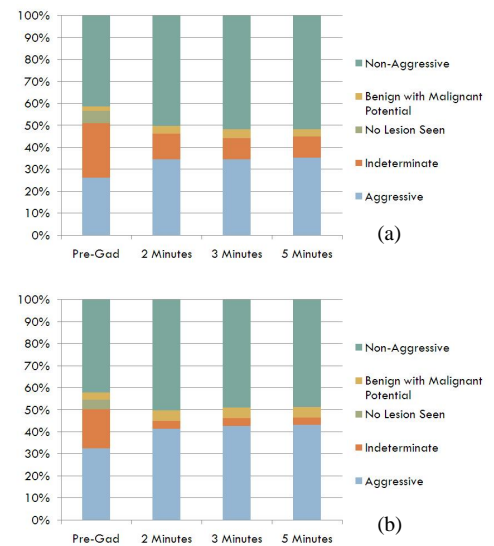

Figure 1: Categorization of FLLs at four sequential assessment points by (a) reader 1, and (b) reader 2.

Figure 2: Change in reader confidence at four sequential assessment points.

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