Case Study: CDT-VIBE Imaging of Liver Metastasis

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Introduction

Magnetic Resonance Imaging (MRI) plays an important role in the detection and characterization of focal and diffuse liver diseases. There is now a large amount of literature describing the value of dynamic contrast-enhanced (DCE) T1-weighted (T1w) imaging using extracellular and liver-specific contrast agents. The patterns of contrast enhancement, in combination with other contrast mechanisms (diffusion-weighted imaging, in/opposed phase, T2-weighted imaging, etc.), provide well-described criteria for detection and characterization of hepatic lesions.

However, conventional liver DCE-T1w imaging requires one breath-hold (~15–20 s) for one phase, and in this case, the lesion enhancement pattern may be weakened or missed due to improper timing or the fast uptake and washout of the contrast agent in certain types of lesions. In order to solve this problem, Siemens recently developed a CAIPIRINHA-Dixon-TWIST-VIBE (CDT-VIBE) sequence allowing 3D T1w imaging with high temporal resolution and with preserved high spatial resolution. The primary study showed that CDT-VIBE has 21% diagnostic improvement for smaller lesion detection [1].

In our hospital, we are interested in using CDT-VIBE in combination with a liver specific contrast agent (Primovist, Bayer Healthcare, Berlin, Germany) to evaluate the enhancement pattern of arterial phase, portal venous phase, and hepatobiliary phase, and the dynamic signal-time curves of liver metastasis from pancreatic neuroendocrine cancer.

Protocol

CDT-VIBE allows us to acquire 5 phases of arterial and portal venous phases in 20 s breath-hold each. The delayed phases and hepatobiliary phase are acquired with only 1 phase for each breath-hold with the same parameters as arterial and portal venous phases. The acquisition of the arterial phase begins at 8 s after the start of contrast injection. Protocol details are given in Figure 1.

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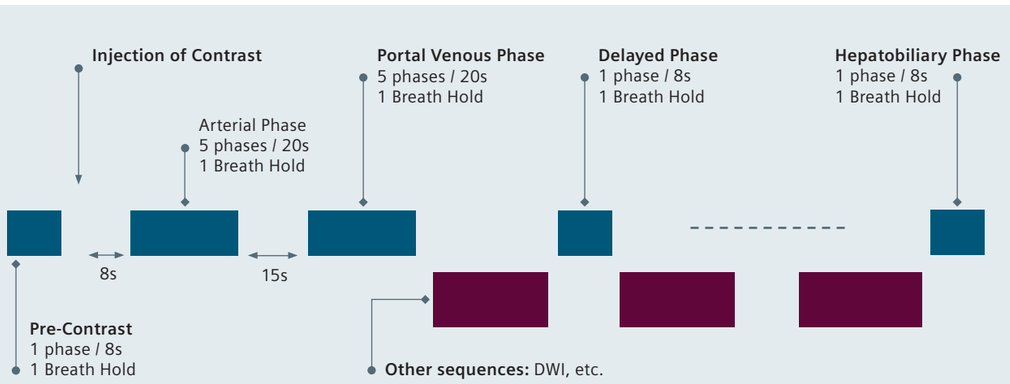
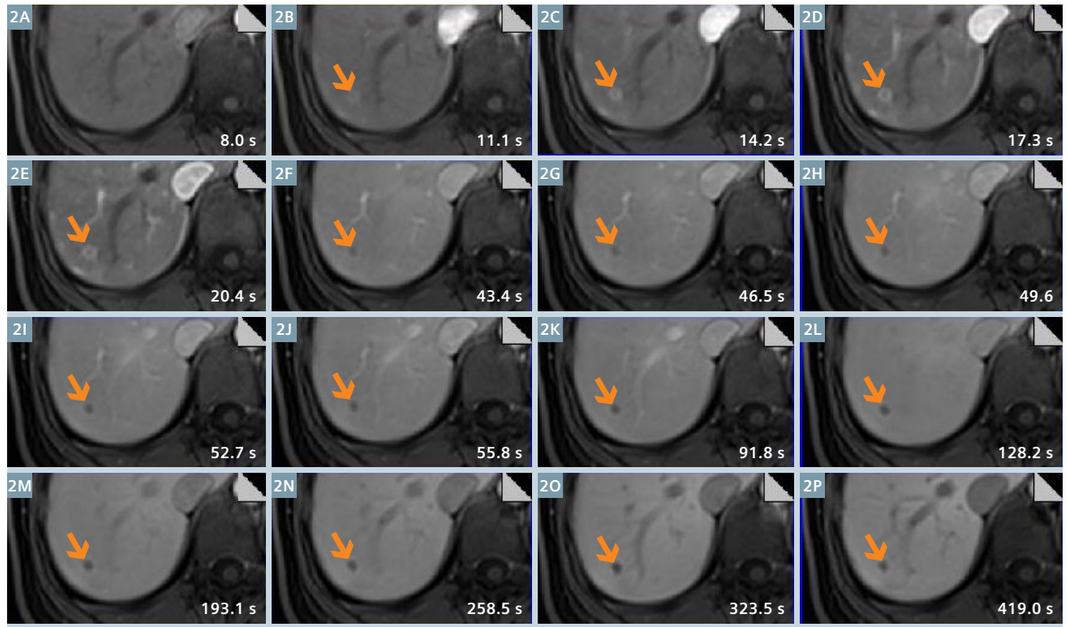


1 Breath-hold CDT-VIBE protocol after injection of Primovist contrast agent is configured for vascularity characterization (multiple arterial and portal venous phases) and lesion/parenchyma contrast enhancement (delayed and hepatobiliary phases). This CDT-VIBE examination is performed with a spatial resolution of 1.3 ×1.3 × 3 mm on a 3T MAGNETOM Skyra system. Other scans during the examination include transverse DWI, transverse in-phase and out-of-phase T1w VIBE, breath-hold and PACE triggered T2w TSE, coronal T2w HASTE and post-contrast coronal T1w VIBE.



2 Contrast-enhanced T1w dynamic series of liver using CDT-VIBE. The lesion is indicated by the arrow.

Imaging findings

It is widely known that hepatobiliary phase imaging enables an increase in sensitivity in the detection of metastasis by exploring the liver-lesion-contrast generated by the adsorption of liver-specific contrast agents by the liver parenchyma. However, the specificity of metastasis characterization using the hepatobiliary phase only remains a challenge. Specifically, the ability to differentiate metastasis from malignant lesions (such as HCC, which also gives hypo intensity in the hepatobiliary phase) and benign lesions (such as cysts and hemangiomas, which appear hypointense in the hepatobiliary phase) is still a problem, not to mention the grading of metastasis.

There is a section of literature that combines the features from arterial enhancement and lesion/parenchyma contrast enhancement in the hepatobiliary phase to differentiate metastases from other lesions by using conventional single phase acquisition per breath-hold sequence. The metastasis shows ring-like enhancement in the arterial phase, and appears hypointense in the hepatobiliary phase. Multiple arterial and portal venous phase imaging enables new opportunities to explore the vascular enhancement features. CDT-VIBE provides the capability of multiple arterial and portal venous phase imaging.

Figure 2 shows a contrast-enhanced T1w dynamic series of metastasis from pancreatic neuroendocrine cancer using the above mentioned CDT-VIBE protocol. In the later arterial phase, the lesion appears as a ring-like enhanced pattern, and in the later hepatobiliary phase, the lesion shows hypointensity compared to the parenchyma. These observations are consistent with previous reports in the literature on the enhancement pattern for metastasis [2]. We also observed that in the early arterial phase (11.1 s), the ring-enhanced pattern is not as apparent as in the later arterial phase (20.4 s). As evidenced in Figure 3, the estimated biggest contrast difference between lesion core and lesion ring is identified at the peak of the arterial phase. In this case, if the conventional single breath-hold protocol is used, the ring-enhanced pattern might be missed, while the multiple arterial phases offer a larger observation window.

In addition, as shown in Figure 4, the subtracted arterial phase images (5^{th} phase – 1^{st} phase) show the visualization of the feeding vessels to the lesion. In this way, it shows the potential to guide surgery to identify

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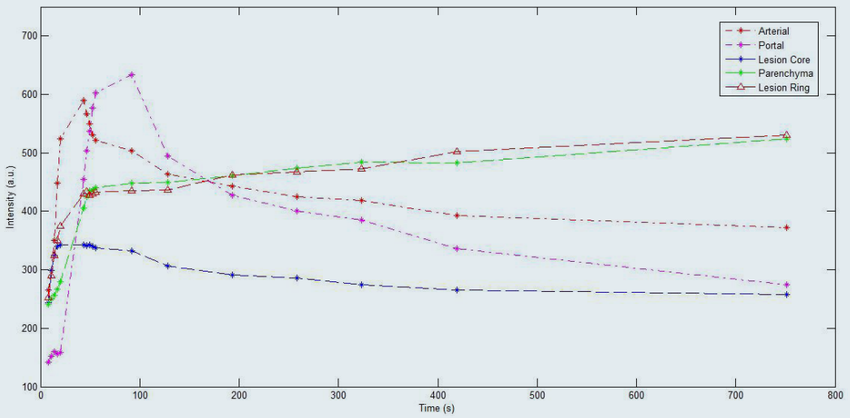

3 Dynamic signal-time curve of arterial phase, portal venous phase, core of lesion (defined hypointensive region in the hepotabiliary phase), ring around lesion core, and parenchyma. The vertical dash line indicates the estimated peak of the arterial phase.

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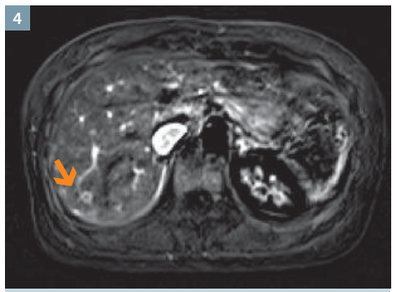

4 Feeding vessel of the lesion is visualized in the 3D subtracted arterial phase images.

arterial and portal venous features, especially the feeding vessel in making a therapy plan.

Conclusion

CDT-VIBE offers better illustration of arterial and portal venous features of lesions due to the multiple arterial and portal venous phases imaging capability. By combining these findings with features of hepatobiliary phases, the metastasis can be well described. For the feature of metastasis, CDT-VIBE not only provides the ring-like enhancement pattern, but also clearly shows the feeding vessel of the lesion. Furthermore, by applying a dual input pharmacokinetic modeling for the liver, a quantitative analysis of lesions will be possible using CDT-VIBE.

References

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