

New Era of Non-Breath-hold MRI of the Abdomen using T1 Radial VIBE



Singapore
General Hospital
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Objective

To explore the value of T1-weighted Radial Volumetric Interpolated Breath-hold Examination (T1 Radial VIBE) in post-contrast abdominal MRI for patients who are unable to suspend respiration adequately.

Background

The sensitivity to motion of MRI makes it essential for patients to suspend respiration when imaging the abdomen. The population in Singapore has been ageing rapidly over the past decade, leading to a growing number of elderly needing abdominal MRI. Many of these elderly patients, as well as severely ill and sedated patients, are unable hold their breath adequately, resulting in motion artefacts on their MR images which may obscure critical findings. Although respiratory triggering offers a solution for some sequences, it cannot be applied to the T1-weighted VIBE sequences that provide important multi-phase contrast information.

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Procedure details

Radial VIBE employs radial k-space sampling. The overlap of sampling lines in the center of k-space makes the data resistant to motion artefacts from breathing. This makes it a feasible replacement for breath-hold Cartesian VIBE (BH cVIBE) in patients who are unable to suspend respiration.^{1,2}

In Singapore General Hospital, MRI of the abdomen is performed on a 3-Tesla Siemens MAGNETOM Skyra (Siemens, Erlangen Germany). Post-contrast-injection T1 sequences are done using BH cVIBE. However, if the patient is unable to hold breath adequately (determined by motion artefacts in pre-contrast images), Radial VIBE would be used instead.

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Procedure details

T1 Radial VIBE is performed through the axial plane, covering the entire liver from above the diaphragm to the mid poles of kidneys, in a single slab. Images are acquired while patients are free-breathing.

Parameters:

FoV read/phase	340mm/100%
TR	3.25
TE	1.54
Slice thickness/Dist. factor	3mm/20%
Averages	1
Flip angle	9°
Fat suppression	Quick Fat-Sat, 68 lines/shot
Base resolution	320
Slice resolution	59
Radial views	700
Acquisition time	3:01

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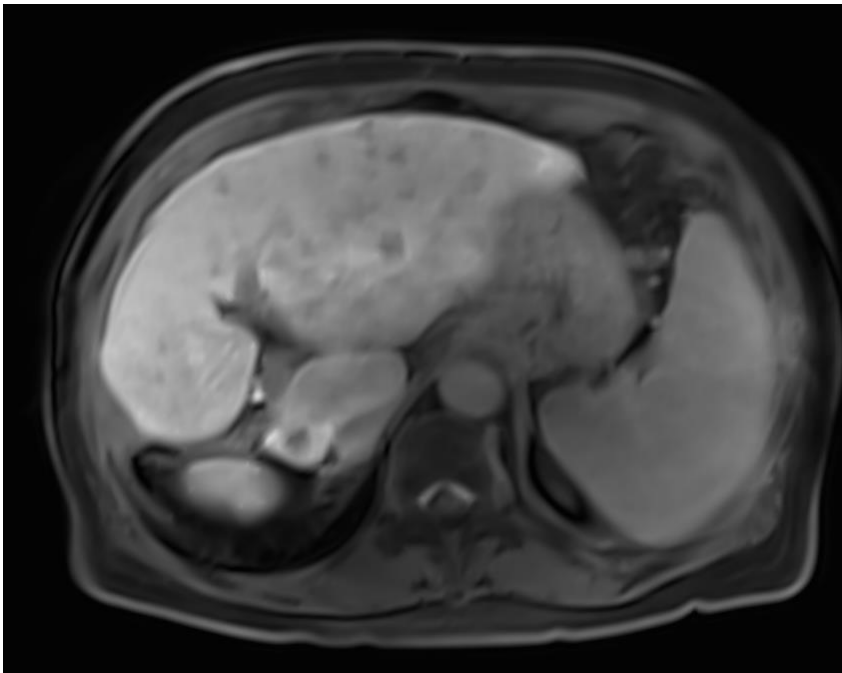
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Imaging findings

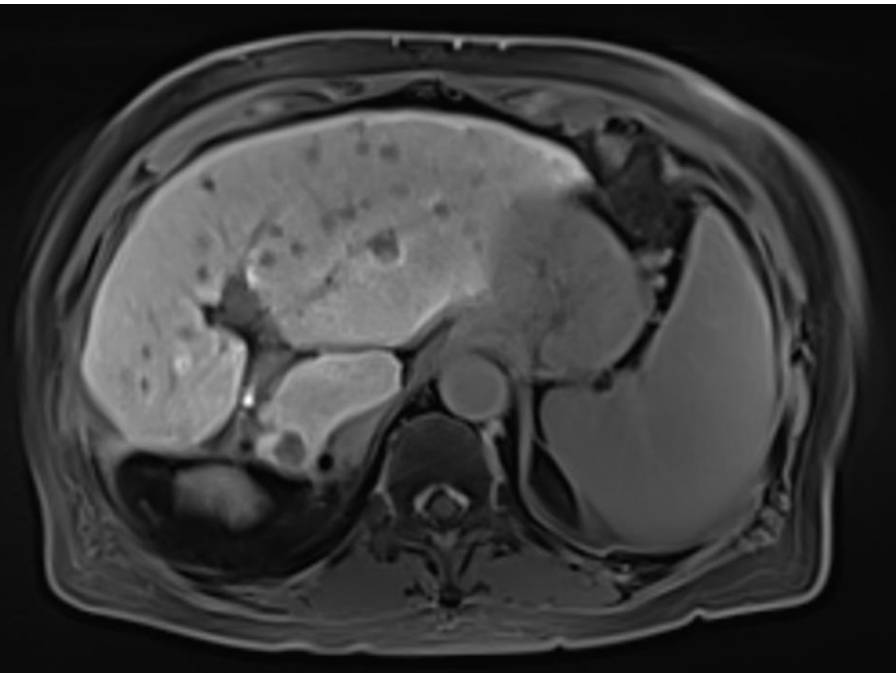
1. Multifocal HCC in patient with sub-optimal breath-holding.

Hepatobiliary phase (20min) using liver-specific contrast media. Comparison was done by first performing BH cVIBE at 20 minutes, immediately followed by Radial VIBE. Similar resolution and signal-to-noise ratio was used for both Radial VIBE and BH cVIBE. HCC lesions are much more clearly depicted on Radial VIBE.

BH cVIBE



Radial VIBE



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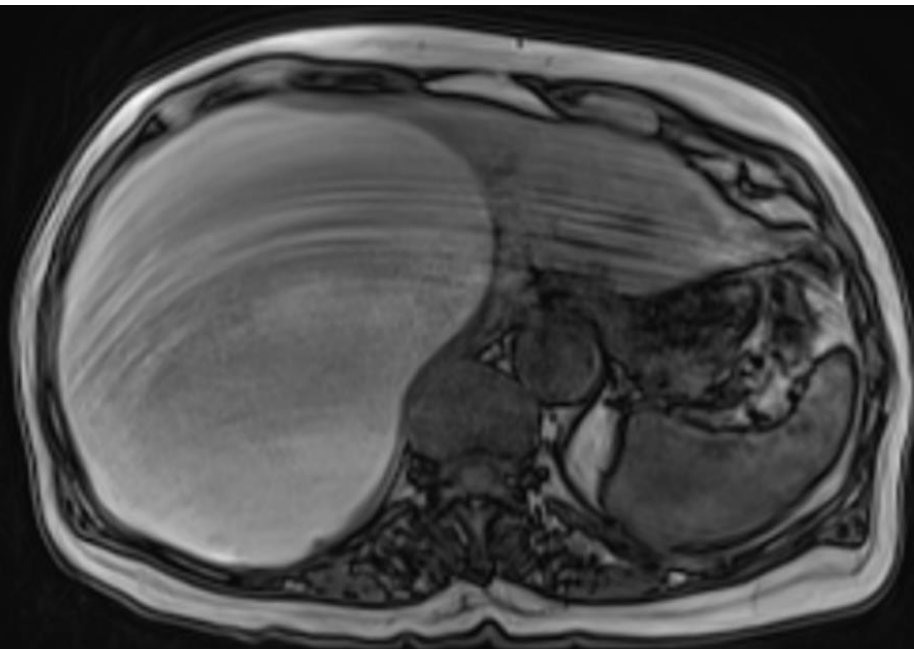
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Imaging findings

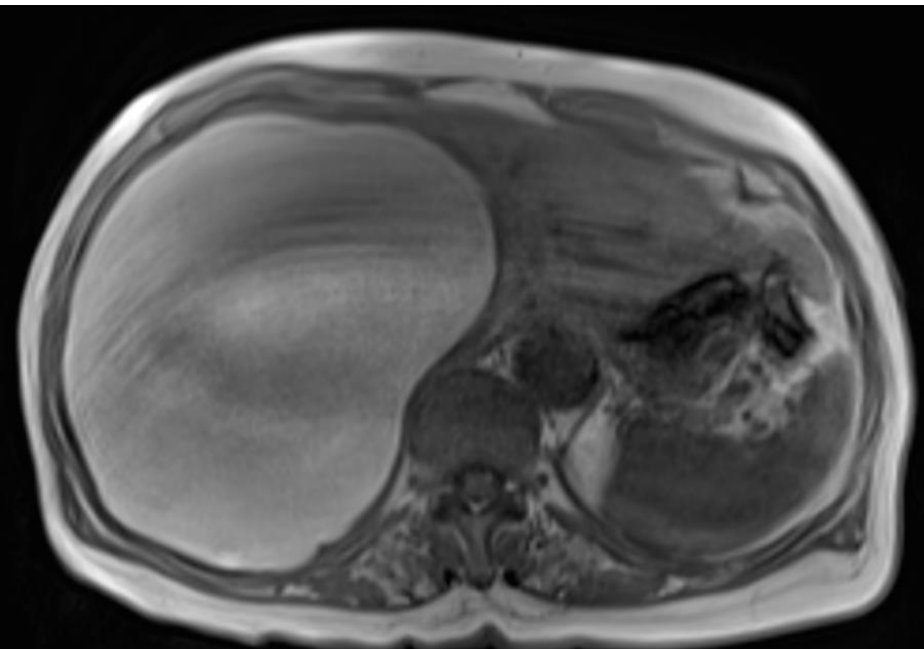
2. Large cystadenoma in patient with poor breath-holding.

Ghosting artefacts were noted on pre-contrast T1 in-phase and opposed-phase images. Radial VIBE was then planned for post-contrast dynamic phase scans.

Opposed-phase



In-phase



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Imaging findings

2. Large cystadenoma in patient with poor breath-holding.

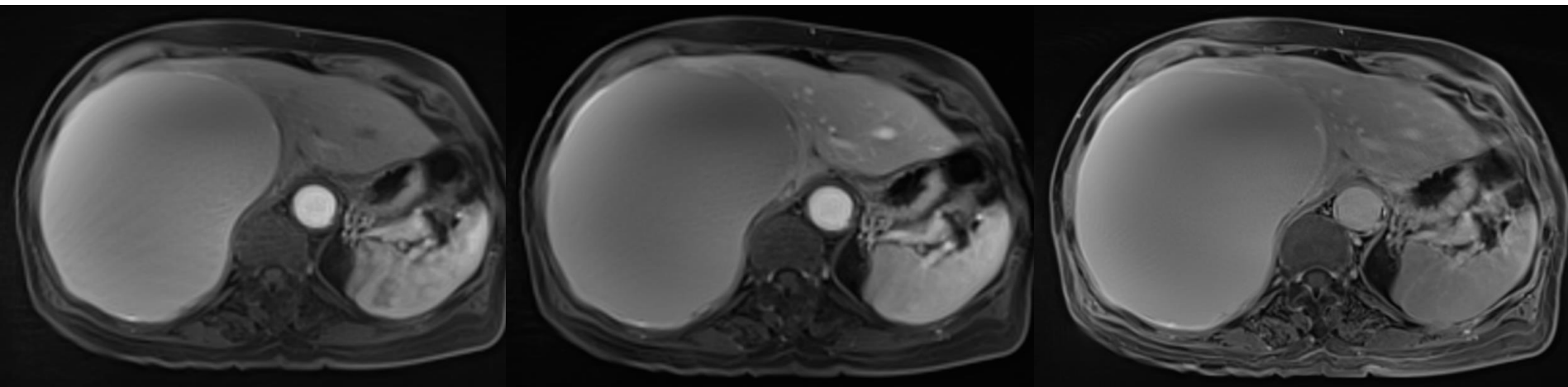
Acquisition time of Radial VIBE can be reduced from 3:01s to 0:15s to allow for dynamic contrast scans (arterial and portal venous phases). To achieve this, matrix was decreased from 320 to 192, and radial views from 700 to 200. However, image quality remains sharp and would undoubtedly be preferred over BH cVIBE with poor breath-holding.

Dynamic Radial VIBE:

Arterial

Portal venous

Equilibrium (5min)



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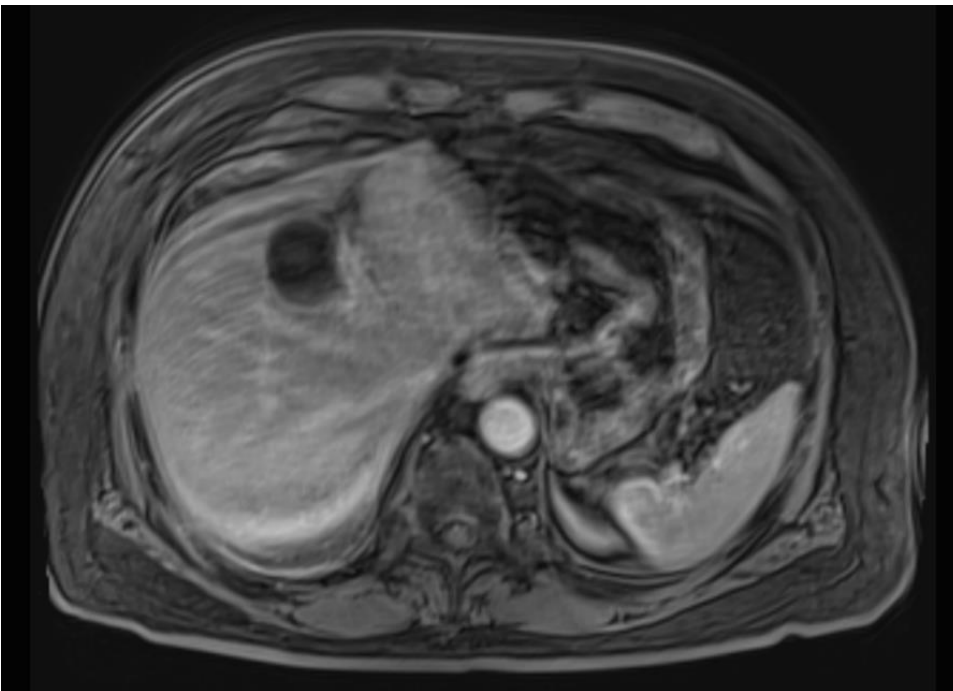
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Imaging findings

3. *Colon cancer surveillance scan for elderly patient unable to follow breathing instructions*

Comparison at equilibrium phase (5min). A 4cm cyst in segment IV is shown in both BH cVIBE and Radial VIBE images. A smaller cyst (yellow arrow) was seen in Radial VIBE but was obscured by breathing artefacts on BH cVIBE.

BH cVIBE



Radial VIBE



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Conclusion

For patients who are unable to suspend respiration, T1 Radial VIBE allows for image acquisition in free-breathing, eliminating motion artefacts and improving image quality for post-contrast abdominal MRI.

References

1. Yedururi S, Kang HC, Wei W, Wagner-Bartak NA, Marcal LP, Stafford RJ, Willis BJ, Szklaruk J. **Free-breathing radial volumetric interpolated breath-hold examination vs breath-hold cartesian volumetric interpolated breath-hold examination magnetic resonance imaging of the liver at 1.5T.** World J Radiol. 2016; 8(7): 707-715.
1. Kaltenbach B, Roman A, Polkowski C, Gruber-Rouh T, Bauer RW, Hammerstingl R, Vogl TJ, Zangos S. **Free-breathing dynamic liver examination using a radial 3D T1-weighted gradient echo sequence with moderate undersampling for patients with limited breath-holding capacity.** Eur J Radiol. 2017 (86): 26-32.

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