Lesion Detection Using Artificial Hepatobiliary Phase Post-Contrast Images Created with a Generative Adversarial Network

Vincent Parenti MD, Chandan GS Yogananda PhD, Yee S Ng MD, Ali Tejani MD, Ivan Pedrosa MD PhD, and Jesse Rayan MD
The University of Texas Southwestern Medical Center Department of Radiology

OBJECTIVES

Apply generative adversarial networks (GAN) to create high resolution artificial hepatobiliary phase images from pre-contrast T1-weighted images (pre-T1)

BACKGROUND

- Hepatobiliary specific gadolinium-based contrast agents can be used to improve liver lesion detection and characterization
  - Hepatic metastasis (improved contrast-to-noise against background liver parenchyma)
  - Focal nodular hyperplasia vs. adenoma
- Steady state imaging during the hepatobiliary phase (HBP) allows for higher spatial resolution acquisitions and shorter breath-hold times
- The use of these agents increases MRI scanning time since the HBP is obtained around 20 minutes after contrast injection

METHODS

- 9 abdominal MRI studies using gadoxetate disodium (trade name Eovist)
  - 7 studies for training
  - 2 studies for validation
- A Super-Resolution GAN was trained using an axially aligned pair of HBP and pre-T1 images from each study

Contact Information

Vincent Parenti, MD
The University of Texas Southwestern Medical Center
Email: vincent.parenti@utsouthwestern.edu
Phone: 301-980-4347

SUPER-RESOLUTION GENERATIVE ADVERSARIAL NETWORK

- Estimates a high resolution image from a lower resolution image
- Perceptual loss function which is a combination of:
  - Adversarial loss
    - Discriminator between super resolved and ground truth images
  - Content loss
    - Perceptual image similarity
    - Does not rely solely on minimization of pixel to pixel mean square error

RESULTS

- Results of this pilot study were based on a subjective assessment of the generated images
- Resolution
  - True and artificial HBP images are subjectively of similar resolution
  - Artificial HBP images have a higher resolution than the pre-T1 images
- Artificial HBP artifact
  - Hyperintensity around certain organs, although the hepatobiliary system was spared
  - Enhancement pattern in the bile ducts and gallbladder is not reproduced
- Similar lesion conspicuity and enhancement features between true and artificial HBP images

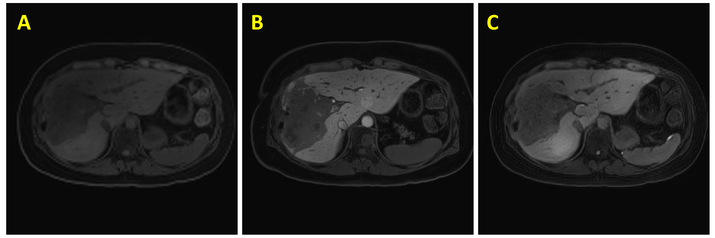

Figure 1 - Pre-contrast T1 (A), true hepatobiliary phase (B), and GAN generated artificial hepatobiliary phase (C) images of a large right hepatic lobe mass

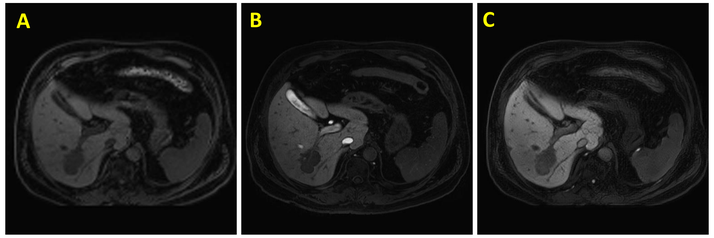

Figure 2 - Pre-contrast T1 (A), true hepatobiliary phase (B), and GAN generated artificial hepatobiliary phase (C) images of a non-enhancing lesion in the right hepatic lobe

DISCUSSION

- A Super-Resolution GAN generates high resolution artificial HBP images from pre-T1 images
- Potential tool to increase sensitivity for lesion detection when applied on non-contrast and non-hepatobiliary specific protocols
- Ability to reduce MRI scanning times

FUTURE DIRECTIONS

- Train and validate a Super-Resolution GAN with a larger dataset of 1,270 MRI studies
- Semi-quantitative comparison between true HBP, artificial HBP, and pre-T1 images with four radiologist readers
  - Resolution
  - Artifact
  - Lesion identification

CONCLUSIONS

GANs have the potential to produce high resolution artificial HBP images from pre-T1 images, which can aid in lesion detection

REFERENCES

Ledig, Christian, et al. “Photo-Realistic Single Image Super-Resolution Using a Generative Adversarial Network.” *2017 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 25 May 2017, https://doi.org/10.1109/cvpr.2017.19.

UT Southwestern Medical Center