

Phantom-Based Optimization of CT Gout Identification: Impact of Acquisition, Reconstruction, and Processing Settings

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Purpose

To assess the impact of parameters on CT gout identification

Innovation/Impact

This study characterizes the impact of various parameters on CT gout identification. This information would be useful for anyone looking to optimize their CT gout identification applications or to harmonize them across vendors

Gout Phantom Details

Please see our sister poster:

[A Phantom for CT Gout Identification: Fabrication and Longevity by Ausmus, Paden, Fahrenholtz, & Sensakovic](#)



INTRODUCTION

- Protocol acquisition and reconstruction parameters are often optimized for perceived radiologist image quality
- Image processing parameters for applications are often left at default vendor values
- Quantitative imaging allows for objective determination of the impact of parameter values
- Understanding how sensitive performance is to individual parameters allows a practice to speed up optimization and harmonization efforts by focusing on the impactful parameters first
- A phantom that can be scanned repeatedly is necessary because it allows direct comparison between systems without increased patient radiation dose
- This study assessed the impact of individual parameters on CT gout identification

RESULTS

- Likert score changes were most pronounced for:
 - Reconstruction kernel (standard to bone)
 - 15 inserts changing (1.5-point mean shift)
- Large uric acid threshold shifts
 - 14 inserts changing (2.4-point mean shift)
- See Figure 1 & Chart 1
- Likert score changes were moderate for:
 - Noise reduction strength (vendor algorithm)
 - 5 inserts changing (1.6-point mean shift)
- Small UA threshold shifts
 - 3 inserts changing (1.6-point mean shift)
- Slice thickness
 - 3 inserts changing (2.0-point mean shift)
- Likert score changes were low or non-existent for:
 - Software voxel size
 - Tube current
 - Hydroxyapatite threshold

DISCUSSION

- Larger and higher-concentration uric acid inserts were generally less impacted by parameter changes
- Partial volume effects often resulted in the outer shell of an insert being identified while the center was not
- Changes that increased noise often moderately improved detection and greatly increased the occurrence of false positives (Figure 1)
 - Due to individual noise pixels crossing identification thresholds
- Noise reduction eliminated identification of the 2mm gout insert likely due to pixel averaging from loss of spatial resolution
- Pseudo-gout only produced false positives when the reconstruction kernel was changed
 - Larger (less clinically reasonable) changes to the hydroxyapatite threshold could likely induce false positives as well
- Changes improving gout identification sensitivity typically decreased specificity
- Tendon was the most likely tissue to exhibit false positives
 - Appearance could be noise-like or falsely identify most of a structure (Figure 1)
- False positives in soft tissue and bone mimics typically appear like noise

CONCLUSIONS

Gout identification is surprisingly insensitive to individual settings, but care must be exercised when changing UA detection thresholds, slice thickness, and reconstruction kernel. The sensitivity-specificity trade-off occurs between positive gout identification and volume of false positives, especially in tendon.

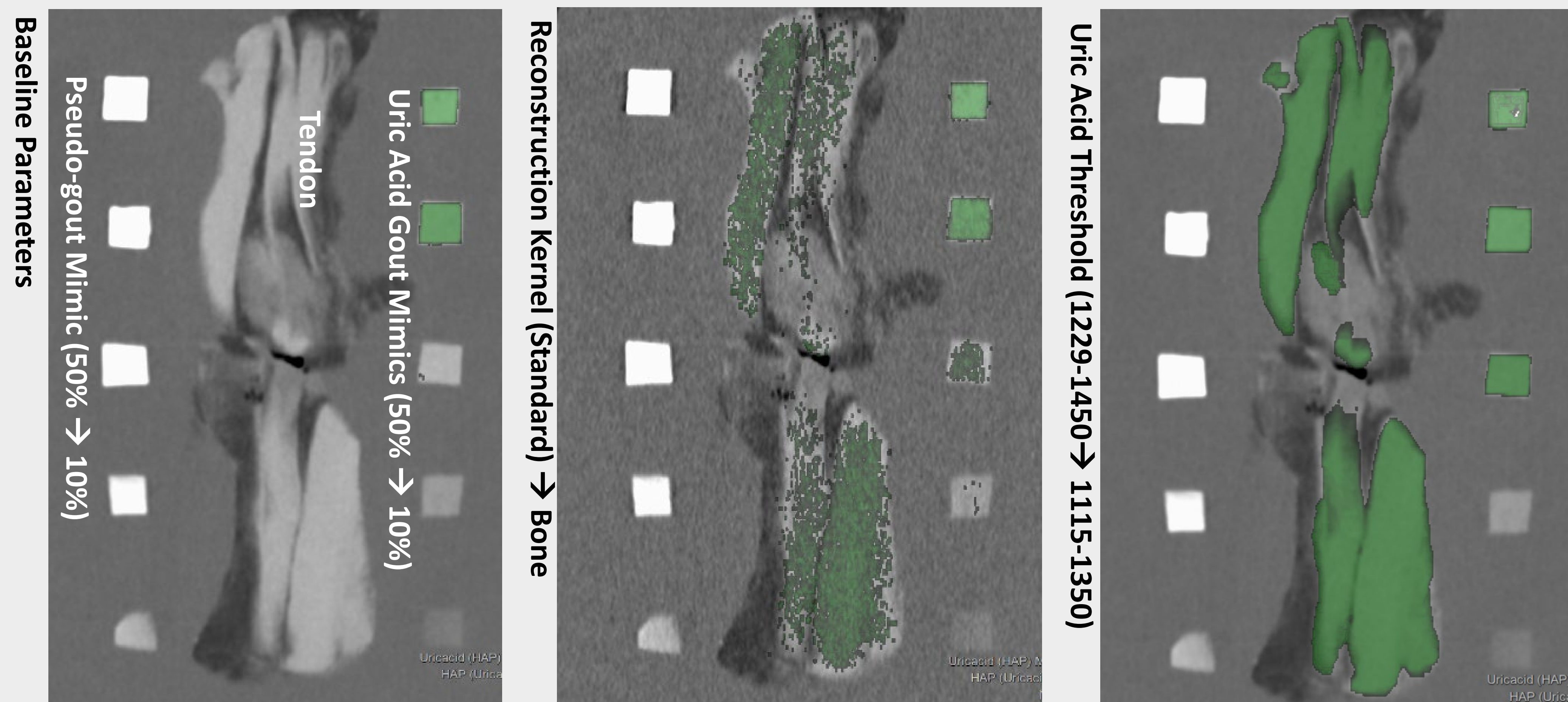
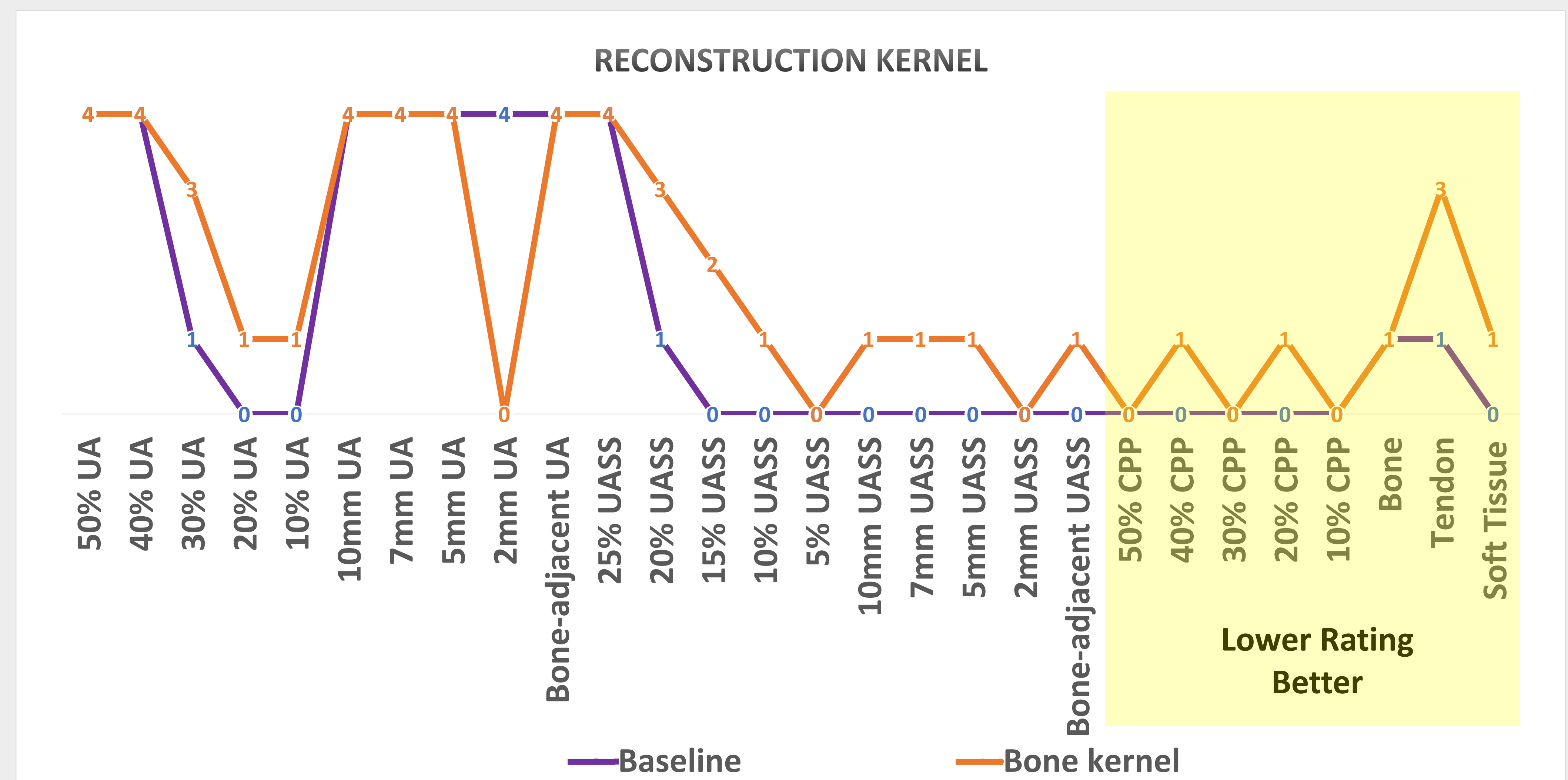


Figure 1. 70keV monoenergetic reconstructions with gout identification overlay (green). Left: Baseline parameters demonstrating no false positives and complete identification of 50% & 40% gout inserts. Middle: Bone reconstruction kernel partially identifying 30% & 20% gout inserts but showing false positives throughout the tendon. Right: Altered uric acid threshold completely identifying 50%-30% gout inserts but showing false positives for the tendon

METHODS AND MATERIALS

- A phantom containing 28 inserts for gout, tendon, bone, and pseudo-gout was created
- Gout mimics were varying concentrations and sizes of uric acid (UA) and UA sodium salt (UASS)
- Pseudo--gout mimics were varying concentrations of calcium pyrophosphate (CPP)
- A baseline axial 70keV image with gout identification overlay was created from our clinical knee protocol for gout (baseline) on a GE Revolution Apex system (3.2 GSI Gout app)
- Images were further acquired varying:
 - Tube current
 - Reconstruction kernel
 - Slice thickness
 - Uric acid & hydroxyapatite thresholds
 - Noise reduction strength
 - Software voxel size
- A medical physicist assessed scans (Figure 1) using a 5-point Likert scale (Chart 1)
 - High scores on gout inserts indicated good sensitivity
 - High scores on pseudo-gout, bone, tendon, and sort tissue indicated poor specificity



Gout (UA & UASS) Likert scale:

- 0: not detected
- 1: < 20% insert volume identified
- 2: 21% - 50% insert volume identified
- 3: 51% - 80% insert volume identified
- 4: > 80% insert volume identified

Pseudo-gout (CPP), bone, tendon, & agar Likert scale:

- 0: no false positives in insert
- 1: false positive volume less than < 20% of insert volume
- 2: false positive volume between 21% - 50% of insert volume
- 3: false positive volume 51% - 80% of insert volume
- 4: false positive volume > 80% of insert volume

Chart 1. Likert ratings demonstrating the impact of reconstruction kernel on gout identification accuracy. The bone kernel generally increases true and false positives but does lose the smallest size gout insert.

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