**Appendix 1: DECT Technique**

Our institutional dual-energy renal mass CT protocol from December 2015 to November 2017, acquired using a 64 channel multi-detector DECT (Discovery 750 HD, GE Healthcare) consists of a true conventional unenhanced CT acquisition (slice thickness 2.5 mm) of the kidneys followed by a delayed conventional nephrographic (NG) phase acquisition (slice thickness 5 mm) acquired at approximately 110-120 seconds after injection, of the entire abdomen and pelvis. A fixed 120-kVp technique is used with automated tube current modulation and a variable 100-500-mAs (matched for both phases of the study). The true NECT and NG phase enhanced CT phases are acquired using a fixed 120-kVp technique, which enables the ability to compare mean attenuation numbers across machines (33). Although automated tube current modulation is performed, the variable tube current affects the standard deviation (noise) of the attenuation measurement but not the mean attenuation within a measured region (33). Acquisition is helical with a rotation time of 0.8 sec and a Noise Index of 41.4.

In our protocol, the corticomedullary (CM) phase is performed as a dual-energy acquisition. After performing conventional 120-kVp NECT, patients are scanned in dual-energy mode with fast tube voltage switching (between 80 and 140 kVp every 0.5 msec) during the CM phase with timing of the CM phase established by bolus tracking. A circular region of interest (ROI) is placed in the abdominal aorta at the level of the diaphragm and the CM phase is acquired 15 seconds after an attenuation threshold of 100 HU is reached (timing of approximately 30 to 40 seconds after injection). The dual-energy CM phase data were reconstructed by using an advanced workstation equipped with the commercially available Gemstone Spectral Imaging viewer (AW Server 2, release 5.5; GE Healthcare). Dual-energy datasets are used to generate CM phase enhanced 70-keV virtual monochromatic images. Previously, it has been shown that attenuation can be compared in cystic and solid renal masses between 120-kVp conventional true NECT images and 70-keV enhanced CT images in phantom and clinical studies (34, 35). Adaptive statistical iterative reconstruction (ASiR, GE Healthcare) level 4 was used for all three phases of the study. Patients are given 105 mL of non-ionic contrast material (Iopamidol [Isovue], Bracco Healthcare) at a fixed intravenous rate of 3.5 mL/second using a power injector followed by a saline flush.

Beginning December 2017, with no other parameter alterations, the true NECT and CM phase enhanced CT phases were performed using a fixed 120-kVp single energy technique, and the NG phase was performed using a dual-energy acquisition.

**Supplementary Table 1. CT Parameters for Dual-Energy CT renal mass protocol used at our institution December 2015 to November 2017**

|  |  |  |
| --- | --- | --- |
| **CT parameter** | **Single energy**  **(Unenhanced and Nephrographic Phase enhanced images)** | **Dual Energy**  **(Corticomedullary phase enhanced images)** |
| Detector configuration (mm) | 64 x 0.625 | 64 x 0.625 |
| Tube voltage (kVp) | 120 | 80/140 |
| Gantry revolution time (sec) | 0.6 | 0.6 |
| Automatic exposure control | ON | NA |
| Noise index | 14 | NA |
| Tube current (mA) | 100-500 | 640 |
| Acquisition mode | Single source, helical | Single source, helical |
| Helical pitch | 1.375 | 1.375 |
| Reconstruction thickness (mm) | 2.5 | 2.5 |
| Reconstruction interval (mm) | 2.5 | 2.5 |
| Reconstruction algorithm | Projection based | Projection based |
| Reconstruction kernel | Soft-tissue standard | Soft-tissue standard |
| Matrix size | 512 x 512 | 512 x 512 |
| Adaptive Statistical iterative Resonstruction (ASiR) level | 4 | 4 |

**Supplementary Table 2. CT Parameters for Dual-Energy CT renal mass protocol used at our institution December 2017 to June 2020**

|  |  |  |
| --- | --- | --- |
| **CT parameter** | **Single energy**  **(Unenhanced and Corticomedullary phase enhanced images)** | **Dual Energy**  **(Nephrographic phase enhanced images)** |
| Detector configuration (mm) | 64 x 0.625 | 64 x 0.625 |
| Tube voltage (kVp) | 120 | 80/140 |
| Gantry revolution time (sec) | 0.6 | 0.6 |
| Automatic exposure control | ON | NA |
| Noise index | 14 | NA |
| Tube current (mA) | 200-500 | 640 |
| Acquisition mode | Single source, helical | Single source, helical |
| Helical pitch | 1.375 | 1.375 |
| Reconstruction thickness (mm) | 2.5 | 2.5 |
| Reconstruction interval (mm) | 2.5 | 2.5 |
| Reconstruction algorithm | Projection based | Projection based |
| Reconstruction kernel | Soft-tissue standard | Soft-tissue standard |
| Matrix size | 512 x 512 | 512 x 512 |
| Adaptive Statistical iterative Resonstruction (ASiR) level | 4 | 4 |

**Appendix 2: MRI Technique**

MRI was performed at a single tertiary care referral center. MRI was performed on one of four clinical 1.5 or 3 Tesla systems (Aera [N=4 patients], Symphony [N=4 patients], TRIO [N=2 patients]) Siemens Healthcare, Malvern PA, USA or Discovery 750W [N=15 patients], General Electric Healthcare, Milwaukee WI, USA) using a torso phased-array coil (6 element anterior array for the TRIO, 4 element anterior array for the Symphony and 16 element array for the Discovery 750W). A summary of the multi-parametric renal mass MRI protocol used at our institution at 1.5 and 3 Tesla is provided in Table 1. For Gadolinium enhanced imaging, 3-Dimensional fat suppressed gradient recalled echo (GRE) T1 weighted (VIBE, Siemens Healthcare or LAVA, GE Healthcare) sequences are performed dynamically after the administration of 1.0/0.1 mmol/kg of gadopentetate dimeglumine or gadobutrol (Magnevist or Gadovist, Bayer Healthcare) injected at a rate of 2 mL/second followed by a 20 mL saline flush. Axial contrast enhanced images were obtained following an empiric 30-40 second delay followed by successive acquisitions every minute for 3-5 minutes. The first axial sequence (obtained at 30-40 seconds) was used as the corticomedullary phase and the second axial sequence (obtained at 60-80 seconds) was used as the nephrographic phase. The most delayed sequence (3 minutes) was considered as the delayed phase. Diffusion weighted imaging (DWI) was performed using either a breath-hold or respiratory triggered fat suppressed single-shot echo-planar sequence with tri-directional gradients and low (b=0 mm2/sec) and high (b=600 mm2/sec) b values for automatic derivation of apparent diffusion coefficient (ADC) map using a standard monoexponential model.

**Supplementary Table 3. Pulse sequence parameters for dual echo T1W (in and opposed phase) GRE, T2W TSE/FSE and volume interpolated T1W fat suppressed pre-and post-gadolinium enhanced GRE at 1.5 and 3 Teslaa.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Pulse Sequence** | **Dual echo T1W GRE** | | | **T2W TSE/FSE** | **Volume Interpolated T1W 3D GREb** | | **Diffusion weighted imagingc** |
| **2D GRE** | **3D GRE** | | **Single shot TSE/FSE** | **3T** | **1.5T** | **Single shot echo-planar imaging** |
| **3T** | **1.5T** |
| **Physiology** | Breath Hold | Breath Hold | Breath hold | Respiratory Triggered  Breath hold | Breath Hold | | Breath Hold |
| **Duration** | 21 sec. | 16 sec. | 20 sec. | 3-4 min.  22 sec. | 20 sec. | | 21 sec |
| **Fat Suppression** | N/A | N/A | N/A | N/A | Chemical or Spectral Inversion Recovery | | Spectral Inversion Recovery |
| **TE (IP/OP)c ; TR (msec)** | (4.6/2.3);160-180 | (2.5/1.3);5.5and (2.2/1.1);4.0 | (4.6/2.3);7.6 | 83-88;1030 | 1.7-2.5; 4.0-4.5 | 1.4;4.3 | 60.8-74;2075-4600 |
| **Flip angle (degrees)** | 70 | 10-12 | 10 | 180 | 10-12 | 10-12 | 90 |
| **Bandwidth (Hz)** | 260 | 700 | 313 | 450 | 325-460 | 488 | 250-1446 |
| **Number of excitations** | 1 | 0.7-1 | 1 | Half-Fourier | 1 | 1 | 2 |
| **Acceleration factor** | 2 | 2 | 1 | 1  2 | 2 | 2 | 2 |
| **Matrix Size** | 256/320 x 134/152 | 294 x 224 | 192 x 320 | 170 x 256 | 256 x 320 | 132 x 320 | 130-38;96-75 |
| **­Field of view (cm)** | 25 x 35 | 25 x 35 | 25 x 35 | 25 x 35 | 25 x 35 | 25 x 35 | 40-380;28-75 |
| **Slice thickness (mm)** | 5-6 | 3-4 | 3-5 | 5 | 2.5-4 | 2.5-4 | 6 |

1. Imaging was performed on clinical 1.5 Tesla (Symphony or Aera, Siemens Healthcare) or 3 Tesla (TRIO, Siemens Healthcare; Discovery 750W, General Electric Healthcare) systems.
2. VIBE (Siemens Healthcare), LAVA (General Electric Healthcare).
3. Diffusion weighted imaging performed with two b values (0 and 600 mm2/sec) with ADC map automatically derived.

d----IP=in phase, OP=opposed phase