Original Investigation

Expanding the Definition of a Benign Renal Cyst on Contrast-enhanced CT: Can Incidental Homogeneous Renal Masses Measuring 21–39 HU be Safely Ignored?

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Rationale and Objective: We aimed to determine the frequency and clinical significance of homogeneous renal masses measuring 21–39 Hounsfield units on contrast-enhanced computed tomography (CT).

Methods: Subjects 40–69 years old undergoing portal-venous-phase contrast-enhanced abdominal CT from January 1, 2006 to December 31, 2010 with slice thickness ≤5 mm and no prior CT or magnetic resonance imaging were identified ($n = 1387$) for this institutional review board-approved retrospective cohort study. Images were manually reviewed by three radiologists in consensus to identify all circumscribed homogeneous renal masses (maximum of three per subject) ≥10 mm with a measured attenuation of 21–39 Hounsfield units. Exclusion criteria were known renal cancer or imaging performed for a renal indication. The primary outcome was retrospective characterization as a clinically significant mass, defined as a solid mass, a Bosniak IIF/III/IV mass, or extirpative therapy or metastatic renal cancer within 5 years' follow-up.

Results: Eligible masses ($n = 74$) were found in 5% (63/1387) of subjects. Of those with a reference standard ($n = 42$), none (0% [95% CI: 0.0%–8.4%]) were determined to be clinically significant.

Conclusion: Incidental renal masses on contrast-enhanced CT that are homogeneous and display an attenuation of 21–39 Hounsfield units are uncommon in patients 40–69 years of age, unlikely to be clinically significant, and may not need further imaging evaluation. If these results can be replicated in an independent and larger population, the practical definition of a benign cyst on imaging may be able to be expanded.

Key Words: Cyst; renal; attenuation; threshold; benign.

INTRODUCTION

Incidental renal masses are common, with some estimates suggesting that at least half of all patients over the age of 50 have at least one renal mass that may be detected with cross-sectional imaging (1–3). When an incidental renal mass is identified at contrast-enhanced computed tomography (CT), a diagnosis of a benign simple cyst can be made if the mass is homogeneous (ie, no wall thickening, septa, calcifications, or visible heterogeneity) and has a measured attenuation between −10 and 20 Hounsfield units (HU) (1). However, if the mass is heterogeneous, or if the mass is homogeneous and measures greater than 20 HU, it is considered incompletely characterized and in general prompts a recommendation for further imaging (1,4–6).

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However, these attenuation criteria may be overly aggressive. For example, it is not possible for a homogeneous renal mass that measures 21–39 HU on contrast-enhanced CT to both fulfill the definition of a nonsimple cyst on unenhanced CT (ie, >20 HU) (7) and meet the threshold for definitive enhancement on contrast-enhanced CT (ie, an increase by 20 HU or more) (1,4). In addition, attenuation values of renal masses at contrast-enhanced CT are commonly spuriously high due to pseudoenhancement (8–10), an artificial increase in attenuation due to the CT scanner's overcorrection for beam-hardening (8). Therefore, an incidentally detected homogeneous renal mass that measures 21–39 HU on contrast-enhanced CT is more likely to be a benign non–enhancing hyperattenuating cyst (ie, Bosniak II cyst), or a simple cyst (ie, Bosniak I) with pseudoenhancement, than it is to be malignant. However, the threshold for definitive enhancement is not always reached for some renal cancers; for example, papillary cancers are known to be hyperattenuating and some may fail to show measurable enhancement on CT (10–13).

Therefore, we sought to determine the frequency and significance of incidentally detected homogeneous renal masses measuring 21–39 HU on contrast-enhanced CT.

METHODS

Institutional review board approval was obtained and the requirement for written informed consent waived for this Health Insurance Portability and Accountability Act-compliant retrospective cohort study. No extramural funding was used.

Subjects

All subjects undergoing contrast-enhanced abdominal CT from January 1, 2006 to December 31, 2010 (to allow at least 5 years of follow-up) were identified through a retrospective query of the institutional electronic medical record system using the following inclusion criteria: subject age 40–69 years, slice thickness ≤5 mm, no prior abdominal CT or magnetic resonance imaging (MRI), no concomitant unenhanced CT, and first eligible CT examination per subject. Subject age was restricted to 40–69 years to target the highest yield and most clinically relevant cohort. This identified 1387 CT examinations in 1387 subjects.

All examinations were manually reviewed by one co-author blinded to the reference standard to identify all renal masses (maximum of three per subject) that were circumscribed, homogeneous, ≥10 mm, and had a measured attenuation of 21–39 HU ($n = 113$ renal masses in 101 subjects). Attenuation was measured by placing a region of interest in the center of each mass to encompass approximately 75% of the mass while avoiding partial volume effects. Homogeneity was determined subjectively. Exclusion criteria were known renal cancer ($n = 19$) and imaging performed for a renal indication ($n = 16$). The remaining masses ($n = 78$ in 66 subjects) were then re-reviewed by two fellowship-trained abdominal radiologists with 5 and 35 years of experience who were blinded to the reference standard to ensure that the masses met the inclusion criteria. Four masses ($n = 1$ subcapsular hematoma, $n = 3$ heterogeneous masses) in three subjects were determined not to meet the inclusion criteria and were removed from the cohort.

The final study population included 74 circumscribed homogeneous renal masses 10 mm or larger with a measured attenuation of 21–39 HU on contrast-enhanced CT in 63 subjects (35 males, 28 females, mean age 58 years, and age range 40–69 years).

Index CT Examinations

All index CT examinations were performed on a 16- or 64-slice CT scanner (Lightspeed-16, HD750, GE Healthcare, Waukesha, WI) in the portal venous phase of acquisition (65-second delay) after the IV administration of 100–125 mL of either iopamidol 300 or iopamidol 370 power-injected intravenously at 2–4 mL/s using 120 kVp and variable mA, reconstructed with a ≤5-mm slice thickness.

Reference Standard

The primary outcome was subsequent characterization of the renal mass as clinically significant, defined as a solid mass (unequivocal enhancement on renal mass protocol CT or MRI, Doppler flow on ultrasound), a Bosniak IIF-IV cystic mass (1,4,7) on subsequent renal mass protocol CT, MRI, or renal ultrasound, or clinical progression within 5 years of follow-up, defined as metastatic renal cancer or extirpative therapy. The CT criteria used for a solid renal mass included ≥20 HU enhancement. The criteria for Bosniak IIF-IV cystic mass have been described previously (4,7). The MRI criteria for a solid mass included enhancement by 15% or more (14), with or without subtraction imaging. The ultrasound criteria for a solid mass was demonstration of intralesional Doppler flow; ultrasound was used as a reference standard only if the mass was not evaluated with multiphasic CT or MRI. Reference standard eligibility was preliminarily assigned by one co-author and then verified in consensus by two separate co-authors.

Data Analysis

Data are summarized with descriptive statistics. The binomial confidence interval for the proportion of clinically significant masses was calculated.

RESULTS

Eligible masses ($n = 74$) were found in 5% (63 of 1387) of subjects. The majority (53% [39 of 74]) was endophytic (Table 1, Fig 1), with a mean attenuation of 28 HU (21–38) and mean maximum diameter of 20 mm (10–56 mm).

Of those with a reference standard ($n = 42$), none (0% [95% CI: 0.0%–8.4%]) were clinically significant. Of those with a