European Journal of Radiology 85 (2016) 1835–1842

Contents lists available at ScienceDirect

European Journal of Radiology

journal homepage: www.elsevier.com/locate/ejrad

New radiologic classification of renal angiomyolipomas

Sohee Song (MD), Byung Kwan Park (MD)*, Jung Jae Park (MD)

Department of Radiology, Samsung Medical Center, Sungkyunkwan University School of Medicine, Seoul, Republic of Korea

ARTICLE INFO

Article history:
Received 15 June 2016
Received in revised form 1 August 2016
Accepted 17 August 2016

Keywords:
Angiomyolipoma
Classification
Computed tomography
Magnetic resonance imaging
Region of interest

ABSTRACT

Purpose: To introduce a new radiologic classification of renal angiomyolipoma (AML).
Materials and methods: Between 1995 and 2014, CT or MR images in 98 patients with histologically proven 98 AMLs were reviewed independently by a radiologist and a resident. The lesions were classified as (a) 53 fat-rich AML ($\leq$−10HU), (b) 22 fat-poor AML (>−10HU) with tumor-to-spleen ratio (TSR) <0.71 or signal intensity index (SII) >16.5%, and (c) 23 fat-invisible AML (>−10HU) with TSR $\geq$0.71 and SII $\leq$16.5%. Inter-reader agreement was assessed with a weighted kappa value. Fat-poor and fat-invisible AMLs were compared in terms of attenuation value, TSR, and SII using unpaired *t*-test.
Results: The weighted kappa value was 0.956 (95% confidence interval, 92.0–99.1%). When a region of interest (ROI) was placed within the most hypodense area on unenhanced CT or within the most signal-dropped area on chemical shift image, the mean attenuation values, TSRs, and SIIs of fat-poor versus fat-invisible AMLs were 19.5 ± 8.1 HU versus 38.1 ± 9.9 HU, 0.59 ± 0.19 versus 0.96 ± 0.01, and 43.7 ± 16.9% versus −5.4 ± 21.1%, respectively ($p < 0.0001$). When a ROI was placed within the other area on CT or chemical shift images, 90.1% (48/53) of fat-rich AMLs were mis-classified as fat-poor or fat-invisible AML and 50% (11/22) of fat-poor AMLs as fat-invisible AML.
Conclusion: The new radiologic classification of renal AML is feasible for clinical practice. ROI location is important in differentiating the types of AMLs.

1. Introduction

Renal angiomyolipoma (AML) is easily diagnosed with CT or MR images because of abundant fat tissue. However, AML with a small amount of fat is frequently identified after the lesion has been managed with biopsy or surgery [1,2]. Therefore, many investigators have reported imaging features of AML with a small amount of fat in order to differentiate this lesion from renal cell carcinoma (RCC). This subset of AML has various names, including “AML with minimal fat” [3–7], “lipid-poor AML” [8,9], “fat-poor AML” [10,11], “low-fat AML” [12], “minimal fat AML” [13–16], “AML without visible fat” [17], “fat-invisible AML” [18], and so on. AML with a small amount of fat is most commonly called “AML with minimal fat” or “minimal fat AML”. AML with minimal fat originally indicated a lesion that does not contain fat attenuation at unenhanced CT (UCT) [19]. However, whether the other terminologies were used to indicate AML with minimal fat is doubtful because of many contradictions between studies in differentiating AML with a small amount of fat from RCC on CT or MR images.

A recent review article reported the classification of renal AMLs, in which clinical behavior, radiologic findings, and pathologic findings are mixed [20]. However, radiologists have difficulty accurately classifying renal AMLs with this classification because they are not usually given sufficient clinico-radio-pathologic information when CT or MR images are interpreted. Therefore, they need a new classification that is feasible to classify renal AMLs. We hypothesized that renal AMLs can be classified according to the amount of fat detected on CT or MRI and that the classification is feasible for application. The purpose of this study was to introduce a new radiological classification of renal AMLs.

2. Materials and methods

This retrospective study was approved by our institutional review board and informed consent was waived.

2.1. Patients

Between 1995 and 2014, 180 patients with histologically proven AML were found in our database. They underwent biopsy

* Corresponding author at: Department of Radiology, Samsung Medical Center, Sungkyunkwan University School of Medicine, 50 Ilwon-dong, Kangnam-ku, Seoul, 135-710, Republic of Korea.
E-mail addresses: rapark@skku.edu, 1436park@gmail.com (B.K. Park).

http://dx.doi.org/10.1016/j.ejrad.2016.08.012
0720-048X/

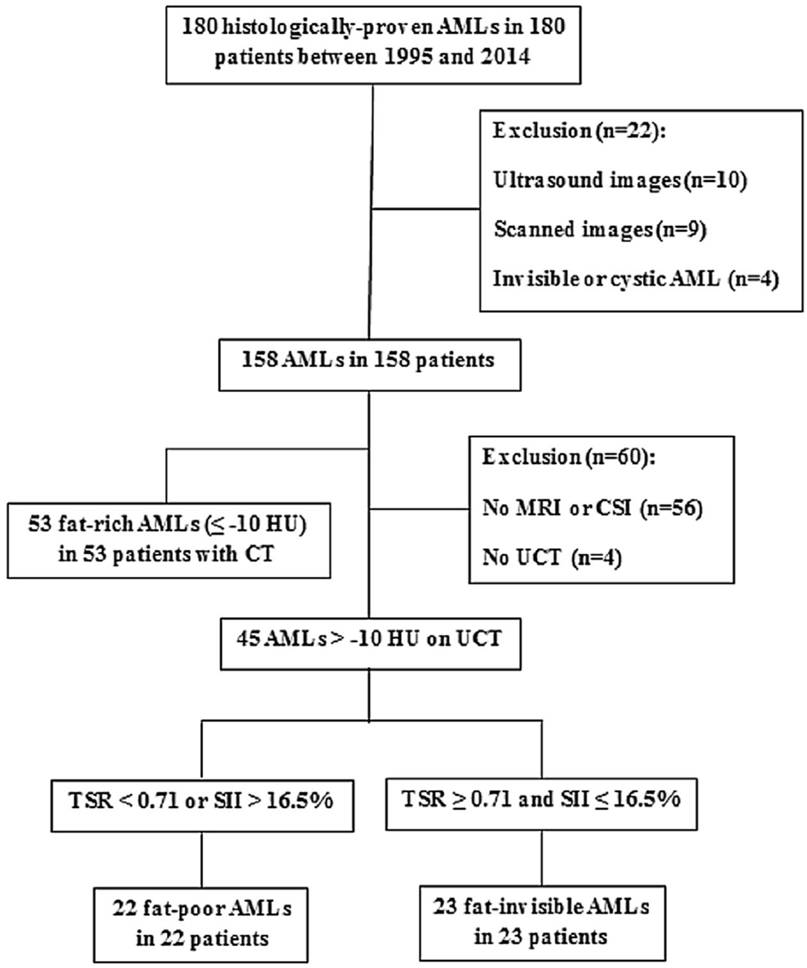

Fig. 1. Flow diagram of study population. AML, angiomyolipoma,; CSI, chemical shift imaging; UCT, unenhanced CT; TSR, tumor-to-spleen ratio; SII, signal intensity index.

or nephrectomy for the following reasons: suspected malignant tumors (n = 148), pain (n = 15), increased lesion size (n = 8), combined malignant lesions (n = 7), bleeding (n = 1), and hypochondriasis (n = 1). Of the 180 patients, 23 were excluded for the following reasons: ultrasonographic images (n = 10), scanned images (n = 9), and invisible or cystic AMLs (n = 4) (Fig. 1). Of the remaining 157 patients, 53 were classified as fat-rich AML that was diagnosed on CT alone. Of the remaining 104 patients, 59 were excluded due to the following reasons: CT images only (n = 54), unavailable UCT (n = 4), and unavailable chemical shift imaging (CSI) (n = 1). Of the remaining 45 patients, 22 were classified as fat-poor AML in which fat was detected on CSI and 23 as fat-invisible AML in which fat was not detected on either UCT or CSI.

Finally, a total of 98 AMLs in 98 patients (men:women = 23:75; mean, 50.9 years; range, 25–76 years) were included in the analysis. Nine patients had multiple fat-rich AMLs, in which the largest one was considered a representative lesion. One patient had five AMLs consisting of one fat-invisible and four fat-rich AMLs. Only the fat-invisible AML was included for analysis. Of the 98 patients, 16 were evaluated in another paper which was quite different from our study regarding a point of view [18].

2.2. Imaging protocols

CT examinations were performed on one of various CT scanners that were shown in the Supplement Table. CT parameters included a slice collimation of 2–10 mm (mean, 4.4 mm), a pitch of 0.6–1.67:1, 120 kvp, and 50–489 mA.

Of 45 patients with fat-poor or fat-invisible AMLs, seven underwent MRI with 1.5T scanners including Genesis Signa (GE Healthcare), Avanto (Siemens Medical Solutions), or Sonata (Siemens Medical Solutions). The remaining 37 patients underwent MRI with 3T scanners including Intera Achieva (Philips Medical Systems, Amsterdam, The Netherlands), Signa (GE Healthcare), and Trio (Siemens Medical Solutions). Phased-array coils were used for MRI examinations. Imaging parameters of the 1.5T and 3T MRIs were summarized in Table 1.

2.3. Data analysis

CT or MR images were reloaded on the picture archiving and communication system (Centricity PACS, GE Healthcare, Barrington, OH, USA). These images were reviewed independently by two readers. One was a radiologist with 16-years of experience in genitourinary imaging. The other was a third-year resident who was training in the Department of Radiology. Inter-reader agreement for each type of AML was obtained.

A region of interest (ROI) was placed within the most hypodense area on CT images to measure the attenuation value. When the ROI was measured ≤−10 HU, the lesion was defined as fat-rich AML [21]. When it was measured >−10 HU, CSI was evaluated. A ROI was placed within the most hypointense area on opposed-phase images and then placed at the corresponding area on in-phase images to calculate the tumor-to-spleen ratio (TSR) and the signal intensity index (SII). When TSR was <0.71 or SII was >16.5%, a lesion was