https://doi.org/10.15218/zjms.2024.034

Evaluation of angiomyolipoma by ultrasound in correlation with computed tomography findings in Erbil province

Received: 22/05/2022 Accepted: 06/12/2022

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Abstract

Background and objective: The benign renal mesenchymal tumor, angiomyolipoma (AML), consists of smooth muscle, fat and blood vessels, representing (1–3%) of the solid renal tumors. The most common type of benign renal tumors is accounting about (0.3–3%) of all kidney masses. AMLs are asymptomatic in general and found incidentally via routine imaging procedures and are seldom symptomatic. This study aimed to evaluate incidental findings of Angiomyolipoma by ultrasound in relation with CT findings in Erbil province.

Methods: This descriptive cross-sectional study was conducted at the Rizgary Teaching hospital from March 2021 to April 2022. Review of ultrasound reports and CT scans data were collected from 61 patients with renal masses who attended to the public and private hospitals in Erbil province during the study period. The patients were older than 25 years in age.

Results: The results showed that female of middle age were predominant among AML patients in the study. By using CT technique, 92.6% of females scored as hypoattenuating AML, and 88.5% of the AMLs were hyperdense or hyperattenuating by using CT technique. The results also revealed that 93.4% of AML cases were hyperechoic by Ultrasound technique, while 6.6% of the fat-poor were hyperechoic by using the Ultrasound technique.

Conclusion: It can be concluded that female of middle age were predominant among AML patients, and CT technique is more accurate and sensitive in the diagnosis of AML cases.
Keywords: Angiomyolipoma; Ultrasound; CT scan; Erbil province.

Introduction

The benign soft tissue tumor, angiomyolipoma consists of blood vessels, fat and smooth muscle in various proportions.[1] The most common type.[2] of benign renal tumors is AML accounting for (0.3-.3%) of all kidney masses.[3] About 80% of such tumors appear sporadically. Nevertheless, other tumors are related to tuberous sclerosis complex and mainly observed in women.[4]

One of the most commonly known benign mesenchymal tumors is renal angiomyolipoma, which consists of blood vessels, fat cells and smooth muscle cells.[5] Fischer, 1911 was the first who defined this pathological condition which mainly influenced women rather than men.[6] AML was found to be prevalent in 0.28% of males and 0.6% of females.[3]

AML, similarly to other tumors of renal origin, can penetrate into the renal veins and the inferior vena cava — a case has even been described of an AML reaching the right atrium of the heart.[7] Fragments of the AML tumor may thus form embolisms.[8]

The patients' symptoms vary from asymptomatic to flank mass, acute flank pain with hypovolemic shock. Kim et al. found that 12% of the analyzed 26 Wunderlich syndrome patients were having AML.[9]

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https://doi.org/10.15218/zjms.2024.034

AMLs are tumors of the mesenchymal kidney that contain adipocytes, smooth muscle cells and dysmorphic blood vessels. AMLs are often benign tumors, but at risk of spontaneous bleedings.[10]

Two types of renal AML were identified by the world health organization (WHO): Classic AML (CAML) and Epithelioid AML (EAML). CAML is a benign tumor composed of the three components which has a main epithelioid component and potentially malignant behavior.[11] Cases of EAML are characterized by malignancy properties, like local recurrence, tumor venous extension and distant metastasis. Thus, it is essential to differentiate EAML from CAML.[12] The middle-aged women are the most common group of sporadic renal AML patients. In general, sporadic AMLs are asymptomatic and can be detected incidentally during kidney imagings.

Furthermore, the slow-growing sporadic AML often does not cause kidney function deteriorations. Some AMLs have the ability for over time growing and have high risk to bleed in lesions more than 4 cm.[13] Additionally, these tumors may be seen outside the kidneys, principally in the liver and in the retroperitoneal areas.[14]

Approximately (20%) of AMLs are related to tuberous sclerosis complex (TSC)[6], which is an autosomal dominant abnormality induced by mutations in the genes of TSC1 and TSC2.[15] TSC patients are characterized by mental retardation, epilepsy and angiofibroma.[16] The majority of TSC patients (80%) develop AML.[15]

The majority of asymptomatic AML patients can be managed via surveillance.[17] The evident AML diagnosis requires a biopsy, but it is very infrequently applied due to the risks of the tumor bleeding and rupture.[15] Physical examinations and CT at 6-month, 12 month and annually are recommended, despite no standard protocol for surveillance is present. For high-risk patients, a close follow-up is required, especially in cases of larger tumor sizes, women in childbearing ages and TSC associated AMLs.[16] Symptomatic renal AMLs or big tumor sizes >4-6 cm are broadly approved as indications for other treatment protocols such as embolization, surgery and mammalian targets for Rapamycin (mTOR) inhibitor therapy.[3]

Radiologic classification of renal AMLs has been reported by two groups of authors. In a review article, Jinzaki et al.[18] classified many types of AML on the basis of clinical features, imaging features, histologic features, and genetic features. In an original article, Song et al.[19] described a radiologic classification based on CT and MRI findings. They classified renal AML into fat-rich, fat-poor, and fat-invisible AML using CT and MRI quantitative values. Fat-rich AML is a lesion with CT attenuation of –10 HU or less.[18,19]

Fat-poor AML is a lesion with CT attenuation of more than –10 HU on CT images but with an MRI tumor to spleen ratio less than 0.71 or a signal intensity index greater than 16.5%.[19] Fat-invisible AML is defined as a lesion with CT attenuation greater than –10 HU and a tumor to spleen ratio of 0.71 or greater and a signal intensity index of 16.5% or less.[19]

Recently, two radiologic classifications of renal AMLs have been introduced. Jinzaki et al categorized them into classic and fat -poor subtypes, and another classification by Song et al categorized them into fat-rich, fat-poor, and fat-invisible subtypes.[18,19] In this pictorial review, CT and MRI features of classic and fat-poor AMLs, AMLs with epithelial cysts (AMLEC), and epithelioid AML (EAML) are the other different imaging features of AMLs including AMLs associated with tuberous sclerosis, haemorrhagic AML, and large AMLs mimicking retroperitoneal liposarcomas are also described. It is important for radiologists to familiarize themselves with the spectrum of AML morphology to be able to establish the correct diagnosis and help clinicians with further treatment planning.[20]

Abdominal imaging studies may detect more than 80% of AMLs. Approximately

https://doi.org/10.15218/zjms.2024.034

10% of patients suffer from retroperitoneal hematomas and even hypovolemic shocks as initial presentation.[21] Ultrasonography is a useful tool as an initial approach and following of AML patients. Nevertheless, there is a difficulty to establish the lipid-poor renal AML diagnosis by ultrasound due to the lack of macroscopic fats.[18]

The decrease in size seen in 17% of angiomyolipoma mas was an unexpected finding. This may be due to genuine fluctuation in tumor size or, more likely, is a reflection on the limitations of ultrasound in the measurement of very small lesions, which have a margin of error of between 1 mm and 7 mm when compared with CT.[22]

Up to now, the commonly used imaging diagnostic methods include conventional ultrasound (CUS), computed-tomography (CT), magnetic resonance imaging (MRI), and so on. However, both CT and MRI have disadvantages of high cost, ionizing radiation, and adverse reactions induced by iodine contrast agents or gadolinium contrast agents.[23] Though CUS is non-ionizing, non-invasive, readily available and inexpensive, it is limited in attempting to differentiate RCC from AML.[24]

Compared to CT and MRI, CUS is usually the preferred choice for detecting renal lesions because it is readily available, inexpensive, noninvasive, non-ionizing, and provides images in real time.[25] However, it has limited use when attempting to differentiate between RCC and AML because of its lower accuracy in the characterization of some renal masses.[24]

In clinical practice, the ellipsoid method can be used to measure the volume.[26] CT or MRI angiogram with vascular reconstruction is the method of choice to obtain vascular mapping of the lesion as a preventive measure in AML > 3 cm or after active bleeding to locate the bleeding point. In these cases, CT is more accurate than MRI.[27]

In our practice, because many patients of renal masses made unnecessary surgical excision and were histopathologically proven as benign renal angiomyolipoma, we could refer these patients to CT department and easily diagnose the CT benign features of their renal masses to prevent unnecessary surgery and avoid wasting of money and comfort, and save time for the patients and medical associations.

The purpose of this study is to provide a radiological category of renal angiomyolipoma that provides the understanding and diagnosis of the different types and to compare between CT scanning and U/S scanning in the diagnosis of AML in Erbil Province.

Methods

Study design

The study was designed as a descriptive cross-sectional study. It included 61 patients with (25-70) years of age. Data have been obtained from patients in Erbil province public and private hospitals during the period from March 2021 to April 2022. The majority of patients received the first kidney mass diagnosis incidentally in the hospital following a (U/S) or (CT) scan referral.

Inclusion criteria

Patients within the age group (25-70) years, both males and females, size of their angiomyolipo mass (5-40) mm, with fat content density on CT scan were the inclusion criteria in our study.

Exclusion criteria

Patients with non-echogenic renal mass on ultrasound examination were not included in the study to enable accuracy of AML. In addition, any patient with cystic renal mass within this period of the study were also excluded.

Patients who were diagnosed by imaging or pathological examination of renal tumor in Hawler Province were evaluated and regarded eligible after (1) confirming the tumor as AML (2) patients were already not diagnosed with malignant kidney tumors.

Data collection

Pre-tested questionnaire form was designed to obtain information from the patients on age, gender, race,

https://doi.org/10.15218/zjms.2024.034

kidney and pulmonary diseases. The questionnaires were face to face interviews which did not request personal or sensitive information. All the patients were not previously diagnosed with angiomyolipoma and underwent ultrasound and CT examinations.

Informed consent was acquired from the subjects. Prior to the study, verbal consent was secured from the participants, and their privacy was ensured. The research data's confidentiality was maintained. The study received approval from the Ethics Committee of the General Health Directorate of Erbil Province.

Statistical analysis

Categorical variables were compared using Fisher's exact test or Pearson's chi-square test. A *P*-value ≤0.05 was regarded as a statistical level of significance. The Statistical Package for Social Sciences (SPSS program Version 23) was used to analyze current data.

Results

In this study, 61 patients with angiomyolipoma (AML) with their age ranging from 25 to 70 years and a mean age ±SD of 37.6 ± 10) years were included. Table (1) shows that 54 patients out of 61 cases of AML were female, while 7 patients were male. The age groups (45–54) among female groups had the most cases of AML recorded, while no cases of AML 0 (0.0%) were recorded among males at the second to third decade of ages; statistically, these differences were not significant (*P* = 0.252).

Table (2) documented those 50 (92.6%) cases of female groups out of 54 (100.0%) of AML patients' lesions were scored as hypodense versus 7 (100.0%) cases among male groups out of 7 were also scored as hypodense when examined by C.T. imaging technique, with non-significant differences (*P* = 0.603).

Table 1 Distribution of AML cases by age and gender

Categorial age group /Years	Genders		Total No. (%)	*P*-value
	Male No. (%)	Female No. (%)		
25-34	0 (0.0)	13 (24.1)	13 (21.3)	0.252
35-44	3 (42.9)	12 (22.2)	15 (24.6)	
45-54	1 (14.3)	17 (31.5)	18 (29.5)	
55-64	3 (42.9)	10 (18.5)	13 (21.3)	
65-70	0 (0.0)	2 (3.7)	2 (3.3)	
Total	7 (100.0)	54 (100.0)	61 (100.0)	

Table 2 Distribution of patient gender according to AML type by using CT

Genders	C.T diagnosis/ Type of tissue density			Total No. (%)	*P*-value
	Hypoattenuating No. (%)	Hyperattenuating No. (%)	Isoattenuating No. (%)		
Male	7 (100.0)	0 (0.0)	0 (0.0)	7 (100)	0.603
Female	50 (92.6)	1 (1.8)	3 (5.6)	54 (100)	

https://doi.org/10.15218/zjms.2024.034

Table (3) revealed that 57 (93.4%) of hyperechoic AML type using ultrasound techniques were scored as classic, versus 4 (6.6%) of AML diagnosed as fat poor cases were also scored as fat poor using CT imaging as a diagnostic technique.
Table (4) indicated that 56 (98.2%) cases out of 57 (93.4%) cases diagnosed as AML classic type using CT technique were scored as Hypoattenuating, versus 1 (1.8%) cases out of 4 (6.6%) diagnosed as AML were Fat poor type and also scored as Hypoattenuating type, with highly significant differences between the groups with (P = 0.001).
Table (4) indicated that 56 (98.2%) cases out of 57 (93.4%) cases diagnosed as AML classic type using CT technique were scored as Hypoattenuating, versus 1 (1.8%) cases out of 4 (6.6%) diagnosed as AML were Fat poor type and also scored as Hypoattenuating type, with highly significant differences between the groups with (P = 0.001).

Table 3 Distribution of sporadic type of AML by using Ultrasound

Type of AML using C.T	US technique Hyperechoic No. (%)	Total No. (%)
Classic	57 (93.4)	57 (93.4)
Fat poor	4 (6.6)	4 (6.6)
Total	61 (100.0)	61 (100.0)

Table 4 Distribution of AML type by using CT

Type of AML using C.T	C.T diagnosis/ Type of density of tissue			Total No. (%)	*P*-value
	Hypoattenuating No. (%)	Hyperattenuating No. (%)	Isoattenuating No. (%)		
Classic	56 (98.2)	1 (100.0)	0 (0.0)	57 (93.4)	0.001
Fat poor	1 (1.8)	0 (0.0)	3 (100.0)	4 (6.6)	
Total	57 (100.0)	1 (100.0)	3 (100.0)	61 (100.0)	

Table 5 Distribution of AML type within the kidney Position

Type of AML using C.T	Position of kideny		Total No. (%)	*P*-value
	Right No. (%)	Left No. (%)		
Classic	27 (93.1)	30 (93.8)	57 (93.4)	0.919
Fat poor	2 (6.9)	2 (6.9)	4 (6.6)	
Total	29 (100.0)	32 (100.0)	61 (100.0)	

Table (6) illustrated that 56 (98.2%) cases out of 57 (100.0%) AML classic types had single tumor when diagnosed by using CT imaging technique versus 4 (100.0%) out of 4 (100.0%) of AML fat poor type also had single tumor, while only 1 (1.8%%) of AML classic type had multiple tumors when diagnosed by CT imaging technique.

Table 6 Distribution of AML type and number by using CT

Type of AML using C.T	Number of tumor		Total No. (%)	*P*-value
	Single No. (%)	Multiple No. (%)		
Classic	56 (98.2)	1 (1.8)	57 (100.0)	0.711
Fat poor	4 (100.0)	0 (0.0)	4 (100.0)	
Total	60 (98.2)	1 (1.6)	61 (100.0)	

Discussion

In this study, 61 AML patients were subjected to US and CT scan examinations to evaluate them by ultrasound in relation with CT findings in Erbil province. Renal AML or (Hamartoma), the second most common benign tumor of the kidney, accounts for 3% of kidney tumors.[28]

The classic renal AML is easily detected depending upon the imaging by computed tomography or magnetic resonance, and in the majority of the sporadic cases, renal AML presents as only a single lesion.[29] Computed tomography is the imaging method of choice for AML diagnosis. Angiomyolipoma diagnosed on CT of abdominal cavity is observed as a well-delimited tumor situated in the parenchymatous layer of kidney, usually with a low value of a signal below –30 Hounsfield units (HU), because of high fatty tissue content.[30]

The study revealed that 54 out of 61 instances of AML were female, while 7 patients were male. The age range of 45-54 among females exhibited the highest incidence of AML, but no instances of AML were documented among males in the second and third decades of life. This conclusion closely aligns with the findings of Parasad et al., who reported a greater frequency of renal AML in middle-aged women.[31] However, it was in disagreement with Flum et al,[6] who stated that AML occurred in the 5th to 6th decade of age. Nevertheless, AML increases both in size and in number with age,[32] and it is less common, but not unheard of, in children, and it is the leading cause of morbidity and mortality in adults.[33]

Prevalence of AML according to gender in our study showed predominance of the disease among females compared to males and this finding was consistent with many previous studies which demonstrated gender disparity among angiomyolipoma patients with predominance of females over males (4:1). A recent study from Germany used abdominal ultrasound to analyze 61,389 patients to determine the frequency and gender association of angiomyolipoma and found an overall prevalence of females.[6] Predominance in females could be explained by the possible involvement of female hormones in the initiation and progression of tumor genesis.[33]

In regard to distribution of patient gender according to AML type by using CT, 50 (92.6%) cases of female groups out of 54 (100.0%) of AML patients lesions were scored as Hypoattenuating versus 7 (100.0%) cases among male groups out of 7 were also scored as Hypoattenuating when examined by CT imaging technique, in comparison with Hyperattenuating and Isoattenuating types.

Two radiologic classifications for renal AML have been established recently. Jinzaki et al classified them into classic and fat-poor subtypes, while the classification of Song et al included fat-poor, fat-rich and fat-invisible subtypes.[18,19] In this pictorial review, CT and MRI features of classic and fat-poor AML, AML with epithelial cyst (AMLEC) as well as epithelioid AML (EAML) are the other different imaging features of AML such as AML associated with tuberous sclerosis, haemorrhagic AML and large AML mimicking retroperitoneal liposarcoma are also explained. It is important for a radiologist to familiarize himself with AML morphology spectrum so that he can establish the perfect diagnosis and help clinicians with further treatment planning.[20]

On sonography, the renal angiomyolipoma is highly echogenic and may demonstrate acoustic shadowing.[34] The sporadic AML is the most commonly observed benign renal tumor; in a retrospective study of 61,389 patients underwent abdominal cavity ultrasound, this type of AML was detected in 0.44% of the whole population. Sporadic AML in younger than 20-year patients constituted about 3.5% of the cases.[35] Renal ultrasound is a safe diagnostic modality to identify AMLs as well-circumscribed hyperechogenic masses with posterior acoustic shadowing.

For AML, ultrasonography is not very sensitive, it often reveals hyperechoic lesions with acoustic shadowing which cannot be distinguished from other renal tumors.[13] After AML diagnosis, ultrasonography can be used in the follow-up period.[6]

The echogenic appearance of the tumor is thought to be related to its fat content and the presence of multiple tissue interfaces within it. In the current study, it was shown that 56 (98.2%) cases out of 57 (93.4%) cases diagnosed as AML classic type using CT technique were scored as Hypoattenuating, versus 1 (1.8%) case out of 4 (6.6%) diagnosed as AML where Fat poor type were also scored as Hypoattenuating type.

The most commonly used radiologic way for AML diagnosis is the computed tomography (CT) with contrast enhancement.[13] It has a very good specificity, sensitivity, positive and negative predictive values in respect with AML and distinguishes it from other lesions. Areas with <10-20 Hounsfield unit (HU) attenuations are usually regarded as diagnostic of macroscopic fats. AML can be mimicked by some types of renal tumors with fat. Other advantages of CT include its rapidity, cost-effectiveness and availability in most hospitals.[6]

Unenhanced CT clearly depicts a hypoattenuating area (≤ –10 HU) suggesting fat in fat-rich AML.[18,19] Therefore, detecting fat is not a problem in most fat-rich AMLs.[19] However, some fat-rich AMLs have very small foci of fat measuring less than –10 HU, so these hypoattenuating areas may not be recognized at preoperative CT.[19] On CT, visible fat density is a hallmark, which appears as internal hypodense areas with <−10 HU attenuation unenhanced CT (UECT) images. Using of thin CT sections (1.5–3 mm) for detection of small amounts of fat is of great importance.[20]

The results in the present study revealed that 30 (93.8%) cases out of 57 (93.4%) of AML classic types were found within the left side of kidney of patients versus 2 (6.9%) cases out of 4 (6.6%) of AML fat poor type, while 27 (93.1%) of AML classic types were found within the right side of kidney of patients. However, in regard to types and numbers of AML investigated by CT scanning, our results demonstrated that 56 (93.3%) cases out of 57 (93.4%) of AML classic types had single tumor when diagnosed by using CT imaging technique versus 4 (6.7%) out of 4 (6.6%) of AML fat poor type also had single tumor, while only 1 (100.0%) of AML classic type had multiple tumors when diagnosed by CT imaging technique.

AML, like other renal tumors, can penetrate renal veins and the inferior vena cava, and there is a case that describes an AML

reaching the right atrium of the heart.[36]
Finally, to compare between ultrasound and CT techniques in the diagnosis of AML, the following points were concluded based on our findings and previous results: The decrease in size seen in 17% of angiomyolipoma was an unexpected finding. This may be due to genuine fluctuation in tumor size or, more likely, is a reflection on the limitations of ultrasound in the measurement of very small lesions, which have a margin of error of between 1 mm and 7 mm when compared with CT.[22]
Up to date, the most common imaging methods used to diagnose AML include conventional ultrasound, computed-tomography, and magnetic resonance imaging and so on. However, both CT and MRI have disadvantages owing to their high cost, ionizing radiation and adverse reactions induced by iodine contrast agents or gadolinium contrast agents.[23] Although conventional ultrasound is inexpensive, non-ionizing, non-invasive and readily available, it is limited in trying to distinguish RCC from AML.[24]

Conclusion

It can be concluded from the current study that females of middle age were predominant among AML patients, and CT technique is more accurate and sensitive in the diagnosis of AML cases. By using CT technique, the majority of females were scored as hypoattenuating AML, and were hyperechoic by using CT technique. The results also revealed that most of AML cases were hyperechoic by CT technique, while small number of the fat-poor were hyperechoic by using the U/S technique.

Funding

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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