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Ultrasound, computed tomography and surgical observations in the evaluation and staging of the renal cell carcinoma

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Abstract

Background: The evaluation and staging of renal cell carcinoma (RCC) has dramatically changed with the introduction of cross-sectional imaging. Nowadays, small renal lesions are easily detected by computed tomography (CT) examination while missed by other modalities.

Objective: To determine whether ultrasound (US) or CT scan is the optimum imaging modality for the evaluation of the renal masses.

Patients and methods: This is a comparative study in which 30 patients with hematuria were attending the urological consulting clinic in Ghazzi Al-Harriry hospital, Baghdad, Iraq from May 2016 to July 2017 were subjected to abdominal US and CT scan.

Results: The patients included in the study were 19 females and 11 males. The results of US, unenhanced and contrast CT for characterization of the consistency of renal mass were 63.4%,56.7%, and 60% respectively for the solid, while the cystic were 23.3%,23.3%, and 26.6% and for complex was 13.3%,20% and 13.4% respectively. The size of the masses was compatible in 60% of cases. Mass surface regularity was compatible in 93.4%.

Regarding mass position, the US showed that 96.7% to be confined to the kidney and 4.3% extended outside, while 66.6% were judged to be confined by CT scan, which is nearly similar to the operative findings which revealed 60% localized masses to kidney and 40% extending outside the kidney.

Conclusion: the US is a good modality to start with in the assessment of renal lesions, but CT scan is still the main tool to diagnose and stage RCC.

Keywords: computed tomography, abdominal ultrasound, renal mass, renal cell carcinoma.

Introduction:

Renal masses, especially renal cell carcinomas (RCC) are the most common cancer affecting the kidney. Early detection before local, lymphatic and venous invasion takes place is critical for the management and subsequent survival. The early detection of the tumor especially when small is easily achieved by cross-sectional imaging namely the CT scan, which also performs preoperative staging (1, 2, 3). Ultrasound, in general, is a simple, fast, available, lacking ionizing radiation and a cost-effective technique (4). Ultrasound can easily detect renal masses and categorize them to solid, cystic, or complex (5). The use of color Doppler is an additive to the efficiency of ultrasound by characterizing the neovascularity of the lesion and assessing its waveform (6). The Drawback of ultrasound, in general, is being operator dependent and subjected to inter-observer variations (7). While detecting the renal mass, it is poor in the detection of extrarenal tissue invasion and in assessing venous extension of RCC especially to distal renal vein and infrahepatic portion of the inferior vena cava (IVC). While 100% sensitive in detecting intrahepatic or suprahepatic venous thrombosis (8), overall still inferior to CT and magnetic resonance imaging in the staging of hypernephroma (9). CT scan became the modality of choice in the assessment of renal tumors, especially when it incidentally detects RCC in patients complaining of flank pain and hematuria (10). CT examination is usually performed unenhanced (without venous contrast), then after intravenous (IV) contrast injection in the corticomedullary phase and nephrographic phase with a delay of 40 seconds and 75-85 seconds respectively. In the corticomedullary phase the contrast enters the renal capillaries and infiltrates the peritubular interstitium and then passes to the cortical tubules, so it usually used to assess renal vascularity, renal artery stenosis, aneurysm, arteriovenous malformation and tumor extension to the renal vein. The nephrographic phase is best for differentiating between renal medulla and renal mass. The excretory phase is usually used for the evaluation of transitional cell carcinoma or urothelial origin, where renal cell carcinoma is usually hypodense in comparison with renal parenchyma and shows enhancement > 20 Hounsfield (HU) to unenhanced scan, highlighted in corticomedullary phase and of less enhancement than surrounding renal tissue on nephrographic phase (11,12).

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Patients and Methods:

This is a comparative study conducted in the period between 25/5/2016 to 20/7/2017 and included thirty patients who were referred to the radiological department from the urological consulting clinic in Martyr Gazzi Al-Harriry Hospital/ Medical City Complex/ Baghdad/ Iraq for abdominal US and CT scan to evaluate them for the presenting symptom, hematuria, from whom only patients with renal masses by ultrasound were included in the study and subsequently underwent CT exam. Patient's data were recorded and included the name, age, gender and the findings of US and the CT scan of the abdomen (unenhanced and contrast) which includes the mass size, component (whether cystic or solid) and the extension of the mass outside the kidney. The US examination was performed using (PHILIPS HD 11 XE) machine with the patient supine and the abdomen exposed from the epigastric area to suprapubic area. The examination lasts for from 20 - 25 minutes during which the patient is examined in supine, then right anterior oblique (RAO) and left anterior oblique (LAO) positions for kidney assessment. These positions are used to reveal the full longitudinal and transverse axes of both kidneys. The right kidney is sometimes scanned through the liver and posteriorly in the right loin. The left kidney is visualized from the lateral approach. In difficult cases the patient lies on the side with a pillow under the left loin and asked to take a deep breath for better visualization. The variable recorded are: Mass size, outline, position, component, probable capsular invasion, renal hilar lymphadenopathy, general lymphadenopathy, renal vessels, and the state of the contralateral kidney. The CT scan of the abdomen is performed using (SIEMENS, SOMATOM AS, Erlangen, Germany). For each patient, venous access was obtained, then the patient lies supine, after that scanogram of chest, abdomen, and pelvis is obtained, then an unenhanced scans of the abdomen is undertaken. Finally, post intravenous contrast scan is performed using low osmolar contrast material (iohexol — Omnipaque) 300 mg/ ml. About 100 ml is given as bolus IV are obtained through the kidneys in order to assess pre-contrast attenuation and subsequent post-contrast enhancement patterns can be performed after 70 seconds of contrast injection. The parameters recorded include: Mass size, outline, position, component, capsular invasion, degree of enhancement, hilum lymph nodes, general lymph nodes, renal vessels invasion, and contralateral kidney assessment. Postoperatively, the operative notes and histopathological results were recorded and correlated with the corresponding ultrasound and CT findings.

Statistical analysis:

All patients' data were entered into computerized statistical software; Statistical Package for Social Sciences (SPSS) version 20 was used. Descriptive statistics were presented as numbers and percentages. Multiple contingency tables were constructed and appropriate statistical tests performed. The Fishers exact test was used for testing associations of categorical variables.

Results:

Figure (1) shows that out of the 30 patients included in the study, 19 were females (63.3%) and the 11 were males (36.7%). Figure (2) shows the age distribution of the cases, with the highest frequency being in the 41-50 years group (40%) followed by 51-60 years group (23.3%).

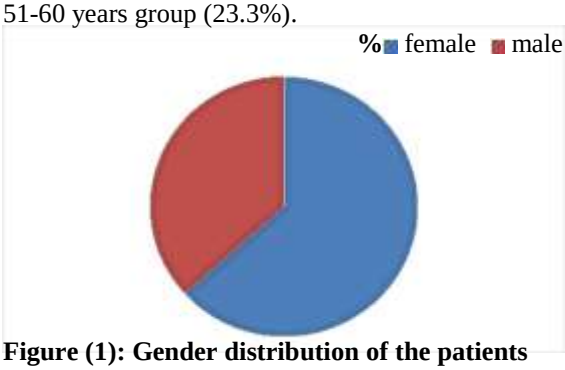

Figure (1): Gender distribution of the patients

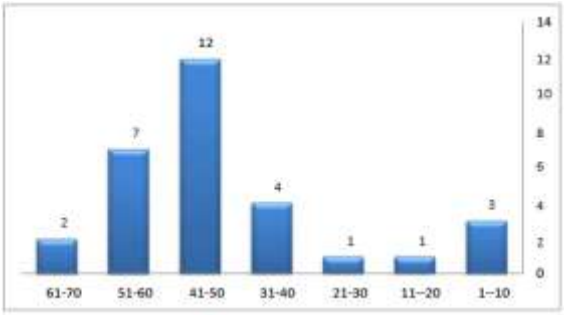

Figure (2): Age distribution of the patients

The consistency of the masses in US examination was found to be solid in 19 cases (63.3%), cystic in 7 (23.3%) and complex in 4 patients (13.3%), while the results of the unenhanced CT scan showed them to be solid in 17 cases (56.7%), cystic in 7 (23.3%) and complex in 6 cases (20%) with no significant difference of the results between US, unenhanced and contrast CT scan regarding the solid and cystic masses. However, a significant difference was found in the detection of complex masses with ($P < 0.05$) – table (1). Comparing the results of contrast CT scan with unenhanced CT scan, the former showed that the mass being solid in 18 (60%), cystic in 8 (26.6%) and complex in 4 (13.4%) – figure (3), with no significant difference regarding the cystic, and significant differences regarding the solid and complex masses ($P < 0.05$).

Table (1): Comparison of the consistency of the mass between ultrasound, unenhanced & contrast CT scan examinations

Consistency of the mass	Ultrasound		Unenhanced CT scan		Contrast CT scan	
	No	%	No.	%	No.	%
Solid	19	63.4	17	56.7	18	60
Cystic	7	23.3	7	23.3	8	26.6
Complex	4	13.3	6	20	4	13.4
Total	30	100	30	100	30	100

The results of US and CT scan examinations regarding the assessment of the size of the mass which was categorized according to AJCC TNM staging system (small < 4cm, moderate 4-7cm and large > 7cm) were compatible in 18 cases (60%) and incompatible in other 12 (40%) of patients with a significant difference P-value at 0.05 (Table 2).

Table (2): Compatibility of the results between the Ultrasound and the CT scan regarding the size of the mass.

	Compatible		Incompatible	
Size of the mass	No	%	No.	%
Small < 4cm	10	33.5	4	13.4
Medium 4-7cm	6	19.8	7	13.3
Large > 7cm	2	6.7	4	13.3
Total	18	60	12	40

Considering the description of mass margin regularity the US and the CT scan results were compatible in 28 (93.4%) cases and incompatible in 2 (6.6%) cases with no significant difference p-value >0.05, table (3)

Table (3): Compatibility of the results between the Ultrasound and the CT scan regarding the outline of the mass surface.

	Compatible		Incompatible	
Outline the mass	No	%	No.	%
Regular	19	63.4	1	3.3
Irregular	9	30.0	1	3.3
Total	28	93.4	2	6.6

The comparative results between the US and the unenhanced CT scan describing the relation of the mass to the kidney outline, the confined tumor defined as lesion limited to renal capsule which appears clear. The lesion was considered outside the kidney when in contact with nearby adrenal or results in perinephric fatty standing. The mass was localized to the kidney in 29 (96.7%) of the cases, while extrarenal extension was detected in one case (4.3%) by US. The outcome of the unenhanced CT scan decreases the limitation of the mass to kidney to 20 (66.6%) cases and increases the extrarenal invasion to 10 (33.4%). Comparing the results of the unenhanced CT scan with the results of the contrast CT scan regarding the assessment of mass position showed that the mass was restricted to the kidney in 19 (63.4%) patients, while in 11 (36.6%) patients the mass extended outside the kidney, with no significant difference with unenhanced scan (P > 0.05, Table (4).

Table (4): Comparative result between the ultrasound, unenhanced & contrast CT scan examination regarding the position of the mass.

Site of the mass	Ultrasound		Unenhanced C.T scan		Contrast C.T scan	
	No	%	No.	%	No.	%
Localized to the kidney	29	96.7	20	66.6	19	63.4
Outside the kidney	1	4.3	10	33.4	11	36.6
Total	30	100	30	100	30	100

Comparing the above results with operative findings there is no significant difference considering the localization of the mass in relation to the kidney for unenhanced and contrast-enhanced CT scan (P >0.05) while there was a significance difference for US findings (P <0.05, Table (5).

Table (5): Descriptive results according to modality imaging and operative findings regarding the position of the mass.

Type of Imaging modality and operative findings	Localized to the kidney		Extending outside the kidney		Total
	No.	%	No.	%	
Ultrasound	29	96.7	1	4.3	30
Unenhanced CT scan	20	66.6	10	33.4	30
Contrast CT scan	19	63.4	11	36.6	30
Operative findings	18	60	12	40	30

Discussion:

The revolution in US software and the introduction of multidetector CT scanners improved the detection and characterization of incidental and symptomatic patients with probable renal masses (13). In our study series, there was a female predominance over the males (63.3% vs 36.7% respectively), in contrast to the results of Mike et al which showed male predominance over females (63% vs 37% respectively). This may be explained environmental, life-style and racial differences (14). The highest number of cases in our study was between 41-50 years, whereas the results of Karakiewicz et al showed that the highest frequency was seen over 50 years (15). In this study the outcome of US and CT scan results for assessment of the mass consistency showed that no remarkable difference even with enhanced technique and likewise regarding the description of mass margin which showed a high compatibility of the results between the US and CT scan to characterize the regularity of the mass which endorses the role and efficiency of US for evaluation of these parameters in comparison with CT scan. The accuracy of US is comparable with CT scan for larger masses, but less so for smaller lesions, which is probably related to body habits of the patients and their cooperation. A recognizable difference between the results of US and CT examination is noted in the description of the extension of the mass outside the kidney, where the US showed masses to be confined to the kidney in 96.7% of patients, while the CT scan showed that 66.6% of the masses were completely within the kidney. This is supported by the operative findings, indicating that CT scan is more reliable in staging renal carcinomas. The difference between the two modalities is due to poor tissue contrast difference between the masses and the perinephric fat and the limited field of view depicted by ultrasound. In our study, the characterization of the mass size in contrast to CT size showed that 53.1% more than 4 cm and 46.8% less than 4 cm which is not highly different from the study done by Nazim et al which showed that the mean size of the tumor is 7.5cm (16). In a study done by Golberg et al, the US

results for characterization of the renal mass were solid 25.3%, cystic 61.3% and complex 13.4%, very close to the results in our study. Another study for evaluation of renal mass size done by Jamis-Dow et al shows 64% compatibility between the US and CT scan examination which is slightly higher than the results in our study (table 2), with the sample size being nearly the same in both studies. This may be explananed by the multiplanar capability of the CT scan and increasing the contrast difference between the mass and nearby renal parenchyma after iodine injection (17). The staging of the tumor is very essential in the management of the patients with renal neoplasms. In the studies of Foster et al and Zagoria et al revealed that the accuracy of sonography for tumor staging was 77% which was different from our study, while the reported results for the accuracy of CT scan for staging was 95% which is close to the results in our study (18,19). The wide difference between in the staging results for these modalities can be probably related to kind and the updated versions of the equipment used in the examination. Since the US detection rate of tumors were similar to the dynamic CT rate, it was suggested that US was as readily applicable as dynamic CT for the diagnosis of renal parenchymal tumors, while CT scan plays an exclusive role in the staging of renal tumors. Abdominal CT represents the modality of choice for staging the primary tumor and for evaluating the possibility of locoregional and abdominal visceral metastasis (20).

Conclusions:

The US plays an important role in detection and evaluation of renal masses as an initial technique and is very accurate in distinguishing cystic from solid masses. However, Contrast-enhanced CT scan remains to be the most important technique in the detection, diagnosis, and staging of renal masses.

Authors' contribution:

Dr. Khaleel Ibraheem Mohson: supervisor and literature reviewer

Dr. Saba Qais, Nawras Khairi Fadhil: data collection, study design, manuscripts writing

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تقييم وتحديد انتشار سرطان الكلية باستخدام فحص الموجات فوق الصوتية والمفراس الحلزوني ومقارنته بالملاحظات الجراحية

د. خليل ابراهيم محسن
د. هناء عبد الرضا

الخلفية:تشخصيص ورم الكلية الخبيث وانتشارة تغير بصورة ملحوضة بعد استخام الاشعة الطبقية المحورية وبهذا يتم تشخصيص الاورام الصغيرة التي ممكن ان لا تشخص بالطرق الاعتايدية.
هدف الدراسة: مقارنة امكانية السونار والمفراس الحلزوني في تشخيص اورام الكلية وانتشارها وايهما افضل
المرضى وطرق العمل: تم تقييم 30 حالة في دراسة تمت في الفترة الممتدة مابين 25 مايس 2016 الى 20 تموز 2017 لحالات تم احالتها الى مستشفى الشهيد غازي الحريري للجراحات التخصصية ممن يعانون من اعراض في المجاري البولية. بعد تسجيل المعلومات الاولية الخاصة بأسم المريض وعمره تم اجراء فحص السونار والمفراس العادي ومن ثم الملون وتسجل نتائج الفحص لكل حالة.تم استبعاد الحالات السالبة والحالات التي لا يمكن علاجها جراحياً، من ثم تمت متابعة الحالات بعد اجراء العمليات الجراحية لتثبيت المشاهدات ونتائج الاجراء الجراحي.
النتائج :تبين من نتائج الفحوصات وجود تباين وتطابق بين فحص السونار والمفراس ولوحظ وجود تطابق في فحص السونار والمفراس العادي الى حد كبير في وصف الكتل الكيسية ووجود اختلاف بينهما في وصف الكتل المعقدة، كذلك اظهرت النتائج وجود تطابق بنسبة 60% فيما يخص الحجم، كما لوحظ تباين بين فحص السونار والمفراس في تقييم امتداد الكتلة. تمت ملاحظة تحدد الكتلة بنسبة 96.6% في داخل الكلية وامتدادها بنسبة 3.4% خارجها في فحص السونار، بينما كانت نتائج المفراس 66.6% داخل الكلية و33.4% خارجها، وعند مقارنة النتائج اعلاه بنتائج العمليات المجراة للمرضى تبين وجود تطابق كبير مع فحص المفراس واختلاف ملحوظ مع فحص السونار.
الاستنتاج :ومن خلال ماذكر في اعلاه، يكون الاستنتاج بأن فحص السونار يمكن الافادة منه كفحص اولي لاكتشاف الكتل الكلوية وفرز طبيعتها الى كيسية وصلبة ويبقى فحص المفراس هو الفحص الاهم والادق في اكتشاف وتشخيص انتشار الكتل الكلوية.
مفتاح الكلمات: المفراس الحلزوني, سونار البطن, الكتل الكلوية , سرطان الكلية.