ORIGINAL RESEARCH ARTICLE

Role of Computed Tomography (Plain and Contrast) in the Evaluation of Renal Masses

NVK Sundeep[1], M Venkatesh[1], P Suneetha[1]

[1]Department of Radiodiagnosis, Narayana Medical College and Hospital, Nellore – 524 002, A.P, India

Corresponding author: Dr. Manchikanti Venkatesh, Department of Radiodiagnosis, Narayana Medical College and Hospital, Nellore – 524 002, A.P, India

DOI: 10.21276/ijcmsr.2018.3.3.9

How to cite this article: NVK Sundeep, M Venkatesh, P Suneetha. Role of computed tomography (plain and contrast) in the evaluation of renal masses. International Journal of Contemporary Medicine Surgery and Radiology. 2018;3(3):C39-C43.

A B S T R A C T

Introduction: Renal masses are most commonly encountered in the present clinical scenario or incidentally detected on CT scanning. The study was designed to understand the role of Multidetector Computed Tomography with multiplanar reconstruction in the evaluation of malignant and benign renal lesions.

Material and Methods: A Hospital based prospective study conducted over a period of two years on 40 patients with clinically suspected renal mass or patients who were diagnosed to have renal mass on ultrasound. They were evaluated with Multidetector Computed Tomography (128 slice GE OPTIMA 660).

Result: Out of 40 cases, 28 were diagnosed to be malignant (70%) and 12 cases were diagnosed benign (30%). The most common renal mass was renal cell carcinoma accounting for 60% of all the renal masses and 85% of the malignant renal masses. Overall there were male to female ratio was 1.85:1. MDCT was able to differentiate a benign from malignant lesion with Sensitivity of 100%, Specificity of 85.71%, Positive predictive value of 92.85% and Negative predictive value of 100% was achieved. The characterstics of malignant renal masss such as perinephric extension, invasion of gerotas fascia, renal vein / IVC, lymphnodal extension, extension to adjacent organs and distant metastases can be exactly identified by MDCT with various reconstructions which is very useful for staging of lesions.

Conclusion: MDCT with good reformatting technique has excellent sensitivity and specificity in the detection, charaterisation and staging of renal masses.

Keywords: Renal Cell Carcinomas, Multidetector Computed Tomography, Malignant Lesions

INTRODUCTION

The detection of malignant renal masses and their differentiation from their benign counterparts is extremely important, especially when these masses are small. Despite recent advances, most renal adenocarcinomas are relatively unresponsive to chemotherapy and radiation therapy. Surgery for higher stage lesions are associated with increased morbidity and mortality. Surgery of low stage lesions when detected and characterised early remains the only hope for long term survival or cure.

There are different studies available regarding the evaluation of renal masses, some using the conventional CT and some using the MDCT with advanced techniques. The studies using MDCT for evaluation are less as it is recently developed. Most of the studies are done in other population groups with fewer studies on Indian population. Our study is done on Indian population using MDCT. Cohan RH et al in 1995 reviewed CMP, NP, and combination images. They concluded that CT scans obtained only during the CMP of contrast enhancement fail to depict many renal masses that are easily seen on NP images[1].

A R Joshi et al (2004) in their study found that Multidetector spiral CT proved to be an excellent modality for the detection, localization and quantification of renal arterial stenosis, neovascularity and feeding vessels of renal malignancies, with the ability to view the data set in all three dimensions, as opposed to angiography this constitutes an added advantage[2]. Toprak et al in 2005 found Out of 20 patients, 13 had histopathologically proven renal cell carcinoma. They concluded Three-dimensional CT and 3D-CTA are non-invasive, effective imaging techniques for the preoperative evaluation of renal masses[3].

Ambros J. Beer et al in 2006 evaluated 28 patients with kidney lesions. Both MDCTand MRI were performed. Classification of lesions as surgical or non surgical was done. Sensitivity and specificity values of 92.3% and 96.3% for MDCT and 92.3% and 91.3% for MRI[4].

When compared to conventional axial CT MDCT has an additional advantage of rapid and continuous scanning which allows an entire sequence to be obtained during a single breath hold to reduce the motion artefacts and scan delay. It is also possible to acquire images with narrow collimation to reduce partial volume averaging. Excellent images can be acquired with multiplanar reconstruction, volume reformatting, MIP and MinIP techniques. By use of Pressure injector different

phases i,e corticomedullay, nephrographic and excretory phases can be exactly acquired with specific time delays. There is optimum load of patients to our hospital from different regions of Andhra Pradesh,with different clinical conditions. The study was done to enlighten high sensitivity and specificity of the MDCT in differentiation of malignant from benign renal masses.

MATERIAL AND METHODS

Clinically suspected patients who were diagnosed to have renal mass on ultrasonography attending Narayana Medical College and Hospital, Nellore. A prospective study was conducted over a period of two years (September 2012 to September 2014) on 40 patients with clinically suspected Renal mass or patients who were diagnosed to have renal mass on ultrasound and were referred to CT for further characterisation. Patients were evaluated with Multidetector Computed Tomography (128 slice GE OPTIMA 660). A provisional diagnosis was suggested after the CT examination and these findings were correlated with histopathology or surgical findings as applicable.

Inclusion criteria: All the patients with clinically suspected renal mass.

Exclusion criteria: Simple cysts are not included in the study. Extrarenal masses invading the renal parenchyma are excluded from the study.

CT technique

The patient was scanned using 128 slice MDCT GE OPTIMA 660 equipped with pressure injector was used in the study. Patients were kept nil orally 4 hrs prior to the CT scan to avoid complications while administrating contrast medium. Risks of contrast administration were explained to the patient and consent was obtained prior to the contrast study. The pathological lesions were evaluated with respect to pre and post contrast attenuation values, size, location of the mass, presence of calcification, presence of fat and extension into the adjoining structures.

Cases were followed up clinically, histopathologically and radiologically as indicated. The radiological diagnosis was correlated with surgical and histopathological findings.

STATISTICAL ANALYSIS

Data analysis done using ratios, averages of different diagnosis. Outcome of sensitivity, specificity, positive predictive value and negative predictive values are computed and compiled.

RESULTS

Hospital based prospective study, to find the efficiency of computed tomography (plain and contrast) in evaluation and characterisation of renal masses. In our study, the maximum percentage of patients were in the age range of 60-69 years (37.5%) followed by 50 to 59 years (22.5%). There was a male preponderance (65%) when compared to females (35%).

Age distribution of the individual pathologies

Renal cell carcinoma was diagnosed in 24 (60%) out of 40 patients. 12 (50%) out of 24 patients (60%) were in the age range of 60 – 69 years, the youngest patient with RCC was 39 y old male patient and the oldest was 71 years old male patient. The mean age was 61.5 years. Metastasis from the breast and gastrointestinal tract are diagnosed in 2 (5%) out of 40 patients. one in the range of 60-69 y and another in the range of 70-79 y. Transistional cell carcinoma was diagnosed in 1 (2.5%) out of 40 patients, was in the range of 60-69 y.

Diagnosis	True positive	False positive	False negative	True negative	Total
Renal cell carcinoma	22	2	0	16	40
Wilms tumor	1	0	0	39	40
Renal pelvic TCC	1	0	0	39	40
Metastases	2	0	0	38	40
Angiomyolipoma	2	0	0	38	40
Oncocytoma	1	0	0	39	40
Complex cyst	2	1	0	37	40
Abscess	4	0	0	36	40
Focal pyelonephritis	2	0	0	38	40

Table-1: True positive, false positive, false negative, true negative values of MDCT for renal masses

Diagnosis	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Renal cell carcinoma	100.0	88.88	91.66	100.0
Wilms tumor	100.0	100.0	100.0	100.0
Renal pelvic TCC	100.0	100.0	100.0	100.0
Metastases	100.0	100.0	100.0	100.0
Angiomyolipoma	100.0	100.0	100.0	100.0
Oncocytoma	100.0	100.0	100.0	100.0
Complex cyst	100.0	97.36	66.66	100.0
Abscess	100.0	100.0	100.0	100.0
Focal pyelonephritis	100.0	100.0	100.0	100.0

Table-2: Sensitivity, specificity, positive predictive value, negative predictive value of MDCT for renal masses

Wilms tumour was diagnosed in 1 (2.5%) out of 40 patients, was in the range of 0-9 years. Angiomyolipomas were diagnosed in 2 (5%) out of 40 patients, one in the range of 20-29 years and another in the range of 30-39 years. Oncocytoma was diagnosed in 1 (2.5%) out of 40 patients, was in the range of 60-69 years. Complex cysts were diagnosed in 3 (7.5%) out of 40 patients, equally distributed in the range of 30-39 years, 40-49 years and 70-79 years. Abscess were diagnosed in 4 (10%) out of 40 patients, equally distributed in the range of 0-9 years, 30-39 years, 40-49 years and 60-69 years. Focal pyelonephritis were diagnosed in 2 (5%) out of 40 patients, one in the range of 20-29 years and another in the range of 50-59 years.

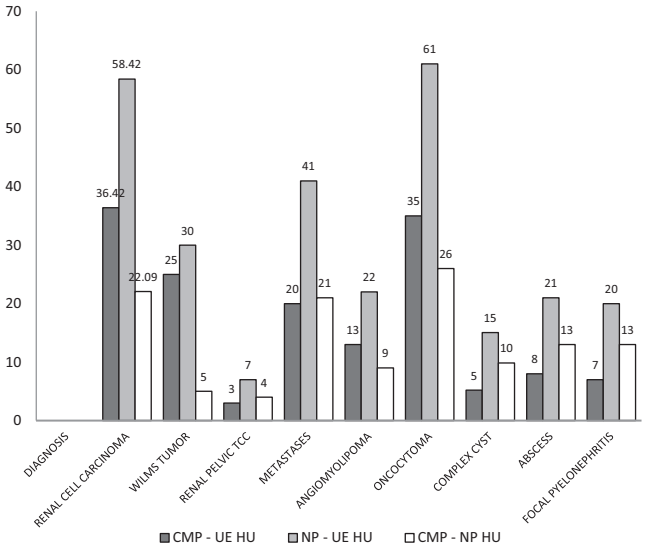

Figure-1: Attenuation and Contrast enhancement of individual Renal masses.

Renal masses distribution according to gender

Overall there were 26 (65%) males and 14 (35%) females, Male to Female ratio was 1.85:1. There was male preponderance (66.66%) in case of renal cell carcinoma when compared to females (33.4%). Male: Female ratio is 2.25:1. Abscess and focal pyelonephritis are distributed equally in males (50%) and females (50%).

CT Characterstics of renal masses

Calcification was seen in 7 (29.16%) out of 24 cases of RCC. When compared to benign renal masses malignant renal masses showed more amount of necrosis (54.16% in RCC

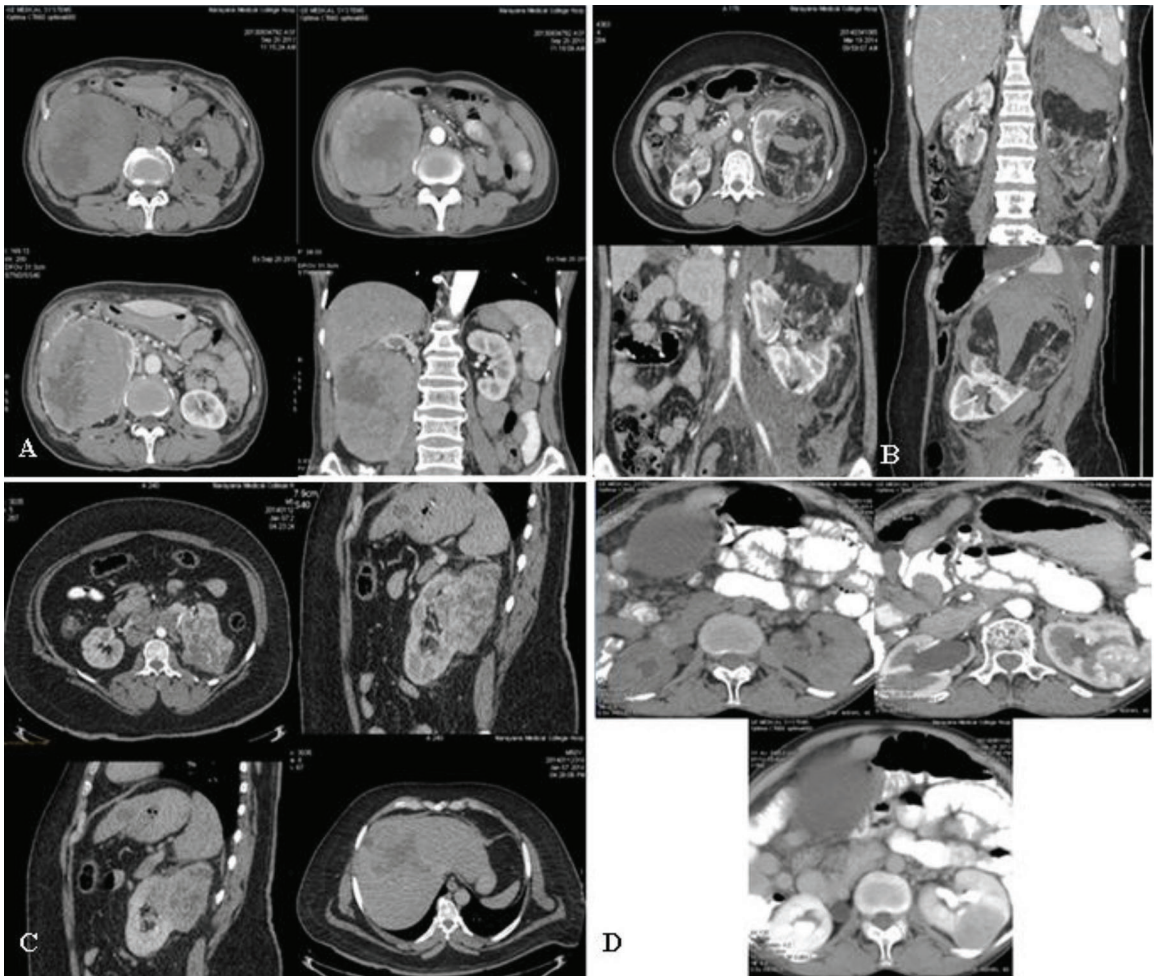

Figure-2: A. Renal Cell Carcinoma: Plain and Contrast enhanced computed tomogram (axial and coronal) No e/o Lymphadenopathy. T N M staging: T2, N0, M0- STAGE II. B. Angiomyolipoma With Hemorrhage: Contrast enhanced computed tomogram (axial and coronal). C. Metastases: Contrast enhanced computed tomography (axial and sagittal) showing the large well defined exophytic heterogeneously enhancing lesion with few non enhancing areas with in it, consistent with the necrosis. D. Oncocytoma: Plain and Contrast enhanced computed tomogram (axial).

and 100% in wilms tumour). Renal vein invasion was seen in 5 (20.8%) cases of where as none of the benign renal masses showed renal vein invasion. Inferior vena caval Iinvasion was seen in 2 (8.33%) out of 24 cases of RCC (figure-1).

Most common site of metastases from renal cell carcinoma was to Lymph nodes (37.5%), Lungs (16.66%), Liver (4.16%) and Appendicular skeleton (4.16%%). Renal transitional carcinoma was located in the renal pelvis and without associated hydronephrosis.

Of all the lesions the angiomyolipomas(100%) showed highest amount of fat content. Involvement of lymphnodes were seen in the abscess (75%) and focal pyelonephritis (50%) but without much enlargement when compared to malignant lesions. Central fibrous scar was seen in oncocytoma (100%). Hemorrhage was seen predominantly in complex cysts (66.66%) followed by angiomyolipomas (50%), RCC (8.3%) and metastasis (50%). Renal vein,adrenals,lungs and Appendicular skeleton involvement was not seen in benign masses.

TNM staging of renal cell carcinoma

Out of 24 cases of renal cell carcinoma 4 (16.6%) are of stage I, 9 (37.5%) are of stage II, 6 (25%) are of stage III, 5 (20.84%) are of stage IV. One case of TCC was of stage II. One case of wilms tumour was of stage II (table-1).

MDCT attenuation values

In our study the benign renal masses had an attenuation value of 20.25 HU on precontrast scans, whereas the malignant renal masses showed a higher attenuation value of 28.21 HU. Mean attenuation value of benign renal masses in corticomedullary phase was 30.41 HU and that of malignant masses was 61.78 HU. Mean attenuation value of benign renal masses in Nephrographic phase was 43.08 HU and that of malignant masses was 82.46 HU. Benign renal masses showed an mean increase of 7.1666 HU in the corticomedullary phase, whereas malignant renal masses showed an significant increase of 33.6538 H U.

Benign renal masses showed an mean increase of 20.8333 HU in the nephrographic phase, whereas malignant renal masses showed increase of 54.2500 HU.

In this work, there was 100% sensitivity, 85.71% specificity, 92.85% positive predictive value, and 100% negative predictive value for final diagnosis of renal mases (table-2).

DISCUSSION

In our study, out of total 40 cases studied, 26 were males and 14 were females (age range from 5 to 73 years), there were 28 (70%) malignant and 12 (30%) benign renal masses. Renal cell carcinoma (n:24) accounted for 60% of all renal masses and 85% of malignant renal masses. The other lesions include Transitional cell carcinoma (n:1), Wilm's tumour (n:01), Metastases (n:2), Angiomyolipoma (n:2), Oncocytoma (n:1), Complex cysts (n:03), Abscess (n=4) and Focal pyelonephritis (n:2).

In our study, the maximum percentage of patients were in the age range of 60 to 69 years (37.5%). Out of 40 cases, 28 were diagnosed to be malignant (70%) and 12 cases were diagnosed benign (30%). The most common renal mass was renal cell carcinoma accounting for 60% of all the renal masses and 85% of the malignant renal masses.12 out of 24 patients (50%) of renal cell carcinomas were in the age range of 60 – 69 years, the youngest patient with RCC was 39 y old male patient and the oldest was 71 years old male patient. The mean age was 61.5 y. In our study out of 24 cases of RCC 12(50%) were in the range of 60-69 years, 7 (29.16%) in the range of 50-59 years, 3 (12.5%) in the range of 40-49 years, 1 (4.17%) case each in the range of 30-39 years. and 70-79 years. Verhoest G et al[6] in their study have found that the incidence of renal cell carcinoma was 6% in < 40 years, 38.5% in 40-60 years, 52.3% in 60-80 years and 3.2% in > 80 years. Our findings were comparable to the study of Verhoest G et al where the maximum percentage of patients were seen in 60-69 years.

In our study out of 40 cases, one (2.5%) case of wilms tumor was noted was the age of 5 years old female patient. Our findings were comparable with the findings of Lonergan et al[7] who have described that the peak incidence of wilms tumor is at 3-4 years and 80% of cases are below 5 years of age.

There was male preponderance (66.66%) in case of RCC when compared to females (33.4%). Male: female ratio is 2.25:1. One case of wilms tumor (100%) was in females. One case of TCC (100%) was in males.2 cases of metastases was equally distributed in males (50%) and females (50%). One case of oncocytoma (100%) was in males. 2 out of 2 (100%) cases of angiomyolipoma were found in females. There was male preponderance (66.66%) in case of complex cyst when compared to females (33.4%). Abscess and focal pyelonephritis are distributed equally in males (50%) and females (50%). Verhoest g et al[6] described the distribution of renal cell cancer with respect to age and gender, in their study too there was predominance of male patients in renal cell carcinoma.

In our study, calcification was seen in 7 out of 24 cases of RCCv (29.16%). When compared to benign renal masses malignant renal masses showed more amount of necrosis (54.16% in RCC and 100% in wilms tumour). Renal vein invasion was seen in 5 (20.8%) cases, whereas none of the benign renal masses showed renal vein invasion. Inferior vena caval invasion was seen in 2 (8.33%) out of 24 cases of RCC. Most common site of metastases from renal cell carcinoma was to Lymph nodes (37.5%), Lungs (16.66%), Liver (4.16%) and appendicular skeleton (4.16%).Involvement of Renal vein, adrenals, lungs and appendicular skeleton was not seen in benign masses. The involvement of renal vein, inferior vena cava,adrenals,lymph nodes, liver and appendicular skeleton was seen only in malignant renal masses. Central fibrous scar was seen in oncocytoma (100%). Hemorrhage was seen predominantly in complex cysts (66.66%) followed by angiomyolipomas (50%), RCC (8.3%), metastasis (50%). Lowe and Cohen et al[8] evaluated the CT characteristics of wilms tumour and found that All cases of Wilms tumor (15/15) were clearly intrarenal. Most Wilms tumors demonstrated necrosis or hemorrhage (87%). Calcification rarely occurred in Wilms tumor. Only one case demonstrated small areas of calcification. No encasement with or without displacement was seen in Wilms tumor. Retroperitoneal lymphadenopathy or contiguous extension of the primary

tumor in the retroperitoneal space was seen in Wilms tumor (13%). In our study the observations were slightly different there was 100% necrosis and spread to adjacent lymph nodes was seen in 28% of cases.

In our study, out of 24 cases of renal cell carcinoma, 4 (16.6%) are of stage I, 9 (37.5%) are of stage II, 6 (25%) are of stage III, 5 (20.84%) are of stage IV. One case of TCC was of stage II. One case of wilms tumour was of stage II. In our study, the benign renal masses had an attenuation value of 20.25 H U on precontrast scans whereas the malignant renal masses showed a higher attenuation value of 28.21 H U. Mean attenuation value of benign renal masses in corticomedullary phase was 30.41 H U and that of malignant masses was 61.78 H U. Mean attenuation value of benign renal masses in Nephrographic phase was 43.08 H U and that of malignant masses was 82.46 H U. Malignant renal masses showed a more heterogenous type of contrast enhancement due to presence of necrosis. Benign renal masses showed an mean increase of 7.16 H U in the corticomedullary phase, whereas malignant renal masses showed an significant increase of 33.65 H U. Malignant renal masses showed a larger difference between nephrographic phase and unenhanced scan with a mean HU value of 54.25 HU whereas benign renal masses showed a difference of 20.83 HU. Using the region of interest technique for differentiating benign from malignant renal masses on pre and post contrast images Sensitivity: 100% Specificity: 85.71%, PPV: 92.85%, NPV: 100% was achieved. In our study, all the malignant renal masses (n: 28) showed soft tissue attenuation on the precontrast scans and showed mean attenuation value of 61.78 ± 11.20 in the corticomedullary phase and 82.46 ± 15.30 in the nephrographic phase, whereas the benign lesions (n : 12) showed a mean attenuation of 30.41 ± 12.35 in in corticomedullary phase and 43.08 ± 16.45 in nephrographic phases. In our study all the renal cell carcinomas displayed soft tissue attenuation on precontrast scan and HU of 65.45 $\pm$ 4.80 and 87.54 $\pm$ 6.05 on corticomedullary phase and nephrographic phase respectively. In the study by Jinzaki et al 37 patients were scanned by MDCT, they have demonstrated that RCC being very vascular tumor shows significant enhancement (>20 HU). Attenuation in corticomedullary phase was 165 ± 45 and in nephrographic phase was 85.5 ±13.4. The higher attenuation value in the CMP of jinzaki et al study is due to faster injection rate of higher contrast volume(120 ml at 3- 5 ml/s) where as we used 80ml with manual injection method [9].

CONCLUSION

MDCT with good reformatting techniques has excellent sensitivity and specificity in the detection, characterisation and staging of renal masses.

REFERENCES

1. Cohan RH, Sherman LS, Korobkin M, Bass JC, Francis IR. Renal masses: assessment of corticomedullary-phase and nephrographic-phase CT scans. Radiology. 1995;196(2):445-51.
2. Joshi AR, Nalavde S, Merchant S, Gujare S. Renal vasculature evaluation using a multidetector CT scanner: A brief study of 20 cases. Indian Journal of Radiology and Imaging. 2004;14(4):373.
3. Toprak U, Erdogan A, Gülbay M, Karademir MA, Pasaoglu E, Akar ÖE. Preoperative evaluation of renal anatomy and renal masses with helical CT, 3D-CT and 3D-CT angiography. Diagnostic and Interventional Radiology. 2005;11(1):35.
4. Beer AJ, Dobritz M, Zantl N, Weirich G, Stollfuss J, Rummeny EJ. Comparison of 16-MDCT and MRI for characterization of kidney lesions. American Journal of Roentgenology. 2006;186(6):1639-50.
5. Bajwa RP, Sandhu P, Aulakh BS, Sandhu JS, Saggar K, Ahluwalia A. Helical CT Evaluation of Renal Mass Lesions: A Prospective Study. Journal, Indian Academy of Clinical Medicine. 2007;8(3):263.
6. Verhoest G, Veillard D, Guillé F, De La Taille A, Salomon L, Abbou CC, Valéri A, Lechevallier E, Descotes JL, Lang H, Jacqmin D. Relationship between age at diagnosis and clinicopathologic features of renal cell carcinoma. European Urology. 2007;51(5):1298-305.
7. Pickhardt PJ, Lonergan GJ, Davis Jr CJ, Kashitani N, Wagner BJ. From the Archives of the AFIP: Infiltrative Renal Lesions: Radiologic-Pathologic Correlation. Radiographics. 2000;20(1):215-43.
8. Lowe RE, Cohen MD. Computed tomographic evaluation of Wilms tumor and neuroblastoma. Radiographics. 1984;4(6):915-28.
9. Jinzaki M, Tanimoto A, Mukai M, Ikeda E, Kobayashi S, Yuasa Y, Narimatsu Y, Murai M. Double-phase helical CT of small renal parenchymal neoplasms: correlation with pathologic findings and tumor angiogenesis. Journal of computer assisted tomography. 2000;24(6):835-42.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 01-07-2018; **Accepted:** 02-08-2018; **Published online**: 13-08-2018