eISSN 2255-0569

ORIGINAL

Evaluation of the correlation between computed tomography and anatomopathological findings in adult renal tumors

Evaluación de la correlación entre la tomografía computarizada y los hallazgos anatomopatológicos en los tumores renales del adulto

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Received: 4 - XI - 2022
Accepted: 9 - XII - 2022

doi: 10.3306/AJHS.2023.38.02.125

Abstract

Purpose: To evaluate the correlation between CT-scan findings in the diagnosis and extension workup of renal tumors to anatomical-pathology findings.
Patients and method: This is a retro-spective, analytical, comparative and single center study over a period of 10 years, including all patients who had an extended total nephrectomy or partial nephrectomy indicated for a renal tumor with preoperative CT-scan and histopathological findings of the operative specimen. The parameters studied were: age, sex and CT-scan results and the results of the anatomical-pathology examination. Data analysis was done using the software SPSS. The threshold of significance was set at a P value of 0.05. Sensitivity, specificity, PPV, NPV for the variables studied were determined from the results of the CT-scan data and histopathological examination.
Results: Forty-three patients were included with a sex-ratio of 0.8. The mean age was 43±16.9 years. In the 40 solid tumors and 3 cystic tumors suspected on CT-scan, histology had confirmed 40 malignant, 2 benign and 1 interstitial nephritis. CT-scan had a sensitivity of 100% and a PPV of 95.4%. CT-scan significantly overestimated tumor size for sizes less than 4 cm (p=0.01). For sizes between 4 and 10 cm, the size overestimation was not significant (p=0.13 and p=0.28). For sizes greater or equal than 10 cm, CT-scan underestimated size non-significantly (p=0.2). CT-scan had a high sensitivity to determine a solid or solid-cystic tumor mass but for cystic tumors it was not very sensitive but very specific. Comparing cTNM and pTNM classification, CT-scan had a specificity >90% to determine tumor size and extension except for tumors classified as T1 and T4.
Conclusion: Our results show a high sensitivity and specificity of CT-scan in the diagnosis and extension of renal tumors.

Key words: tumors, kidney, computed tomography, histology, cancer.

Resumen

Objetivo: Evaluar la correlación entre los hallazgos de la TC en el diagnóstico y la extensión de los tumores renales con los hallazgos anatomopatológicos.
Pacientes y método: Se trata de un estudio retrospectivo, analítico, comparativo y unicéntrico durante un periodo de 10 años, que incluye a todos los pacientes a los que se les realizó una nefrectomía total ampliada o una nefrectomía parcial indicada por un tumor renal con los hallazgos preoperatorios de la TC y los histopatológicos de la muestra operatoria. Los parámetros estudiados fueron: la edad, el sexo y los resultados de la TC y del examen anatomopatológico. El análisis de los datos se realizó con el programa informático SPSS. El umbral de significación se fijó en un valor P de 0,05. La sensibilidad, la especificidad, el VPP y el VPN de las variables estudiadas se determinaron a partir de los resultados de la TC y del examen histopatológico.
Resultados: Se incluyeron 43 pacientes con una proporción de sexo de 0,8. La edad media era de 43±16,9 años. En los 40 tumores sóli-dos y 3 quísticos que se sospechaban en la TC, la histología había confirmado 40 malignos, 2 benignos y 1 nefritis intersticial. La TC tuvo una sensibilidad del 100% y un VPP del 95,4%. La TC sobrestimó significativamente el tamaño del tumor para los tamaños inferiores a 4 cm (p=0,01). Para tamaños entre 4 y 10 cm, la sobreestimación del tamaño no fue significativa (p=0,13 y p=0,28). Para tamaños mayores o iguales a 10 cm, el CT-scan subestimó el tamaño de forma no significativa (p=0,2). El CT-scan tuvo una alta sensibilidad para determinar una ma-sa tumoral sólida o sólida-quística pero para los tumores quísticos fue poco sensible pero muy específico. Comparando la clasificación cTNM y pTNM, el CT-scan tuvo una especificidad >90% para determinar el tamaño y la extensión del tumor, excepto para los tumores clasificados como T1 y T4.
Conclusión: Nuestros resultados muestran una alta sensibilidad y especificidad del CT-scan en el diagnóstico y la extensión de los tumores renales.

Palabras clave: tumores, riñón, tomografía computarizada, histología, cáncer.

Introduction

A renal tumor is a benign or malignant (primary or secondary) tissue neoformation that develops at the expense of the renal parenchyma. Its incidence varies geographically. It is higher in Europe, North America and Australia and lower in China, India, Japan and Africa[1]. Tossou H et al. estimated their frequency in Dakar in 1971 at 1.1% of all urogenital cancers[2]. Currently, with the major contribution of CT-scan in the diagnosis and management of these tumors, the question that must be asked is to what extent this examination can be relied upon in the diagnosis and extension of kidney cancer, thus avoiding excessive surgical procedures such as radical nephrectomy in the case of benign tumors. The aim of this study was to evaluate the correlation between CT-scan findings in the diagnosis and extension workup of renal tumors and anatomical-pathology findings in our center.

Patients and method

This is a retrospective, analytical, comparative, single-center study from August 1, 2009 to July 31, 2019. This study focused on kidney tumor patients who had a radical nephrectomy or partial nephrectomy (PN) with complete preoperative CT-scan and anatomical-pathology findings in our center. Patients with incomplete records, non-operated patients, and patients without anatomical-pathology findings on the surgical specimen or preoperative CT-scan were not included. The parameters studied were: age, sex, CT-scan result and anatomical-pathology findings. The processing and analysis of the collected data were performed with the software SPSS. Figures were made with Microsoft Office-Excel 2007 software (Microscoft, Redmond, WA, USA). The statistical test used for the comparison of proportions was the chi-square test (Chi2). The Student's t-test was used for the comparison of means. The significance level was set at 0.05 (p=0.05). Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) for the variables studied were determined from the results of the CT-scan data and the histopathological study.

Results

Forty-three patients were included during the study period. The mean age was 43.3 ± 16.9 with extremes ranging from 18 to 81 years. The sex-ratio was 0.8. In the 43 sus-pected renal tumors on CT-scan, histology had confirmed 40 solids including 39 ma-lignant tumors and one benign tumor, 2 cystic tumors including one benign and one malignant tumor, and one interstitial nephritis. For detection of renal tumor, CT-scan had a sensitivity of 100% and a PPV of 95.4%. CT-scan significantly overestimated tumor size compared to histology for sizes less than 4 cm (p=0.01) (**Table I**). For sizes between 4 and 10cm, the size overestimation was non-significant (p=0.13 and p=0.28) and for sizes greater or equal than 10cm CT-scan underestimated size non-significantly (p=0.2) (**Table I**).

Table I: Comparison of tumor size means.

Slices of sizes	Size averages on CT-scan	Mean sizes on histology	Difference in averages	Value of P (<0,05)
Less than 4 cm	1.3	0	1.3	0.01
4 - 7 cm	5.6	5.4	0.2	0.13
7 - 10 cm	8.3	8.2	0.1	0.28
10 cm and more	15.4	15.8	-0.4	0.2

Table II: Sensitivity, specificity, PPV, NPV of CT-scan in relation to the histological nature of the mass.

	Solid	Solid-cystic	Cystic
Sensitivity	83.3%	100%	33.3%
Specificity	78.2%	78.8%	95.4%
PPV	83.3%	70.8%	33.3%
NPV	78.2%	100%	94.5%

Table III: Comparison of cTNM and pTNM classification.

T.N.M	Stage	CT- Scan	Histology	Sensitivity	Specificity	PPV	NPV
Tumor	T1	6	5	62.5%	97%	83.3%	91.9%
	T2	22	22	88%	100%	100%	86%
	T3	13	10	91%	90.6%	76.9%	97%
	T4	2	3	38%	100%	100%	87.8%
Nodes	Nx	16	34	100%	57%	47.1%	100%
	N0	14	2	56%	100%	100%	70.3%
	N1	4	2	80%	100%	100%	97.3%
	N2	6	2	67%	100%	100%	91.9%
Metastases	Mx	16	34	100%	57.1%	47.1%	100%
	M0	20	5	58.8%	100%	100%	58.8%
	M1	4	1	66.7%	100%	100%	94.7%

CT-scan is sensitive in determining the nature of the tumor mass if it was solid or solid-cystic. However, for cystic tumors it was not sensitive but was very specific (**Table II**).

On CT-scan, the Gerota fascia was invaded in 2 patients, but the histological results showed invasion in 3 patients. The CT-scan had a sensitivity of 100% to search for the involvement of the Gerota fascia with a PPV of 75%. CT-scan and histology showed that the adrenal gland was involved in one patient only. Comparing cTNM and pTNM classification, for tumor size, we noted that CT-scan had a specificity > 90%. On the other hand, for tumors classified as T1 and T4, CT-scan showed a low sensitivity with respective rates of 62.5% and 38%.

For the search for lymph node involvement and metastases, CT-scan had a specificity of 100% and a sensitivity greater than 50% (**Table III**).

Discussion

CT-scan examination remains the reference examination for the detection of a renal mass with a sensitivity greater than or equal to 94% and a specificity greater than 98%[3,4]. In our series, of the 43 cases of tumors suspected on CT-scan, 40 malignant tumors were confirmed on histology. The PPV was 95.4% and the sensitivity was 100%. It seems clear that none of the currently available imaging modalities can accurately predict the histology of a renal tumor. However, some lesions have suggestive morphological features on CT-scan that could point to a diagnosis and therefore guide the choice of therapy[5]. CT-scan is currently considered the gold-standard for accurate assessment of renal cancer, although it may appear as iso-, hyper- or hypodense on a non-contrast enhanced CT-scan, it shows significant enhancement after injection of approximately 115±48 HU in the cortico-medullary phase, and 62±25 HU in the excretory phase[6]. An enhancement level greater than or equal to 84 HU in the arterial phase characterizes clear cell carcinoma with a specificity of 100% and a sensitivity of 76%[7]. Some very characteristic but inconstant elements may also be associated: the presence of intra-tumoral calcifications and the invasion of the renal vein and the inferior vena cava. Sheir et al. had published a series where they tried to determine the histological type of renal tumors based on multi-barrier CT-scan data by comparing the data of the 3 most frequent histological types: clear cell carcinoma, papillary carcinoma, and chromophobe carcinoma[8]. He found that the degree of enhancement was significantly different between the 3 types in the cortico-medullary phase and the excretory phase (p=0.001), with higher enhancement noted in 48.6% of clear cell carcinomas, compared to 15.4% in papillary carcinoma and 4.2% in chromophobe carcinoma (p=0.001). The chromophobe subtype showed homogeneous enhancement in 75% of cases compared to 45% and 65% of clear cell and papillary subtypes (p=0.05) respectively. Calcifications were obvious in 21.6%, 23.1% and 25% of clear cells, papillary and chromophobe subtypes respectively (p=0.05). Zhang et al[9], noted that some tumor features revealed by CT-scan could point to the histological type, thus the presence of intra-tumor hemorrhage or necrosis pointed more to chromophobe carcinoma (p<0.05). The absence of cystic degeneration increased the probability of finding papillary or chromophobe carcinoma (p<0.05). In our series, clear cell carcinoma was the most frequent histological type followed by papillary carcinoma and chromophobe, which roughly agrees with the WHO results published by the EAU Guidelines in 2012[10]. Considering the great interest of tumor size measurement in the classification of kidney cancer as well as in the therapeutic choice, it is important to determine how accurate the radiological measurements were compared to the measurements found on histopathological examination. In our series, we tried to evaluate the predictive ability of CT-scan to estimate tumor size in relation to histopathologic features. The mean size of discovery of renal cancer in our series was slightly higher than the results found by Cheville et al[11]. Schlomer et al[12] published a study of 133 cases of renal cancer and found no significant difference between tumor size on CT-scan and on the resection specimen. CT-scan detects one out of two lesions among renal masses less or equal than 5mm, and 75% of masses less than 15 mm, the best results are obtained on spiral CT-scan by combining acquisitions obtained after contrast injection to the arterial and excretory phase[13]. By subdividing the tumor size into ranges, while using the TNM classification, we noticed that CT-scan tended to significantly underestimate the tumor size especially when histology did not find any tumor smaller than 4 cm. The smallest tumor found on histology was 4 cm in size, whereas on CT-scan it was 2.6 cm in size. Muscat JE et al[14] found similar results to ours where CT-scan underestimated tumor size by 1.7 to 4.4 mm for tumors smaller than 4 cm. For tumors smaller than 4 cm in our series, CT-scan significantly overestimated tumor size as well as for size between 7 cm and 10 cm. For a size of more than 10 cm, CT-scan underestimated the measurements. In addition, in their study, Muscat JE et al[14] compared the perfor-mance of the 3 most commonly used radiological modalities in kidney cancer imaging: ultrasound, CT-scan and MRI; he found that all 3 modalities were excellent in determining tumor size although CT-scan slightly and significantly underestimated tumor size for sizes smaller than 4 cm. Ultrasound and MRI also overestimated tumor size but not significantly. The correlations between tumor size on imaging and histopathological examination were similar between the three techniques with a slight advantage found for MRI[15]. In the study by Choi et al[16], the sensitivity of CT-scan for estab-lishing tumor size was 94% while the specificity was 41%. In the Hallscheidt work[17], the sensitivity of CT-scan was 88% while the specificity was 77%. Comparing these results with our own, we note that CT-scan is reliable for tumors of size 4 cm and larger. A significant dependency between tumor size and nuclear grade was demonstrated. Larger tumors often had a high nuclear grade and were potentially more aggressive[18,19]. A

renal mass is said to be cystic if it has a predominantly fluid component[20]. The diagnosis of a cystic tumor is often difficult and relies primarily on the demonstration of a solid component (wall, septum, vegetation or mural nodule) vascularized (significant enhancement after contrast) which should classify the lesion in one of the two suspicious categories (types III and IV) of the Morton Bosniak classification[20]. Category IV lesions represent the typical form of cystic CRC with a specificity of 100%[3-20]. This is in agreement with our results, which showed that for tumors of cystic nature, CT-scan was not sensitive but was very specific. The reference for the characterization of a solid renal mass is CT-scan[20], which is confirmed by our results which showed that CT-scan had a sensitivity >80% to determine the nature of the tumor mass in solid or solidcystic tumors. The renal pelvis and Gerota fascia are perfectly individualized on CT-scan. In the normal state, the perirenal fat is the site of linear elements due to the presence of vessels or fibrous elements (infectious or inflammatory history, fat necrosis phenomena). It is therefore often difficult to affirm that there is a real diffusion of tumor to the renal cavity, all the more so as the tumor may be responsible for perirenal hemorrhagic phenomena which further disturb the reading of the CT-scan. The most reliable sign is the presence of a tissue nodule of at least one centimeter in diameter, satellite of the tumor but located in the perirenal fat. This sign is valuable to differentiate a T2 or I stage from a T3a or II stage because it is very specific (98%). Unfortunately, its sensitivity is low (46%). Involvement of Gerota's fascia is strongly suspected when it presents a focal thickening opposite the tumor. This is difficult to analyze in the posteromedial regions in contact with the psoas muscles and anteriorly where the renal pelvis is very thin[10]. However, in our series, CT-scan has a sensitivity of 100% in the search for involvement of the Gerota fascia and a PPV of 75%. It is done by contiguity for tumors of the upper pole or by hematogenous route. Enlargement, displacement or even non-visualization of the adrenal gland has been associated with malignant extension in 24% of cases after histological study, conversely a normal adrenal gland on imaging is also normal on histology[21]. According to the literature, extension to the homo-lateral adrenal gland is in the range of 1.8-8.5% of patients with renal cancer[22]. Therefore, many clinical studies have been conducted to evaluate the accuracy of imaging modalities in diagnosing adrenal involvement to reduce the need for unnecessary adrenalectomy. Autorino et al[23] performed a study on 192 patients to evaluate the need for adrenalectomy in these cases. He found that CT-scan had a specificity of 92.9% and an NPV of 99.4%. These data show that a normal adrenal appearance on CT-scan correlates well with histopathologic findings. This is consistent with our results where CT-scan and histology showed that the adrenal gland was affected in just one patient. The study of tumor extension was based on tumor size, tumor boundaries, venous involvement in relation to the diaphragm, involvement of the Gerota Fascia and homo-lateral adrenal gland. The lack of visualization of the normal renal capsule on CT-scan explains the possibility of false negatives in case of early or microscopic capsular invasion. Thus, the sensitivity of CT-scan is low (44%), and not very compatible with a reliable preoperative diagnosis to differentiate a T1-T2 from a T3 [24]. Based on these data, the best classification for tumor extension is that of histopathological examination. In our series for tumor extension CT-scan had a specificity >90%. The same result was found in the study of Johnson et al[25] where the specificity was between 91% and 100%. Lymph node involvement is suspected on the basis of lymph node size criteria. However, with this criterion, there are 5-43% of false-positives[26]. The false-negative rate is low (4-5%), which tends to prove that the vast majority of invaded lymph nodes show an increase in size. Catalona et al[27] showed in their study on the place of multibarette CT-scan in the preoperative evaluation of cancer that all patients who had synchronous lymphadenopathy at the time of nephrectomy had it previously on CT-scan; the false positive rate due to reactive hyperplasia was 6.3%. In the study by Johnson et al[25], CT-scan had an ac-curacy of 83-88% for detecting lymph nodes at least 10 mm in diameter. Histo-pathological assessment of regional lymph nodes (pN) implies appropriate lymph node excision to affirm the absence of regional lymph node metastasis (pNo) and sufficient to assess the pN category[28]. In our series the specificity of CT-scan had a sen-sitivity between 56% and 100% and a specificity of 100% with a PPV of 100% and an NPV >70%. In the literature, the reliability of CT-scan in the differentiation of N0, N1 and N2 stages in kidney cancer is only 83-89%. It has recently been shown that lymph node dissection is unnecessary when there is no suspicion of lymph node involvement on CT-scan[29]. Thorco-abdomino-pelvic CT-scan is the gold standard examination for the search for metastases. It allows not only the study of the kidneys, but also a hepatic, complete abdominal and thoracic exploration. A cerebral CT-scan to search for a secondary location is performed in case of clinical signs. The analysis of all these radiological elements allows in the final phase to classify the tumor according to its distant extension. Histopathological assessment of distant metastases is only possible in case of sampling of suspicious lesions, otherwise it is limited to the perirenal fat, the fascia of Gerota and the adrenal gland if it is sampled.

Conclusion

These results show a high sensitivity and specificity of CT-scan in the diagnosis and extension assessment of renal tumors. The two complementary examinations, CT-scan and histology, should be combined for a better management of patients with renal tumors.

Conflict of Interest

The authors declare that no competing interests exist.

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