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Effectiveness of Computed Tomography Density Value in the Differential Diagnosis of Benign and Malignant Renal Lesions

Böbrek Kitlelerinin Benign-Malign Ayırıcı Tanısında Bilgisayarlı Tomografi Dansite Değerlerinin Etkinliği

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ÖZ

Amaç: Benign ve malign böbrek kitlelerinin ayrımında kontrastlı ve kontrastsız Bilgisayarlı Tomografi imajlar üzerinde lezyonlardan ölçülen ortalama Hounsfield Unit (HU) değerinin rolünü araştırmayı amaçladık.

Araçlar ve Yöntem: Bu retrospektif çalışmada böbrekte kitle nedeniyle biyopsi yapılan hastaların histopatolojik sonuçları, demografik özellikleri ve Bilgisayarlı Tomografi incelemeleri hastane veritabanından tarandı. Hastaların patoloji sonuçları benign ve malign olarak gruplara ayrıldı. Kontrastlı ve kontrastsız bilgisayarlı tomografi imajlarda lezyonlardan ortalama dansiteler HU olarak ölçüldü. Benign ve malign gruplar arasında ölçülen HU değerleri açısından student t testi ile karşılaştırmalar yapıldı.

Bulgular: Kontrastlı BT'si olan ve histopatoloji sonucu malign çıkan hastaların (17 erkek,11 kadın hasta) ölçülen HU değerlerinin ortalaması 83.7± 39.4 benign çıkanların (5 erkek,4 kadın) ortalaması ise 81.0± 52.9 olup iki grup arasında anlamlı farklılık saptanmadı (p:0.8704). Kontrastsız BT'si olup histopatoloji sonucu malign çıkan hastaların (12 erkek,9 kadın hasta) ölçülen HU değerlerinin ortalaması 29.3± 8.1, benign çıkanların (1 erkek, 4 kadın) ortalaması ise 9.4± 42.0 olup benign grupta HU değeri anlamlı olarak düşük bulundu. (p:0.0426).

Sonuç: Kontrastlı BT imajlarında (70. Saniye) renal kitlelerden ölçülen ortalama HU değerlerinin çalışmamızda malign-benign kitle ayrımına katkı sağlamadığı saptanmıştır ancak kontrastsız imajlarda ölçülen değerler bu ayrım için faydalı olabilir.

Anahtar Kelimeler: bilgisayarlı tomografi; dansite görüntüleme; hounsfield ünite; renal lezyon

ABSTRACT

Purpose: We aimed to investigate the role of mean Hounsfield Unit(HU) values measured on enhanced or unenhanced Computed Tomography(CT) images for the differentiation of benign and malignant kidney lesions.

Materials and Methods: In this retrospective study, CT images, demographic features, and histopathological results of the patients with renal lesions were reviewed from the hospital database. The pathological results were classified as benign and malignant. Mean attenuation values of the lesions were measured as HU on enhanced or un-enhanced CT images. The mean HU values of benign and malignant lesions were compared by using the student's t-test.

Results: The mean HU value of lesions who have enhanced CT scan with malignant histopathological results (17 males, 11 females) was 83.7±39.4, with benign histopathological results (5 males, 4 females) was 81.0±52.9. There was no statistically significant difference between malignant and benign lesions regarding the HU values on enhanced (70. Second delay) CT images (p:0.8704). The mean HU value of lesions which has unenhanced CT scan with malignant histopathological results (12 males, 9 females) was 29.3±8.1 with benign histopathological results (1 male, 4 females) was 9.4±42.0. The mean HU value of malignant lesions was higher than those of benign lesions on unenhanced images, and this difference was statistically significant (p:0.0426).

Conclusion: The mean HU values of kidney masses on unenhanced CT images were found to be useful for the differentiation of benign and malignant lesions but values on enhanced (70 second delay) images in our study did not achieve such discrimination.

Key Words: computed tomography; hounsfield unit; density; imaging; renal lesion

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INTRODUCTION

Renal cell carcinoma (RCC), urothelial carcinoma, lymphoma, and metastasis are the most common malignant kidney masses while benign lesions include angiomyolipoma, oncocytoma, and inflammatory pseudotumors/pseudolesions [1]. Some subtypes of malignant renal tumors may have overlapping imaging findings with benign masses, such as angiomyolipoma and oncocytoma, leading to difficulties for the radiological differentiation of these lesions.[2] It is reported that 16.1% of the patients who underwent a partial nephrectomy due to a suspicious malignant kidney lesion had benign histopathological diagnosis.[3]

Hounsfield units (HU) are the numbers that are obtained from a linear transformation of the measured attenuation coefficients to calculate the density of a lesion on Computed Tomography scans.[4]

Although most of the solid kidney lesions are benign[5], some lesions may clinically or radiologically be interpreted as malignant. To prevent unnecessary surgical interventions, radiological findings of these lesions should be carefully considered. In this study, we aimed to evaluate the effectiveness of CT densitometry for the differential diagnosis of benign and malignant lesions by measuring HU values.

MATERIALS and METHODS

Patients

The study was approved by Yüzüncü Yıl University ethics committee at the date of 17.01.2019 with an approval number of 2019/2. Medical data of the patients with an enhanced or unenhanced abdomen CT examination (within 2 weeks before biopsy) who underwent a surgical or percutaneous tru-cut biopsy and histopathological examination for a renal lesion between 2017 and 2019 years were recruited from hospital records. The patients with renal failure, bleeding diathesis, polycystic renal disease, phakomatosis, granulomatous disease of urogenital system, a history of current abdominal trauma or urinary tract infection were excluded from the study.

Computed Tomography Imaging

A multislice CT device with 16 detectors (Somatom Emotion 16-Slice; CT 2012 Siemens AG Berlin and Munchen-Germany) was used to obtain images, and all the patients were scanned in a supine position. The scan parameters included 120 kvp and 200 MAS with a slice thickness of 3 mm. For the enhanced examinations, 100-120 cc (1.5 cc/kg) intravenous iohexol (Omnipaque 300, Nycomed Amersham, Princeton, NJ) was injected preferably into a cubital vein with a rate of 3 cc/second, and the images were obtained after a 70-second scan delay.

All the images were transferred to The Picture Archiving and Communication System (PACS) workstation (Syngovia Siemens Medical System, Siemens/Germany) and interpreted by two radiologists who have 10 and 12 years of experience in abdominal radiology .

Measurement of HU values

The axial images in which the lesions have the biggest sizes were chosen for the measurement of HU values. Manually drawn circular Region of interest (ROI) measurements were obtained from all four quadrants (anteromedial/anterolateral/posteromedial/posterolateral) for each lesion on enhanced or unenhanced CT images. An average of these four measurements was calculated and presented as a mean HU value (Figures 1-3).

Figure 1. Mean Hounsfield units density measurement (four quadrants) of a lesion (angiomyolipoma) of right kidney on unenhanced image.

Figure 2. Mean Hounsfield units density measurement (four quadrants) of a lesion (Renal Cell Carcinoma) of left kidney on unenhanced image.

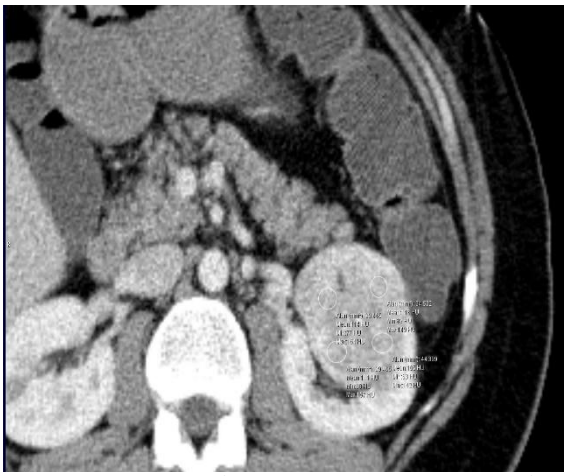

Figure 3. Mean Hounsfield units density measurement (four quadrants) of a lesion (Oncocytoma) of left kidney on enhanced image.

Statistical Analysis

SPSS Windows version 21.0 package software (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Continuous variables were expressed as mean±standard deviation. Statistical significance between groups was examined by student's t-test, and $p < 0.05$ was considered statistically significant.

RESULTS

A total of 83 patients were detected in hospital records. Of the patients, 8 with renal failure, 2 with bleeding diathesis, 2 with polycystic renal disease, one with phakomatosis, one with granulomatous disease of urogenital system, 2 with a history of current abdominal trauma and 4 with urinary tract infection were excluded from the study. Finally, a total of 63 patients with histopathologically identified kidney lesions who had an enhanced or unenhanced CT examination were included in the study. Male/ female ratio was 1.25 (35/28). Percutaneous ultrasonography-guided core needle biopsy and surgical excisional biopsy were performed in 12 and 51 patients, respectively. A total of 49 malignant (44 renal cell carcinoma, 5 metastases) and 14 benign lesions (7 oncocytoma,5 angiomyolipoma, 1 metanephric adenoma, and 1 sequela of chronic pyelonephritis) were detected. Malignant/ benign ratio was 3.5.

Table 1. The histopathological results of the patients with enhanced CT examination.

Malignant Histopathological Results (n:28)	Benign Histopathological Results (n:9)
-RCC(n:25)	-Oncocytoma (n:5)
- Metastasis (n:3)	-Angiomyolipoma (n:3)
- Lung cancer metastasis (n:2)	-Metanephric Adenoma (n:1)
-Salivary gland metastasis (n:1)	

RCC: Renal cell carcinoma

Among 37 patients who had an enhanced CT examination, 22 were male and 15 were female. 28 patients had a malignant histopathological diagnosis (17 male, 11 female) (mean age 59.5± 14.8 years), while 9 patients (5 male, 4 female) (mean age 56.4± 19.3 years) had benign histopathology. The mean attenuation of the malignant lesions was 83.7± 39.4 HU while the benign lesions showed 81.0± 52.9 HU in contrast-enhanced images (70-second delay). The difference in mean attenuation values between malignant and benign lesions was not statistically significant (p:0.8704)

Among 26 patients who had an unenhanced CT examination (see Table 2), 13 were male and 13 were female. A malignant histopathology was identified in 21 patients (12 male, 9 female) (mean age 59.6±14.0 years), while 5 (1 male, 4 female) (mean age 49.0± 19.3 years) showed benign histopathology. In unenhanced images, the mean attenuations of the malignant and benign lesions were 29.3± 8.1 and 9.4± 42.0 HU, respectively. The mean attenuation value of malignant lesions was higher than those of benign lesions, and this difference was statistically significant (p:0.0426).

Table 2. The histopathological results of the patients with unenhanced CT examination.

Malignant Histopathological Results (n:21)	Benign Histopathological Results (n:5)
- Renal cell carcinoma (n:19)	-Oncocytoma (n:2)
-Metastasis (n:2)	-Angiomyolipoma(n:2)
-Lung cancer metastasis (n:2)	-Sequele of chronic pyelonephritis (n:1)

DISCUSSION

The kidney is one of the frequently involved organs in various malignant and benign conditions. Accurate differentiation of these processes is very important for making an early diagnosis, starting treatment, and also preventing unnecessary interventions.

Malignant renal tumors include renal cell carcinoma (RCC) (90%), collecting duct-medullary carcinomas (<1%) and the others (e.g. metanephric, nephroblastic and mesenchymal tumors) (10%).[6] Oncocytoma, minimal fatcontaining angiomyolipoma, transitional cell carcinoma, lymphoma, metastasis, infection and infarction should be considered for the differential diagnosis of renal cell carcinoma.[7,8] In some cases, it can be challenging to differentiate renal cell carcinoma from benign lesions such as oncocytoma and angiomyolipoma which may have similar radiological findings.[6] In this study, malignant renal masses (49 patients) included RCCs (n=44, 89.8%) and metastatic lesions (n=5, 10.2 %). Of the 14 benign lesions, 7 were oncocytoma (50%), 5 were angiomyolipoma (35.7%), one was metanephric adenoma (7.1%) and the remaining one was sequelae of chronic pyelonephritis (7.1%).

Choi et al. compared CT findings of chromophobe renal cell carcinoma and oncocytoma. They found that oncocytomas had higher HU values than chromophobe RCCs in the corticomedullary and nephrogenic phases on contrast-enhanced images.[9]

Yang et al. compared CT findings of lipid-poor angiomyolipomas and renal cell carcinomas. They found that lipid-poor angiomyolipomas had significantly higher mean attenuation values when compared with renal cell carcinomas on unenhanced images.[10] In our study, contrarily, the mean HU value of malignant lesions was significantly higher than those of benign lesions on unenhanced images. We believe that this difference is probably due to the inclusion of not only lipid-poor angiomyolipomas but also all angiomyolipomas in the present study.

Mancini et al. reported HU values of contrast-enhanced CT examinations on portal phase as follows: 136 HU for clear cell carcinoma, 161 HU for chromophobe carcinoma, 60 HU for papillary carcinoma, 147 HU for oncocytoma, and 128 HU for angiomyolipoma. They suggested that angiomyolipomas had a <30 HU mean density on unenhanced images.[11] This finding is in keeping with our results as the difference of the mean HU values between malignant and benign lesions is nonsignificant on contrast-enhanced images (portal phase) while this difference increased and became statistically significant for unenhanced images. We think that this finding is because angiomyolipomas have low density on unenhanced images and also enhance well on portal phase enhanced scans.

In the relevant literature, studies commonly used dynamic renal CT protocols for the comparison of benign and malignant renal lesions. However, renal lesions, especially small ones, are usually detected incidentally on routine abdominal CT examination with a delay of 70 seconds. Our study showed that the mean attenuation value of malignant and benign lesions was very similar (83.7± 39.4 HU versus 81.0± 52.9 HU, respectively) on 70-second delay CT scans. In this context, we believe that the measurement of mean density on 70-second delay is not useful for the differentiation of malignant and benign renal lesions.

Heilburn et al. suggested that a kidney lesion with a density of <20 HU on an unenhanced CT image is usually compatible with a simple cyst while a >70 HU density usually represents a lesion with hemorrhagic or proteinaceous contents. They concluded that a kidney lesion with <20 HU or >70 HU may be considered as benign but a range of 20-70 HU must be further evaluated

for the suspected malignant condition.[12] Our unenhanced group results were in keeping with the previous studies as the mean HU value of benign lesions was 9.4± 42.0 while malignant lesions showed a mean value of 29.3± 8.1. Higher standard deviation (42.0) in the benign group also supports this data as there are either fat-containing lesions such as angiomyolipoma or lesions with a higher density such as oncocytoma. In this setting, measurement of attenuation values on unenhanced images may be helpful for the discrimination of benign and malignant lesions.

In this study, a total of 5 metastatic lesions were observed. Metastatic lesions/all malignant lesions ratio was 10.2% (5/49). In their series including 151 patients, Zhou et al. reported that the most common origin of renal metastasis was lungs (43.7%) followed by ear-nose-throat (6%).[13] In a study by Adamy et al., lungs (38%) (most common) and salivary glands (8%) are the most common primary sites of a malignant lesion which spreads to kidney[14]. In our study, the most common origins of renal metastatic lesions were lungs (80%) followed by cervical region (20%).

The retrospective nature and relatively small sample size of the patients who underwent unenhanced CT examination were the main limitations of our study.

Measurements of attenuation of lesions at 70-second delay on contrast-enhanced CT images may not be a useful technique for the discrimination of benign and malignant renal lesions. But lower HU values measured on unenhanced CT images may support a benign process rather than malignant lesions.

Conflict of Interests

The authors declare no conflict of interest.

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