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ORIGINAL REPORT

Usefulness of dual-energy computed tomography with and without dedicated software in identifying uric acid kidney stones☆,☆☆

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KEYWORDS
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Abstract
Objective: To prospectively evaluate the usefulness of dual-energy computed tomography (DECT) with and without dedicated software in identifying uric acid kidney stones *in vivo*.
Material and methods: We studied 65 kidney stones in 63 patients. All stones were analyzed *in vivo* by DECT and *ex vivo* by spectrophotometry. We evaluated the diagnostic performance in identifying uric acid stones with DECT by analyzing the radiologic densities with dedicated software and without using it (through manual measurements) as well as by analyzing the attenuation ratios of the stones in both energies with and without the dedicated software.
Results: The six uric acid stones included were correctly identified by evaluating the attenuation ratios with a cutoff of 1.21, both with the dedicated software and without it, yielding perfect diagnostic performance without false positives or false negatives. The study of the attenuations of the stones obtained the following values on the receiver operating characteristic curves in the classification of the uric acid stones: 0.92 for the measurements done with the software and 0.89 for the manual measurements; a cutoff of 538 HU yielded 84% (42/50) diagnostic accuracy for the software and 83.1% (54/65) for the manual measurements.
Conclusions: DECT enabled the uric acid stones to be identified correctly through the calculation of the ratio of the attenuations in the two energies. The results obtained with the dedicated software were similar to those obtained manually.

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PALABRAS CLAVE
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Litiasis urinarias;
Ácido úrico

Utilidad de la tomografía computarizada de doble energía con un programa específico para la identificación de litiasis renales de ácido úrico

Resumen
Objetivo: Valorar de manera prospectiva e *in vivo* la identificación de litiasis renales de ácido úrico con tomografía computarizada (TC) de doble energía (TCDE) con y sin *software* específico.
Material y métodos: Se estudiaron 65 litiasis de 63 pacientes analizadas *ex vivo* con espectrofotometría y que habían sido estudiadas con una TCDE. Se valoró el rendimiento diagnóstico en identificar litiasis de ácido úrico con TCDE mediante el análisis de las densidades radiológicas de las litiasis utilizando el *software* específico, o sin utilizarlo (midiéndolo manualmente), y mediante el análisis de las ratios de densidad de las litiasis en ambas energías con o sin el *software* específico.
Resultados: Las seis litiasis de ácido úrico incluidas fueron correctamente identificadas mediante la valoración de la ratio de densidades con un punto de corte de 1,21, tanto con el *software* específico como sin él, con un rendimiento diagnóstico perfecto, sin presencia de falsos positivos ni negativos. El estudio de densidades de las litiasis obtuvo valores de las curvas COR en clasificación de litiasis de ácido úrico de 0,92 para medición con la aplicación informática y de 0,89 para las mediciones manuales y una precisión diagnóstica del 84% (42/50) con el *software* y del 83,1% (54/65) para las mediciones manuales para un punto de corte de 538 UH.
Conclusiones: El estudio de litiasis con TCDE permite identificar correctamente las litiasis de ácido úrico mediante el cálculo de la ratio de densidades en ambas energías. Los resultados obtenidos con y sin *software* específico son similares.

Introduction

Urinary lithiasic disease affects up to 12% of men and 6% of women in their life time, and recurrently which means high healthcare costs and a potential cause for kidney failure. When it comes to deciding treatment, the main considerations are the patient's clinical signs and kidney stone sizes. In the context of a renal colic, most kidney stones are expelled spontaneously and the success of the expulsive medical treatment regardless of the density of the kidney stone.[1] However, when an invasive treatment is considered, it is essential to know the composition, toughness or fragility of kidney stones. Uric acid kidney stones, whose incidence ranges from 6 to 10%,[2] can be treated with urine alkalinization in many cases. On the other hand, patients with struvite kidney stones require an antibiotic treatment prior to the kidney stone treatment, and cystine, brushite and calcium oxalate monohydrate kidney stones, cannot be fragmented with extracorporeal lithotripsy.

Computed tomography (CT) without contrast is one of the most frequently used modalities in the initial assessment of urinary kidney stones, with sensitivity and specificity rates to detect them >90%.[3] The densities of the different kidney stones measured with CT allow us estimate their composition, since uric acid kidney stones present a density that is lower than that of the rest of kidney stones. However, there is overlapping between the densities measured in uric acid kidney stones and the rest, which entails a low specificity and sensitivity in their diagnosis this is why the clinical application of the measurement of kidney stone densities has not been generalized.[4–6]

Dual-energy CT, whether with a single source (alternating the energy or performing a dual study at different energies) or with a dual source (double tube) allows us to differentiate materials of similar densities based on the differences in the variation of absorption at different energies using a decomposition algorithm in three materials.[7–9] Dual-energy analysis of data, that is, the determination of densities and the density ratio at different energies, is made easier with softwares developed specifically for this purpose though it can be performed manually. Calcified kidney stones attenuate low-energy radiation even more, unlike uric acid kidney stones, which attenuate high-energy radiation even more with a resulting ratio that is lower than that of the remaining calcified kidney stones.

In vitro dual-energy studies have been performed for the analysis of kidney stones, and with the use of specific post-processing programs and in these studies it has been possible to demonstrate that double-energy studies allow us to identify uric acid kidney stones with great accuracy and in some of the studies with good *in vivo* results too.[10–13]

Our study, which is prospective and *in vivo*, intends to confirm the initial results which show a good differentiation between uric acid kidney stones and those which are not through dual-energy CTs (DECT) with and without specific post-processing software tools.

Material and methods

The patients were informed about the study and prior written informed consent was obtained from the patients referred to CT kidney stone study. The design of the prospective study did not include pregnant patients or patients