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Tuberculous Addison's disease: Morphological and quantitative evaluation with multidetector-row CT

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Abstract

Objective: To determine the characteristics of tuberculous Addison's disease on the axial and multiplanar reformatted (MPR) images of the multidetector-row computed tomography (MDCT).

Materials and methods: The unenhanced and contrast-enhanced MDCT features in 19 patients with tuberculous Addison's disease were retrospectively assessed for the location, contour, size, calcification, attenuation, and enhancement patterns. The correlation between the duration of Addison's disease and the percentage of calcification presence was evaluated.

Results: The adrenal glands were infected bilaterally in all of the 19 cases (100%, 38 glands). Enlargement of the glands appeared in 18 cases (94.7%, 36 glands) and the remaining one case (5.3%, two glands) showed atrophy bilaterally. Of the 36 enlarged adrenals, 13 (36.1%) had preserved contours, and the other 23 (63.9%) were mass-like. The size of the adrenals ranged from 0.6 to 4.8 cm (mean 1.92 ± 0.96 cm). Calcification was revealed in 16 adrenals (16/38, 42.1%), increasing in incidence with disease progression. Fourteen of the 36 (38.9%) enlarged adrenals showed peripheral enhancement while the remaining 22 (61.1%) demonstrated heterogeneous enhancement. The ΔCT value, the attenuation measurement of mass-like lesions, was less in the central area (7 ± 4 HU) than that in the peripheral area (32 ± 14 HU) ($P < 0.01$) between the unenhanced and contrast-enhanced scan.

Conclusion: MDCT can reveal the characteristic morphology and CT attenuation in the tuberculous Addison's disease. Combined with its clinical presentations and biochemical findings, we can diagnose and stage adrenal tuberculosis with high specificity and accuracy on MDCT.
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Keywords: Adrenal gland; Tuberculosis; Addison's disease; Computed tomography

1. Introduction

Thomas Addison reported adrenal tuberculosis in 1855 for the first time [1]. Adrenal tuberculosis has been considered a major cause of chronic primary adrenal insufficiency since then. Addison's disease also refers to chronic primary adrenal insufficiency. During the past several decades, with the introduction of anti-tuberculosis drugs, the incidence of adrenal tuberculosis has been greatly decreased. Currently, adrenal tuberculosis only accounts for 30% of primary adrenal insufficiency, and idiopathic adrenal atrophy accounts for 60% in the developed countries. While in developing countries, adrenal tuberculosis is still the major cause of Addison's disease [2]. Multidetector-row computed tomography (MDCT) has been used in clinical setting. Its volumetric CT acquisition makes it possible to generate high-resolution multiplanar reformation (MPR) images. Although previous reports have described the CT features of adrenal tuberculosis, most of them were case report with plain CT scans [1,3–6]. To the best of our knowledge, no study has analyzed the specific characters of adrenal tuberculosis on contrast-enhanced MDCT. In this study, we retrospectively reviewed a series of data of adrenal tuberculosis with the aim of determining the specific findings on contrast-enhanced MDCT.

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2. Materials and methods

2.1. Subjects

We received approval from the Institutional Review Board (IRB) of our hospital to undertake this study. Nineteen patients (10 men, 9 women; age range, 31–76 years; mean age, 49 years) with adrenal tuberculosis were recruited between March 2003 and August 2006 by the department of radiology in our hospital. The course of the disease ranged from 5 months to 12 years (mean, 20 months). All patients exhibited symptoms of lethargy, anorexia, and nausea. Physical examination revealed hyperpigmentation, weight loss, hypotrichosis and signs of hypotension. Lab reports confirmed adrenocortical insufficiency in all patients, including elevated serum adrenocorticotrophic hormone (ACTH) level, and/or a flat response to dynamic ACTH testing, low concentration of serum and urine free cortisol, electrolyte disturbances, anemia, etc. Among the 19 cases, 17 patients had the diagnosis of tuberculosis that was confirmed by laboratory examinations (positive for tuberculin test and negative for serum adrenal autoantibody) and improved clinical symptoms and/or a CT follow-up over 12 months, which demonstrated calcification and a progressive decrease in the enlarged glands after anti-tuberculosis therapy. One case was confirmed by histological examination. The last one was diagnosed by percutaneous aspiration biopsy. Eleven of the 19 cases (57.9%) had concomitant extra-adrenal tuberculosis, such as pulmonary tuberculosis, tuberculosis of lumbar spine or thoracic vertebra, nephrotuberculosis, tuberculosis of peritoneum and pleura, or tuberculous lymphadenopathy. All patients had no evidence of human immunodeficiency virus infection, histoplasmosis, or neoplastic disease.

2.2. CT scanning technique

Opacification of the bowel was carried out routinely with oral contrast materials (800–1000 ml of a 1% solution of sodium diatrizoate) before the CT scan. All images were performed with MDCT scanners with 4 or 16 channels (sensation 4 or sensation 16, Siemens Medical System, Erlangen, Germany). All patients were scanned with identical parameters: 120 kVp, 200–300 mA, 0.5 s gantry rotation time, 30 mm table feed per gantry rotation, 1.5 mm detector collimation, and section profile 3 mm with a 3 mm section interval and a standard reconstruction algorithm. Initially, unenhanced images were obtained in all patients. Then 80–100 ml of a contrast agent with 300 mg of iodine per milliliter (Iopromide, Ultravist300, Schering) was administrated intravenously through an antercubital vein by using a power injector at a rate of 3 ml/s. Contrast-enhanced images were obtained after a 75 s scan delay.

2.3. Image and data analysis

Two experienced radiologists who were blinded to the diagnosis independently reviewed all contiguous CT scans on hard-copy images and a dedicated workstation (Leonardo; Siemens Medical System). The CT characters of the lesions, including the location, contour, size, calcification, and enhanced patterns, on axial and coronary MPR images were recorded. The contour was classified as mass-like enlargement, enlargement with preserved contour, or atrophy. To obtain the mean diameter of the lesion, the long and short axes were measured at the transverse section of the CT images. Calcification was evaluated on an unenhanced CT scan. The correlation between the course and the percentage of calcification was evaluated. Based on the clinical data, the patients were divided into four categories by the course of the disease: less than 1 year (stage 1); 1–4 years (stage 2); 4–10 years (stage 3); and more than 10 years (stage 4). The enhancement patterns were characterized as peripheral enhancement and heterogeneous enhancement. When the adrenal glands were bilaterally involved, a contrast study of MDCT features between right and left glands was performed to evaluate the differences. The CT value in central and peripheral zone of a mass-like enlargement was also recorded on unenhanced and contrast-enhanced images, respectively. The difference in CT value (ΔCT) for the central or peripheral zone between unenhanced and enhanced scan was then calculated, respectively. A cursor was placed in the circular interested region of the central and peripheral zone of the adrenal mass on the section where the mass appeared the largest, with the surrounding calcification excluded. The interested region varied in size. Each lesion was measured at least twice for calculating the average by using a cursor with the same size and configuration placed at similar locations in the lesions. Any discrepancies between interpretations were resolved by consensus.

2.4. Statistical analysis

Data analysis was performed with commercially available statistical software (SPSS, Version 11.5; Chicago, III). The independent sample *t*-test was used to compare the difference in attenuation value between unenhanced and contrast-enhanced scans, and the ΔCT value between central zone and periphery of the mass-like adrenals, as well as the size of the lesions between left and right adrenal glands. Pearson χ^2-test was used to compare mass-like lesion, calcification and peripheral enhancement between left and right adrenal glands. A P value less than 0.05 was considered statistically significant difference. Scattergrams were generated to assess the differences in attenuation values between the central and peripheral zone of tuberculous masses on unenhanced or contrast-enhanced images.

3. Results

Adrenals were involved bilaterally in all 19 cases (100%). Enlargement of the adrenal glands appeared in 18 cases (94.7%, 36 enlarged adrenals) (Figs. 1–3) and the remaining one case (5.3%, two adrenals) showed bilateral atrophy with triangulate calcification (Fig. 4). Of the 36 enlarged adrenals, 13 (36.1%) had their contour preserved (Fig. 1), and 23 (63.9%) were mass-like enlarged (Figs. 2 and 3). The size of the adrenals ranged from 0.6 to 4.8 cm (mean 1.92 ± 0.96 cm). Calcification was

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