Differentiation of pyogenic hepatic abscesses from malignant mimickers using multislice-based texture acquired from contrast-enhanced computed tomography

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BACKGROUND: Pyogenic hepatic abscess may mimic primary or secondary carcinoma of the liver on contrast-enhanced computed tomography (CECT). The present study was to explore the usefulness of the analysis of multislice-based texture acquired from CECT in the differentiation between pyogenic hepatic abscesses and malignant mimickers.

METHODS: This retrospective study included 25 abscesses in 20 patients and 33 tumors in 26 subjects who underwent CECT. To make comparison, we also enrolled 19 patients with hepatic single simple cyst. The images from CECT were analyzed using a Laplacian of Gaussian band-pass filter (5 filter levels with sigma weighting ranging from 1.0 to 2.5). We also quantified the uniformity, entropy, kurtosis and skewness of the multislice-based texture at different sigma weightings. Statistical significance for these parameters was tested with one-way ANOVA followed by Tukey honestly significant difference (HSD) test. Diagnostic performance was evaluated using the receiver operating characteristic (ROC) curve analysis.

RESULTS: There were significant differences in entropy and uniformity at all sigma weightings ($P<0.001$) among hepatic abscesses, malignant mimickers and simple cysts. The significant difference in kurtosis and skewness was shown at sigma 1.8 and 2.0 weightings ($P=0.002-0.006$). Tukey HSD test showed that the abscesses had a significantly higher entropy and lower uniformity compared with malignant mimickers ($P=0.000-0.004$). Entropy (at a sigma 2.0 weighting) had the largest area under the ROC curve (0.888) in differentiating abscesses from malignant mimickers, with a sensitivity of 81.8% and a specificity of 88.0% when the cutoff value was set to 3.64.

CONCLUSION: Multislice-based texture analysis may be useful for differentiating pyogenic hepatic abscesses from malignant mimickers.

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Introduction

Hepatic abscess is a pus-filled mass inside the liver which is classified as pyogenic, amebic or fungal.[1] The incidence of hepatic abscess is relatively low but it is a potentially life-threatening disease.[2] Pyogenic hepatic abscesses are usually treated with antibiotics and percutaneous drainage. Modern medical imaging techniques such as computed tomography (CT) and magnetic resonance imaging (MRI) play a pivotal role in the diagnosis of hepatic abscess.[3] Hepatic abscesses usually appear as thick-walled lesions with low attenuation at CT and show increased peripheral rim enhancement at contrast-enhanced CT (CECT).[4] However, imaging findings are often nonspecific because certain primary or secondary carcinoma of the liver may develop central necrosis which may mimic the appearance of hepatic abscesses.[5] Therefore, though various studies using CT or MRI have

been conducted to differentiate hepatic abscesses from malignant mimickers, many overlapping image features still remain.[1, 3, 6, 7]

With recent advances in computer-aided diagnosis, texture analysis of CT has great potential to depict tissue morphological complexity and gives new insights into the complicated manifestations of diseases such as non-small cell lung cancer,[8-10] ground-glass nodules,[11] colorectal cancer,[12] gastric tumor[13] and hepatic tumor.[14, 15] Generally, texture analysis refers to various mathematic methods used to measure the distribution of pixels with different gray-level intensities.[16] Computer-based radiologic image texture analysis may maximize the information obtained from the medical images in clinical diagnoses in an objective, quantitative and reproducible way.[17]

CECT is widely used in the diagnosis of liver disease because it provides useful information about the enhancement patterns and the heterogeneity of lesions. Thus, although the images of hepatic abscesses and malignant mimickers are similar by eyes, the texture features extracted from CECT may indirectly capture the tissue heterogeneity and cell morphology. Microscopic biological changes within tissues could be reflected on texture heterogeneity.

The purpose of the study was to explore whether texture analysis of CECT helps differentiate pyogenic hepatic abscesses from malignant mimickers.

Methods

Study population

This study was approved by our Institutional Review Board. The requirement for written informed consent from patients was waived due to the retrospective study design. A systematic search of liver CECT image database was queried for clinically diagnosed hepatic abscess and malignant hepatic tumor with search key "cystic", "liquefactive" or "necrotic" between November 2011 and November 2013. Only cases with initial diagnosis of focal liver abscess or malignant hepatic tumor that underwent CECT before treatment were enrolled. Inclusion and exclusion criteria are listed in Table 1. The hepatic abscess group consisted of 25 abscesses in 20 patients and the malignant mimickers had 33 tumors in 26 subjects. The 26 patients with malignant mimickers included those with necrotic hepatocellular carcinoma (n=9), mass-forming cholangiocarcinoma (n=6) and hepatic metastasis [n=11, with primary malignant lesions in the stomach (n=6), colorectum (n=3), duodenum (n=1) and esophagus (n=1)]. Since the hepatic abscesses and malignant mimickers included in the study were all cystic focal liver lesions, to make comparison, we enrolled 19 patients with hepatic single simple cyst diagnosed in the same period. Anechoic lesions at ultrasonography were accepted as hepatic cysts if the patients were clinically asymptomatic and with negative serological tests.[18] The detailed patient characteristics for all groups are shown in Table 2.

CT examination

CECT scans were performed with a 128-row helical quadruple-phase (i.e., unenhanced, hepatic arterial, portal venous and delayed phases) CT scanner (Somatom Definition AS+; Siemens Healthcare, Forchheim, Germany). A nonionic contrast agent (Ultravist 370 mgI/mL; Schering, Berlin, Germany) was administered (1.5 mL/kg body weight) at the rate of 4.0 mL/s, followed by 50 mL saline

Table 1. Inclusion and exclusion criteria for hepatic abscesses and malignant mimickers

	Hepatic abscesses	Malignant mimickers
Inclusion criteria	1. confirmed by percutaneous aspiration (n=9) 2. at least 3-month follow-up CT or MRI showed improvement after antibiotic therapy and percutaneous drainage (n=11)	1. malignancy with liquefactive or cystic necrosis proven by surgical resection (n=16) or percutaneous biopsy (n=1) 2. image follow-up indicated hepatic metastasis (increase in the size/number of hepatic lesions with primary malignancy in other organs) with necrotic cavities (n=9)
Exclusion criteria	1. less than 1 cm sized lesion (n=4) 2. amebic or fungal abscess (n=3) 3. typical CT features of presence of air or double-target sign (n=9) 4. no confirmed clinical diagnosis (n=8)	1. less than 1 cm sized lesion (n=23) 2. treatment history (n=38) 3. no pathological/image follow-up proof (n=40)

Table 2. Patients characteristics

Variables	Hepatic abscess group (n=20)	Malignant mimicker group (n=26)	Simple cyst group (n=19)
Gender (male/female)	13/7	15/11	11/8
Mean age (yr, range)	62.4 (47-82)	61.7 (38-86)	63.2 (44-82)
Mean weight (kg, range)	71.2 (52-91)	69.5 (49-90)	73.2 (54-93)
Mann-Whitney test found no significant difference between the subgroups for gender, age and weight (P>0.05).			