HAEMAL SUPPLIES CORRELATION BASED HEPATIC NODULES IDENTIFICATION FROM DYNAMIC CONTRAST-ENHANCED MR IMAGES

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Introduction: Early detection of liver nodular lesions is critical in improving patient's survival rate. Liver nodular lesions are divided into three categories: regenerative nodule (RN), dysplastic nodule or tumor nodule (DN) and small hepatocellular carcinoma (SHCC) [1]. Previous studies have shown that for dynamic contrast-enhanced imaging of liver nodules, there is correlation between liver nodules' blood supplies and MRI signal change [2]. In this retrospective study, we proposed a computer-aided method for automatic hepatic nodules identification, based on characteristics of liver nodules' haemal supplies, by calculating the correlation coefficients between suspected areas (obtained by scanning the nodules vascular areas in original images from left to right and top to bottom using a 9 pixels ×9 pixels block with pixel-by-pixel) and their blood supply regions using dynamic contrast-enhanced MRI.

Materials and Methods: The dynamic contrast-enhanced whole liver MR images of 10 patients(mean age 53.9 years, range 41-73 years) in this retrospective study were acquired on a 3.0 T whole-body MR scanner(Signa Excite™; GE Medical Systems, Milwaukee, Wisconsin, USA) with 8-channel torso phased array using LAVA sequence(TR /TE 2.8 ms/1.2ms, TI 5.0 ms, receiving bandwidth 125 kHz, effective thickness 2.2 mm, FOV 38~40 cm, matrix 270x224, and flip angle 15°). The images of hepatic arterial phase (3 phases), portal venous phase (3 phases) and balanced phase (3 phases) were obtained. The automatic identification steps were as follows: 1) Selected a working layer and detected quasi-nodules, and then segmented the working image into three parts: nodules vascular area, liver parenchyma area and other tissues area, by using fuzzy C-means (FCM) algorithm. 2) Iterated over the nodules vascular area from left to right and top to bottom by using a 9 pixels ×9 pixels block with pixel-by-pixel in all time phases and estimated the gray scale mean of each block, forming a N×P (N is the number of scanning blocks and P is the number of phases) array. Calculated the gray scale mean of portal venous region (or artery region) in all phases to yield a P×1 array, and then evaluated the correlation coefficients of these two arrays in portal venous phase and extracted the candidate nodule blocks with the maximal coefficient values. 3) Estimated the correlation coefficients between the gray scale mean arrays of quasi-nodules and portal veins (or artery) in all phases, and then screened out veins by searching for maximal coefficient values. 4) Removed the interferences of the tissue regions, such as liver parenchyma area that has a similar dynamic enhancement kinetic curve pattern, by using a typical image texture analysis algorithm (gray level co-occurrence matrix, GLCM), and finally the target nodules were located.

Results: Typical results from three subjects in this retrospective study were given in the figures. Portal venous phase indicated by the shaded areas in Fig.1(C), Fig.2(C) and Fig.3(C). The correlation coefficients between the kinetic curves of two candidate nodules and portal vein were 0.98 and 0.99 in portal venous phase, respectively, shown in Fig.1 and Fig.2. Furthermore, compared with liver parenchyma, the suspected lesion area was identified as a low-grade DN or a RN depended on their higher or lower signal intensity. As shown in Fig.3, the suspected nodule was identified as a SHCC due to its strong relationship to artery with the correlation coefficient 0.88 in portal venous phase. The whole analysis results consisted with clinical diagnosis from two professional radiologists in hospital under double-blind test.

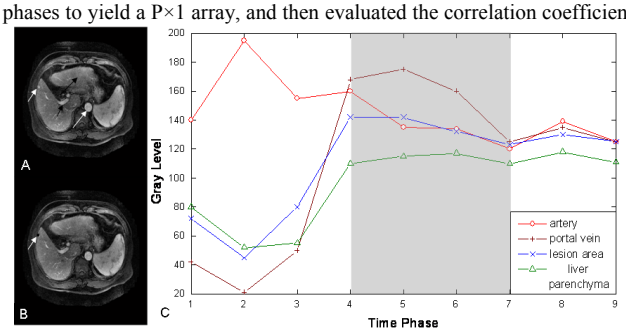

Fig.1 Typical analysis results of a patient with a low-grade DN
A) the original image (the real nodule, portal vein, artery and liver parenchyma were pointed by the short white arrow, the short black arrow, the long white arrow and the long black arrow, respectively); B) the low-grade DN indicated by the white arrow and covered by a square with the size of 9×9 pixels; C) dynamic enhancement curves of artery in red, portal vein in wine, lesion area in blue, and liver parenchyma in green.

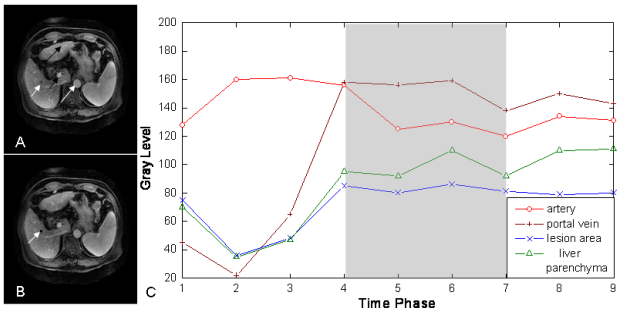

Fig. 2 Typical analysis results of a patient with a RN
A) the original image (the real nodule, portal vein, artery and liver parenchyma were pointed by the short white arrow, the short black arrow, the long white arrow and the long black arrow, respectively); B) the RN indicated by the white arrow and covered by a square with the size of 9×9 pixels; C) dynamic enhancement curves of artery in red, portal vein in wine, lesion area in blue, and liver parenchyma in green.

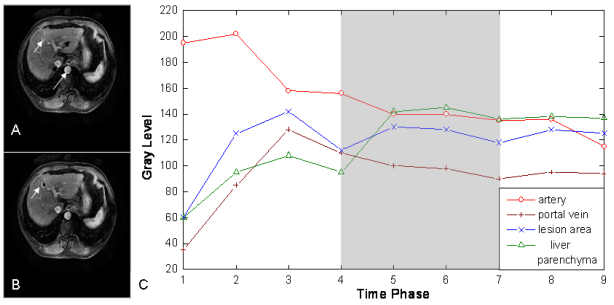

Fig. 3 Typical analysis results of a patient with a SHCC
A) the original image (the real nodule, portal vein, artery and liver parenchyma were pointed by the short white arrow, the short black arrow, the long white arrow and the long black arrow, respectively); B) the SHCC indicated by the white arrow and covered by a square with the size of 9×9 pixels; C) dynamic enhancement curves of artery in red, portal vein in wine, lesion area in blue, and liver parenchyma in green.

Conclusion: In this retrospective study, haemal supplies correlation based strategy was introduced to identify the suspected hepatic nodules from dynamic contrast-enhanced MR images, and the analysis results were in consistence with the clinical diagnosis under double-blind test. The proposed computer aided identification approach could be helpful to provide valuable information for the detection of hepatic nodules.

References:

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