Distinguishing early and progressed HCC using texture analysis using gadoxetic acid-enhanced hepatobiliary phase image

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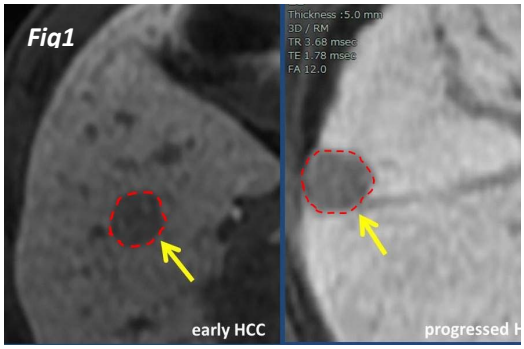
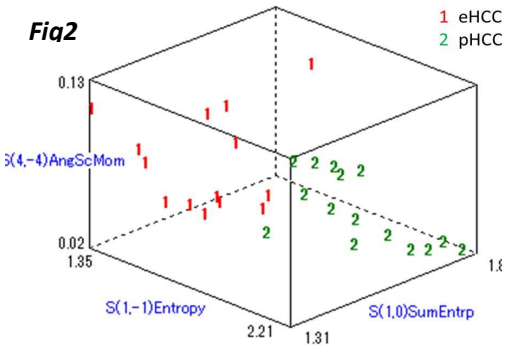
[Target audience] This presentation will be targeted to audience interested in clinical usefulness of texture analysis for the diagnosis of hepatocellular carcinoma (HCC) on gadoxetic-acid enhanced MRI (Gd-EOB-MRI).

[Background and Purpose] Early hepatocellular carcinoma (HCC) is distinct pathological diagnosis from progressed HCC. Early HCCs are often small and macroscopically vague low grade tumor and usually managed conservatively, whereas progressed HCCs are high grade and require surgical and/or ablation therapy. Gadoxetic acid-enhanced hepatocyte phase image is typically useful for detecting small HCCs including both eHCC and pHCC, in which both are shown as clear hypointense nodule[1] (Fig 1). Early HCCs rarely show hypervascularity on contrast-enhanced arterial phase images, while progressed HCCs are usually hypervascular. So, arterial phase images typically enable to distinguish these two pathologies. However, radiologists sometimes experience difficulty of discrimination due to variation of vascularity of these HCC such as hypovascular poorly differentiated HCCs[2]. Since early HCC is at early stage of hepatocarcinogenesis, the tumor cells are supposed to preserve a little function of hepatocyte including ability of taking up gadoxetic acid, also known as a function of surface receptor (OATP1B3)[3] . In fact, according to radiologists' impression, the signals of eHCC can be more heterogeneous and a little higher than that of pHCC. A texture analysis of the images may have a role for characterizing signal distribution and discriminating these two pathologies[4].





[Purpose] To evaluate texture analysis based classification by using comprehensive texture analysis[5] on hepatocyte-phase image of Gd-EOB-MRI for distinguishing early from progressed HCCs.

[Methods] Surgically resected and pathologically confirmed 14 cases of hypovascular early HCCs and 16 of hypervascular progressed HCCs were included in this retrospective study, all of which demonstrated hypoinsensity on hepatocyte-phase image of Gd-EOB-MRI. Mean and standard deviation of the nodule size was statistically significant different between the two groups (12 ± 5 mm in early HCC and 23 ± 8 mm in overt HCC; p = 0.002). By placing a region of interest on the target lesion on an axial hepatocyte-phase image of Gd-EOB-MRI, a total of 280 texture features derived from grey-scale histogram, co-occurrence matrix, run-length product, absolute gradient, auto-regressive model, and wavelet transform were calculated by using texture analysis software, MaZda 4.6[6]. By using these parameters, after features selection, misclassification rates of lesion classification were calculated. Misclassification rates were also calculated for nodule size by using receiver operating characteristic analysis and qualitative visual assessment by two blinded radiologists with consideration of nodule size.

Methods	Misclassification rate
Texture analysis (feature selection methods)	
(1, Fisher)	1/30 (3%)
(2, probability of classification error and average correlation)	5/30 (17%)
(3, mutual information coefficients)	3/30 (10%)
Nodule size (15mm of threshold value)	3/30 (10%)
Radiologist 1	3/30 (10%)
Radiologist 2	5/30 (17%)

Table. Results of misclassification rate for the classification of early and progressed HCCs

[Results] Misclassification rate was in the range of 3–17% (1/30–5/30) (example, Fig2) for texture analysis based classification. These results were as good as those of nodule size-based classification (misclassification rate =10% [3/30]) with cutoff value of 15 mm and that of visual analysis by two radiologists (10–17% [3/30–5/30]) (Table).

[Discussion] Texture analysis enabled discrimination between early and progressed HCCs by itself. While nodule size is an important discriminating feature between early and progressed HCCs, texture analysis based classification reveals comparable misclassification rates as compared with those of nodule size based classification and qualitative assessment by diagnostic radiologists. Further study with combined use of these would be of interest for further accurate classification.

[Conclusion] Texture analysis may provide additional or alternative quantitative diagnostic ability to conventional qualitative assessment and may be promising in the development and implementation of computer-assisted lesion detection on Gd-EOB-MRI.

[References]

1. Sano K, et al. Radiology 2011;261:834-844, 2. Jang HJ,et al.Radiology 2007;244:898-906, 3. Kitao A, et al. European radiology 2011;21:2056-2066,

4. Mayerhoefer ME, et al. Investigative radiology 2010;45:543-547, 5. Castellano G, et al. Clinical radiology 2004;59:1061-1069,

6. Szczypinski PM, et al. Computer methods and programs in biomedicine 2009;94:66-76.