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Commentary

Deep learning promotes B-mode ultrasound screening for focal liver lesions

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The focal liver lesions (FLLs) can be divided into two categories such as benign and malignant. The most common primary malignant FLL is hepatocellular carcinoma (HCC) that is 6th most common cancer in humans. HCC is fourth leading cause of cancer-related death worldwide [1]. Approximately 3/4 of all new cases occur in low- and middle-income countries [2]. Therefore, cost-effective cancer screening method of the liver is mandatory. B-mode ultrasound (US) without use of contrast agent can be one of the ideal screening methods for FLLs because it is widely available (inexpensive and small enough to install in outpatient clinics), less invasive (free from radiation exposure and adverse effects induced by contrast agent), and prompt (real time diagnosis). However, B-mode US has been recognized as less accurate at diagnosing FLLs compared to the other advanced tomographic modalities such as contrast-enhanced CT/MRI because of high dependence on the examiner's experience and skills [3,4].

In this article of *EBioMedicine*, Yang and colleagues report the excellent diagnostic performance of the developed deep convolutional neural network of US (DCNN-US) in classification of malignant from benign FLLs using 11 standard still US images and clinical-ultrasonic factors [5]. It is noteworthy that DCNN-US showed higher diagnostic performance compared to experienced radiologists and comparable diagnostic performance to contrast-enhanced CT for lesions detected by US in a large external validation cohort obtained from a prospective multicentre study. Therefore, deep learning-based method such as DCNN-US may improve current clinical practice for patients with liver cancer especially in the situation experienced radiologist or advanced imaging modalities are not available.

In the basic technical aspects, significance of this paper can be that the diagnostic performance of proposed model based on deep convolutional neural network was improved when an independently trained network and clinical-ultrasonic factors classified by experienced abdominal sonologists were additionally integrated with simple transfer learning method. Although, transfer learning is an effective method to develop a deep learning-based diagnostic model with relatively small database utilizing pretrained convolutional neural network such as ResNet that was used in this study, such an effective training of independent deep neural network can't be achieved without a large database built in this study [6,7].

On the other hand, it is interesting that imaging features classified by human experts such as clinical-ultrasonic factors could improve the diagnostic performance of DCNN-US. This means imaging feature extraction by ResNet architecture has not reached the level equivalent to human experts in classification of FLLs by US images. In other words, it can be said that we can improve deep neural network architecture as an imaging feature extractor by reference to human experts' attentions in particular tasks [8].

I would like to suggest three unanswered questions to be solved in the future after achievement of this paper. Firstly, more detailed classification of histological subtypes further than simple classification into the two categories such as malignant and benign is mandatory to improve clinical practice for the patients with liver cancers because the therapeutic strategy can significantly differ according to the histological subtypes in FLLs. For example, transarterial chemoembolization is not effective for cholangiocellular carcinomas different from hepatocellular carcinomas even if both are primary liver cancers.

Secondary, development of real time DCNN-US is mandatory to improve overall diagnostic performance of B-mode US not only classification but also detection of FLLs [9]. One of the major weaknesses of abdominal US examination is its high dependence on the examiner's skill to visualize the lesions. The detection performance of FLLs by B-mode US may be improved by presentation of real time attention map obtained from real time DCNN-US to the US examiner in the future.

Thirdly, development of fully dedicated deep neural network architecture for diagnostic US imaging is mandatory because the deep convolutional neural network used in this study was originally developed for the classification of environmental images in ImageNet database not for clinical US images [10].

In conclusion, the study by Yang and colleagues contributes to improve clinical practice for the patients with FLLs providing a clinically applicable and technically robust prototype of deep learning-based diagnostic model using B-mode US images.

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Declaration of Competing Interest

The author has no conflicts of interest to disclose.

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