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● *Original Contribution*

COMPARISON OF 2-D SHEAR WAVE ELASTOGRAPHY AND TRANSIENT ELASTOGRAPHY FOR ASSESSING LIVER FIBROSIS IN CHRONIC HEPATITIS B

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Abstract—This study compared 2-D shear wave elastography (SWE) and transient elastography (TE) for liver fibrosis staging in patients with chronic hepatitis B (CHB) infection using liver biopsy as the reference standard. Patients with CHB infection who underwent liver biopsy were consecutively included. After exclusions, 257 patients were analyzed. Two-dimensional SWE resulted in a significantly higher rate of reliable measurements (98.1%, 252/257) than TE (93.0%, 239/257) ($p = 0.011$). Liver stiffness measurements of the two examinations exhibited a strong correlation ($r = 0.835$, $p < 0.001$). In patients given a confirmed histologic diagnosis, Spearman's rank coefficients were 0.520 in stage F0 ($p < 0.001$), 0.684 in stage F1 ($p < 0.001$), 0.777 in stage F2 ($p < 0.001$), 0.672 in stage F3 ($p < 0.001$) and 0.755 in stage F4 ($p < 0.001$). There were no significant differences between the areas under the receiver operating characteristic (ROC) curves of 2-D SWE and TE for liver fibrosis staging (all p values > 0.05). Two-dimensional SWE had diagnostic accuracy comparable to that of TE for liver fibrosis staging. The measurements that the two techniques provide are not interchangeable. (E-mail: zhengrq@mail.sysu.edu.cn) **© 2017 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Hepatitis B, Liver fibrosis, 2-D shear wave elastography, Transient elastography, Liver stiffness.**

INTRODUCTION

In patients with chronic hepatitis B (CHB) infection, evaluating the degree of liver fibrosis is important in determining their medical management and prognosis. As fibrosis progresses, there is increasing portal hypertension, loss of liver function and a higher risk of hepatocellular carcinoma. Liver biopsy (LB) is still considered the reference standard in the evaluation of liver fibrosis (Bravo et al. 2001). However, LB is an invasive procedure and may occasionally cause severe complications, limiting its use for screening and frequent follow-up (Yoshioka and Hashimoto, 2012). Tracking not only the progression, but also the regression of liver fibrosis over time could be of clinical significance. Therefore, considerable effort has been extended to develop non-invasive methods for the staging of liver fibrosis.

Transient elastography (TE) is a non-invasive method for staging liver fibrosis that evaluates liver stiffness by measuring the velocity of shear waves in the liver parenchyma generated by a mechanical push. TE is the oldest and most validated elastographic method used to assess liver fibrosis and has been recommended as a non-invasive method for the staging of hepatic fibrosis by the clinical practice guidelines of the European Association for the Study of the Liver 2012 (Myers et al. 2012; Trembling et al. 2014). However, TE can be difficult in obese patients or those with a narrow intercostal space and cannot technically be performed in patients with ascites (Cosgrove et al. 2013).

Two-dimensional shear wave elastography (2-D SWE) is a newer ultrasound elastography technique based on shear waves that is available on a clinical diagnostic ultrasound scanner (Muller et al. 2009). Like TE, 2-D SWE can measure liver stiffness based on shear wave velocity

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estimation, which is used to calculate Young's modulus (Bamber et al. 2013). Unlike TE, 2-D SWE can be conveniently performed using a conventional ultrasound scanner and can create a real-time, 2-D quantitative map of liver tissue stiffness under the guidance of very high frame rate B-mode imaging (Shiina et al. 2015). Two-dimensional SWE has proven to be a reliable method for the non-invasive evaluation of liver stiffness (Ferraioli et al. 2012, 2015; Gerber et al. 2015; Hudson et al. 2013; Woo et al. 2015). Mutual validation or interchangeability among the two ultrasound elastography techniques may be important for patient care because different imaging techniques are frequently used to monitor disease progression in patients with chronic liver disease, and the results of both techniques can be expressed in kilopascals. Most published studies concerning the use of TE and other ultrasound elastographic techniques have focused on hepatitis C virus-related fibrosis. There have been few published studies comparing 2-D SWE and TE in the assessment of liver fibrosis with histologic confirmation in patients with CHB infection (Leung et al. 2013; Zeng et al. 2014).

Therefore, the goal of this study was to compare 2-D SWE and TE for liver fibrosis staging in the same individuals with CHB infection, considering liver biopsy as the reference standard.

METHODS

Patients

Between August 2013 and April 2015, patients with CHB infection who were consecutively admitted to our hospital to undergo LB to assess liver fibrosis were prospectively considered for inclusion in this study. Informed consent was obtained from all the patients, and the study was approved by the clinical medical research ethics committee of our hospital. CHB infection was diagnosed when hepatitis B surface antigen and hepatitis B virus DNA were present in the serum for at least 6 mo. The exclusion criteria included the following: age <18 y; no consent for 2-D SWE or TE examination; chronic hepatitis caused by other hepatitis virus or disease; biopsy samples <15 mm long or with fewer than six portal tracts under a microscope; undergoing antiviral therapy; liver transplant. LB was performed on the same day as TE examination. Two-dimensional SWE was performed within 3 d of LB. Blood samples were obtained on the day of LB. The following data were collected from all patients: age; sex; weight; height; alanine aminotransferase (ALT), aspartate aminotransferase (AST), serum alkaline phosphatase (ALP), γ-glutamyl transpeptidase (GGT), total bilirubin and serum albumin concentrations; platelet count; and prothrombin time (PT). Body mass index (BMI) was calculated as the weight (kg)/(height [m])^2.

Transient elastography

An operator and two radiologists (J. Zeng and J. Zheng) performed the TE procedures. The operator performing the TE examination had experience with at least 100 TE procedures at the Department of Infectious Diseases. The radiologists had 9 y of experience in performing liver US examinations, and each had performed at least 100 TE procedures. The operator and radiologists were blinded to the patients' clinical information, pathology and 2-D SWE results.

Transient elastography was performed using FibroScan (Echosens, Paris, France) with a standard M probe. All patients had fasted for at least 6 h before the examination. Measurements of liver stiffness were obtained from the right lobe of the liver through the intercostal spaces with the patient lying in the dorsal decubitus position and the right arm in maximal abduction. The tip of the transducer probe was covered with a coupling gel and was placed on the skin between two ribs at the level of the right lobe. The operator, assisted by a time–motion ultrasound image, located a liver portion at least 6 cm thick and free of large vascular structures. The operator then pressed the probe button to begin the measurements (Ganne-Carrié et al. 2006). A minimum of 10 attempts were made. Median liver stiffness measurements (LSMs), success rates (SRs) and interquartile ranges (IQRs) were recorded.

Liver stiffness measurement failure was recorded when no value was obtained after at least 10 attempts (valid measurements $= 0$). The results were considered unreliable in the following circumstances: <10 valid measurements; SR $<60\%$; or IQR $>30\%$ of the median LSM value (IQR/LSM $>30\%$) (Castéra et al. 2010).

2-D shear wave elastography

Two radiologists (J. Zeng and J. Zheng) performed the procedures. Both radiologists had at least 6 mo of experience in performing 2-D SWE examinations. The radiologists were blinded to the patients' clinical information, pathology and TE results. Two-dimensional SWE was performed using the Aixplorer US system (SuperSonic Imagine, Aix-en-Provence, France) with a convex broadband probe (SC6-1, 1–6 MHz). All patients had fasted for at least 6 h before the examination. Two-dimensional SWE measurements were performed on the right lobe of the liver through the intercostal spaces with the patient lying in the supine position and the right arm in maximal abduction. The operator positioned the target area of the liver under the guidance of conventional, real-time B-mode imaging. When the target area was located, SWE was launched, and the patient was asked to hold his or her breath during quiet breathing for approximately 5 s. The elasticity image box, which was approximately 4×3 cm, was set 1–2 cm deeper