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Diagnostic accuracy of point shear wave elastography in the detection of portal hypertension in pediatric patients

M. Burak Özkan [a,*], M.C. Bilgici [b], E. Eren [c], G. Caltepe [c]

[a] *Department of Pediatric Radiology, Dr Sami Ulus Research and Training Hospital, 06580 Altindag, Ankara, Turkey*
[b] *Department of Pediatric Radiology, 55080 Omu, Samsun, Turkey*
[c] *Department of Pediatric Gastroenterology, 55080 Omu, Samsun, Turkey*

KEYWORDS
Point shear wave elastography (p-SWE);
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Abstract
Purpose: The purpose of this study was to determine the usefulness of point shear wave elastography (p-SWE) of the liver and spleen for the detection of portal hypertension in pediatric patients.
Materials and methods: The study consisted of 38 healthy children and 56 pediatric patients with biopsy-proven liver disease who underwent splenic and liver p-SWE. The diagnostic performance of p-SWE in detecting clinically significant portal hypertension was assessed using receiver operating characteristic (ROC) curves.
Results: Reliable measurements of splenic and liver stiffness with p-SWE were obtained in 76/94 (81%) and 80/94 patients (85%), respectively. The splenic stiffness was highest in the portal hypertension group ($P < 0.01$). At ROC curve analysis, the area under the curve in the detection of portal hypertension was lower for splenic p-SWE than for liver p-SWE (0.906 vs. 0.746; $P = 0.0239$). The cut-off value of splenic p-SWE for portal hypertension was 3.14 m/s, with a specificity of 98.59% and a sensitivity of 68.18%. The cut-off value of liver p-SWE for portal hypertension was 2.09 m/s, with a specificity of 80.28% and a sensitivity of 77.27%.

* Corresponding author.
E-mail addresses: bozkan04@me.com, burakozkan79@hotmail.com (M. Burak Özkan), mbilgici04@gmail.com (M.C. Bilgici), eeren044@gmail.com (E. Eren), gctepe04@yahoo.com (G. Caltepe).

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Conclusion: In pediatric patients, p-SWE is a reliable method for detecting portal hypertension. However, splenic p-SWE is less accurate than liver p-SWE for the diagnosis of portal hypertension.

Measurement of the hepatic venous pressure gradient (HVPG) is used to assess the therapeutic response in patients with portal hypertension. [1—18]. However, the use of HVPG measurements in children is limited due to their invasive nature. Thus, a non-invasive diagnostic method is needed to detect the presence of portal hypertension in this specific population . A few studies have investigated the potential application of point shear-wave elastography (p-SWE) in the detection of portal hypertension in children [2,19]. However, none of these have compared the usefulness of p-SWE for measuring splenic and liver stiffness in pediatric patients with portal hypertension.

The purpose of this study was to determine the usefulness of p-SWE of the liver and spleen in the measurement of tissue stiffness and detection of portal hypertension in pediatric patients.

Materials and methods

Patients

Fifty-six children with liver disease who underwent liver biopsy were included in this prospective study. The patients underwent splenic and hepatic p-SWE on the day of the biopsy or the following day. Thirty-eight healthy volunteers who were referred to the pediatric ultrasonography unit for other reasons were included as the control group.

Among the 56 children with liver disease, 23 had portal hypertension (group I), and 33 had chronic liver disease without portal hypertension (group II). The control group was further referred to as group III. There were 12 boys and 10 girls in group I, 16 boys and 17 girls in group II, and 17 boys and 21 girls in group III. The median age in group I was 5.4 years (Q1, Q3; 2.5—7.6 years), 6.7 years (Q1, Q3; 4.15—9.1 years) and 7.6 years (Q1, Q3; 5.28—9.8 years) in group III. Basic data including results of biological tests of the 3 patient groups are given in Table 1.

The etiology of the chronic liver diseases were portal venous thrombosis (8 patients), autoimmune hepatitis/primary sclerosing cholangitis (11 patients), Wilson disease (13 patients), metabolic diseases (including α-1-antitrypsin deficiency, cystic fibrosis, glycogenosis, ornithine transcarbamylase deficiency, galactosemia, autosomal recessive polycystic kidney diseases; 6 patients), biliary atresia (9 patients), hepatopathy of unknown origin (2 patients), and others (including Alagille syndrome, progressive familial intrahepatic cholestasis, liver tumor ([7 patients]).

Liver cirrhosis was proven by ultrasound and histopathological analysis. The Knodell histopathological scoring system was used for liver fibrosis staging.

Eighteen patients underwent upper endoscopy examination. The varices were graded as follows: grade I, varices < 5 mm and flattened by air insufflation; grade II, varices > 5 mm, no luminal obstruction; grade III, great, winding veins, considerable luminal obstruction; grade IV, almost complete occlusion of the lumen [2]. Among the 18 patients who had endoscopy, two had no varices, one had grade I, one had grade I—II, three had grade II, three had grade II—III, seven had grade III and one had grade III—IV varices. All patients underwent p-SWE assessment between one to four days after the endoscopy examination.

Portal hypertension was defined as the presence of one of following items in addition to biopsy-proven liver cirrhosis: esophageal varices, splenomegaly, portal vein occlusion and portal systemic collateral vessels, as determined by endoscopic or ultrasonographic findings. Eight patients had portal venous thrombosis that was detected at Doppler examination. The etiology of portal venous thrombosis included sepsis, idiopathic, tumoral invasion and pancreatitis. The presence of splenomegaly was based on criteria published in the literature [20].

In group I, 21 patients had splenomegaly, 23 patients had ascites, 8 patients had portal venous thrombosis, and 14 patients had more than grade two varices at endoscopy.

p-SWE method

The p-SWE measurements of the liver and spleen were performed during ultrasonographic examinations using the Siemens Acuson S2000® Virtual Touch Q™ (Mountview, CA, USA) system. All elastography assessments were done by a pediatric radiologist (MBO) with more than three years of experience in elastography. All the p-SWE measurements were done with the standard 9L4.

During p-SWE measurements, the patient was placed in a supine position, with his right or left arms at maximal abduction. The p-SWE measurements were made at three different sites of the liver and spleen, as previously described [21]. Prior to the measurements of the selected areas, each patient was asked not to move for least 3 s to obtain a homogenous two-dimensional image of the ROI. The measurement area was at least 10 mm wide because depth of measurement has an influence on the values of stiffness. The median of the measurement depth was 3.2 mm (Q1, Q3, 2.2—4.5 mm).

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