

Spleen extracellular volume fraction and platelet count/spleen volume ratio are accurate non-invasive markers of portal hypertension

C. LEVICK^{1,2}, M. PAVLIDES^{1,2}, D. BREEN⁴, K. NASH⁴, G. HIRSCHFIELD⁵, D. TRIPATHI⁵, M. ROBSON^{2,6}, S. NEUBAUER^{2,6}, E. BARNES^{1,3}

1Translational Gastroenterology Unit, University of Oxford; United Kingdom

2Oxford Centre for Clinical Magnetic Resonance Research, University of Oxford; United Kingdom

3Peter Medawar Department, University of Oxford; United Kingdom

4Southampton General Hospital; United Kingdom

5Queen Elizabeth Hospital, Birmingham; United Kingdom

6Perspectum Diagnostics Ltd; United Kingdom

Background and aims

Non-invasive markers of portal hypertension are needed. In portal hypertension, splenic venous congestion and fibrosis may increase splenic extracellular water content. A magnetic resonance imaging (MRI) measure of total spleen water content, spleen cT1, correlates with hepatic venous pressure gradient (HVPG, $r = 0.68$). This multicentre study explores markers of portal hypertension including splenic extracellular fluid volume fraction (ECV) specifically.

Methods

Twenty healthy volunteers and 122 cirrhosis patients of mixed aetiologies had spleen MRI with gadoxetic acid contrast and blood assessment. All cirrhosis patients had endoscopy within median 31 days (IQR 12 – 93) of MRI. Portal hypertension was defined as the presence of varices, ascites or HVPG >5 mmHg. MRI was analysed for spleen ECV, T1, cT1 and size. Spleen ECV was calculated as $(1 - \text{haematocrit}) * \Delta R1_{\text{spleen}} / \Delta R1_{\text{blood}}$, where $\Delta R1 = 1/T1_{\text{native}} - 1/T1_{\text{post gadoxetic acid}}$. Diagnostic accuracy for portal hypertension was assessed by area under the receiver operator curve (AUROC).

Results

Patients had median age 61 years, 78% were male and 65% had portal hypertension. Healthy volunteers had median age 56 years and 60% were male. Median spleen ECV was higher in cirrhotic subjects with portal hypertension (0.402 (IQR 0.364 – 0.457)) than without (0.343 (IQR 0.319 – 0.368), $p < 0.001$), but similar between healthy (0.338 (IQR 0.324 – 0.352)) and cirrhotic subjects without portal hypertension ($p = 0.302$). In cirrhosis, spleen ECV and platelet/spleen volume ratio identified portal hypertension with the highest accuracy (AUROC 0.79 each, table 1) of all measures tested.

Conclusions

Spleen ECV and platelet/spleen volume ratio can identify portal hypertension accurately and non-invasively.

Table 1. Diagnostic accuracy of non-invasive markers for the identification of portal hypertension in 122 patients with cirrhosis

	AUROC (95% CI)	p	Cut off	Sensitivity (%)	Specificity (%)
Spleen ECV	0.79 (0.71 – 0.87)	<0.001	0.36	78	72
Spleen T1 (ms)	0.71 (0.62 – 0.80)	<0.001	1332	63	79
Spleen cT1 (ms)	0.73 (0.63 – 0.82)	<0.001	1274	73	73
Spleen volume (ml)	0.77 (0.69 – 0.86)	<0.001	480	77	67
Platelet/spleen volume	0.79 (0.71 – 0.87)	<0.001	0.28	74	71
Platelets (x10 ⁹ /l)	0.73 (0.64 – 0.81)	<0.001	117	55	84
Spleen diameter (mm)	0.74 (0.65 – 0.83)	<0.001	152	58	82
Platelet/spleen diameter	0.76 (0.68 – 0.85)	<0.001	0.71	53	94

Abbreviations: AUROC, area under the receiver operator curve; ECV, extracellular volume fraction.

Spleen T1 and spleen diameter criteria can identify and exclude oesophageal varices accurately

C. LEVICK^{1,2}, M. PAVLIDES^{1,2}, D. BREEN⁴, K. NASH⁴, M. ROBSON^{2,5}, S. NEUBAUER², E. BARNES^{1,3}

1Translational Gastroenterology Unit, University of Oxford; United Kingdom

2Oxford Centre for Clinical Magnetic Resonance Research, University of Oxford; United Kingdom

3Peter Medawar Department, University of Oxford; United Kingdom

4Southampton General Hospital; United Kingdom

5Perspectum Diagnostics Ltd; United Kingdom

Background and aims

Baveno VI criteria (platelets $>150 \times 10^9/l$, liver stiffness <20 kPa) can avoid 10-34% of screening endoscopies for oesophageal varices needing treatment (VNT) in compensated advanced chronic liver disease (cACLD), but leave $>46\%$ performed unnecessarily. Magnetic resonance imaging (MRI)-derived spleen T1, cT1, extracellular fluid volume fraction (ECV) and size measures have been associated with portal hypertension. This study explores these spleen MRI measures to improve the identification of cACLD patients with and without VNTs.

Methods

Ninety-one cACLD patients of mixed aetiologies had spleen MRI, blood and liver stiffness assessment within median 30 days (IQR 11 – 117) of endoscopy screening for varices. MRI with gadoxetic acid administration was used to measure spleen T1, cT1, ECV, volume and diameter. Measures were explored for the identification of VNTs. New criteria were derived to avoid the most endoscopies for VNTs, whilst missing $<5\%$ of VNTs. Baveno and other published criteria were also tested.

Results

Patients had median age 61 years and 70% were male. VNT prevalence was 14%. Spleen T1 x spleen diameter had the highest accuracy for the identification of VNTs (area under the receiver operator curve 0.87, $p < 0.001$). Spleen T1 <1307 ms or spleen diameter <137 mm was the best performing criteria to avoid screening endoscopies for VNTs, saving 66% of endoscopies (table 1).

Conclusions

Spleen T1 and spleen diameter criteria have high accuracy for the identification of VNTs and could avoid more endoscopy screening for VNTs safely than published criteria.

Table 1. Ability of non-invasive criteria to avoid endoscopy screening for VNTs in cACLD.

	Endoscopies avoided (%)	VNTs missed (%)
New criteria		
Spleen T1 <1307 ms or spleen diameter <137 mm	60 (66%)	0
Spleen diameter <159 mm and platelets >112 x10 ⁹ /l	52 (57%)	0
Platelet/spleen volume <0.267 x10 ⁹ /l/ml	49 (54%)	0
Spleen T1 x spleen diameter <185088 mmm	46 (51%)	0
Spleen T1 <1307 ms	41 (45%)	0
Spleen cT1 <1252 ms	37 (43%)	0
Spleen diameter <137 mm	36 (40%)	0
Spleen volume <403 ml	33 (36%)	0
Platelet/spleen diameter <1.27 x10 ⁹ /l/mm	24 (26%)	0
Platelets >213 x10 ⁹ /l	15 (16%)	0
Spleen ECV <0.317	13 (14%)	0
Published criteria		
Baveno VI	16 (20%)	0
Expanded Baveno	39 (48%)	2 (5%)
MELD = 6, platelets >150 x10 ⁹ /l	15 (16%)	0
LSPS <1.33	23 (28%)	1 (4%)

Abbreviations: MELD, modified end stage liver disease score; LSPS, liver stiffness and platelet count/spleen diameter ratio score; ECV, extracellular volume fraction.