Role of Splenic 2D-Shear Wave Elastography in Diagnosis of Portal Hypertension in Cirrhotic Patients

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Abstract

Background: Portal hypertension as a result of liver cirrhosis, which lead to severe clinical symptoms and death. Spleen stiffness measurements (SSM) are a noninvasive, simple technique has a correlation with the hepatic venous pressure gradient (HVPG).

Aim of Study: This study aimed to determine whether SSM can predict high-risk varices in patients with liver cirrhosis.

Patients and Methods: This is a case control study, which took place between December 2021 and April 2022 at the Kasr Al-Ainy Radiology Department's ultrasound unit, 22 patients with cirrhotic patients and 24 healthy controls participated. SSM and ultrasound were performed in correlated to endoscopic findings of varices.

Results: Patients were 17 males and 5 female with mean age (49.8), age was positively weakly linked with high shear wave elastography (SWE) values with a *p*-value of 0.046. *p*-values of 0.011 indicated a statistically significant difference between high SWE values and higher grade esophageal varices. Age and SWE of >29 kpa are independent predictors of liver cirrhosis, according to multivariate regression analysis, with *p*-values of 0.016 and 0.002, respectively, and an OR for SWE of 27.2 (3.3-220.3).

Conclusion: SSM By 2D-shear wave elastography is a good method for assessment of liver cirrhosis and associated clinically significant portal hypertension.

Key Words: Liver cirrhosis – Portal hypertension – Splenic stiffness – SWE.

Introduction

PORTAL hypertension as a consequence of liver cirrhosis, which raises risk of patient death and puts patients at risk for severe clinical symptoms [1].

Hepatic vein pressure gradient (HVPG) is the best method for determining the severity of portal hypertension [2].

"Clinically significant PH" (CSPH) is defined by an HVPG >10mmHg, and "clinically severe PH" (CSPH) is defined by an HVPG >12mmHg [3].

Gastroesophageal varices (GEV) and a risk of decompensation clinically with occurence of as cites, variceal hemorrhage, and hepatic coma have been related to clinically significant portal hypertension [4]. The likelihood of GEV hemorrhage is mostly determined by variceal size; however, it could be managed when receiving the appropriate medical or endoscopic treatment which is primarily administered to high-risk varices (HRV), which are identified by the presence of big varices or hemorrhagic stigmata regardless the size [5].

Transient elastography (TE) assessments of spleen stiffness (SSM) are a simple, noninvasive technique that have been thoroughly investigated and found to be linked with HVPG and the existence of GEV [6].

Recently developed two-dimensional shear wave elastography (2D-SWE) technology seems to have superior success rates than TE for SSM [7]. Moreover, it has been discovered that SSM employing 2D-SWE correlates with HVPG [8]. Our study's objective is to determine whether SSM can exclude high-risk varices from cirrhosis patients without the need for an upper gastrointestinal endoscopy (UGE).

Patients and Methods

This case control observational study was conducted at the radiology department's Kasr Al-Ainy Ultrasonography Unit between December 2021 and April 2022, patients were gathered from inpatient units or outpatient clinics.

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Every patient agreed to be included in the research. Both gender cirrhotic patients with portal hypertension who are older than 20 years were chosen in this study

Patients that were younger than twenty years old, with a history of sepsis, alcoholic hepatitis, transjugular intrahepatic Porto systemic shunt (TIPS), splenectomy, porto-splenic venous thrombosis, pregnancy/lactation, and severe sickness were excluded.

Every procedure was conducted in compliance with the 1975 Helsinki Declaration, as revised in 2008, and the ethical guidelines developed by the relevant committee on human experimentation (national and institutional).

The full history, clinical examination, lab investigation, upper gastrointestinal tract endoscopy, abdominal ultrasound using a conventional ultrasound machine (TOSHIBA Aplio 500) with (6C1) curvilinear probe, and shear-wave elastography examination were performed on all included patients.

The statistical data and techniques: The 22nd edition of SPSS was used for the statistical analysis. The quantitative data were given as mean and standard deviation, and the Mann Whitney U test was used for means when comparing two groups, and the Kruskal Wallis test for groups larger than three. The Chi² test was used in comparing the categorical data between the research groups. The

results were given as percentages and frequencies. Sensitivity analysis was used to evaluate SWE's diagnostic potential for splenic affection in high-risk varices and cirrhotic individuals. significant *p*-value when became less than 0.05.

Results

This case-control study included 22 cirrhotic patients and 24 healthy controls. The age and gender distributions of the study groups differed statistically significantly (p=0.0001 and 0.001, respectively). Table (1) illustrates that the cases had significantly bigger PV diameters (p 0.0001), larger spleen lengths (p 0.0001), and higher Kpa in SWE with a p-value of 0.0001.

They also had significantly smaller liver lengths $(p \ 0.048)$.

Nine patients (40.9%) in the cases group had grade II esophageal varices. The majority of cases had upper gastrointestinal bleeding as their clinical presentation; 10 (45.4%) had hematemesis, 8 (36.4%) had melena, 3 had both hematemesis and melena, and 1 patient only had anemia symptoms. Table (2) Fig. (1A,B,C).

Sensitivity study revealed that, with a Cutoff value of 29, shear wave elastography may diagnose splenic affection in cirrhotic patients with 81.8% sensitivity, 87.5% specificity, 84% NPV, 85.7% PPV, 84.8% diagnostic accuracy, 80% AUC, and *p*-value of 0.0001. Fig. (2).

Table (1): Demographics and SWE findings among study groups.

	Group				
-	Cases (n=22)		Control (n=24)		value
Age (years): Mean, SD	49.8	9.0	38.3	7.9	0.0001
Gender: Female N, %	5	22.7%	17	70.8%	0.001
Male N, %	17	77.3%	7	29.2%	
<i>Liver length (cm):</i> Mean, SD	13.6	1.5	14.4	1.2	0.048
P.V diameter (mm): Mean, SD	13.3	2.6	10.0	1.8	0.0001
Length of spleen (cm): Mean, SD	16.8	2.8	10.9	1.5	0.0001
Elasticity of spleen measured by elastography (Kpa): Mean, SD	30.3	6.7	28.8	12.8	0.0001

			Control (n=22)	
Grade of varices	0	N, %	1	4.5%
	Ι	N, %	7	31.8%
	Π	N, %	9	40.9%
	III	N, %	4	18.2%
	IV	N, %	1	4.5%
Clinical presentation	Anemia	N, %	1	4.5%
	Both	N, %	3	13.6%
	Hematemesis	N, %	10	45.4%
	Melena	N, %	8	36.4%

Table (2): Clinical presentation and grade of esophageal varices among cases group.

Age was positively weakly associated with high shear wave elastography values, according to the correlation matrix, with a *p*-value of 0.046. With a *p*-value of 0.0001, the length of the spleen showed a substantial and positive correlation with high shear wave elastography results. SWE levels, however, did not substantially associated with liver length or PV diameter. Table (3).

A statistically significant difference in SWE kpa according to grade of EV was seen when SWE values according to grade of esophageal varices were compared; higher grade was linked to higher spleen stiffness (p=0.011). Fig. (3).

Sensitivity analysis revealed that, with *p*-value of 0.256 and an AUC of 67.1%, SWE is not a significant predictor of high risk esophageal varices. Fig. (4).

Multivariate regression model demonstrated that, with *p*-values of 0.016 and 0.002, respectively, and an OR for SWE 27.2 (3.3-220.3), age and SWE of >29 kpa are independent predictors for liver cirrhosis. Table (4).

Table (3):	Correlation matrix between Elasticity of spleen
	measured by elastography and other US parameters
	and age.

		Elasticity of spleen measured by
		elastography
Age	Correlation Coefficient	0.295*
	<i>p</i> -value	0.046
Length of	Correlation Coefficient	0.517**
spleen (cm)	<i>p</i> -value	0.0001
P.V diameter	Correlation Coefficient	0.290
(mm)	<i>p</i> -value	0.050
Liver length	Correlation Coefficient	-0.039
(cm)	<i>p</i> -value	0.796

Table (4): Binary regression model showing predictors for liver cirrhosis.

	<i>p</i> -value OR		95% C.I.		
			Lower	Upper	
Age	.016	.844	.735	.969	
Gender	.243	3.192	.455	22.392	
SWE (>29 kpa)	.002	27.220	3.362	220.382	



Fig. (1A): 55yrs old HCV male patient Male patient presented with hematemesis Liver & spleen appearance by grey scale ultrasonography showing mildly enlarged spleen & cirrhotic liver.



Fig. (1B): Shear-Wave Elastography stiffness values in 37.7kPa in case of Portal Hypertension Gastropathy & Grade III varix.



Fig. (1C): Esophgealvarices, Grade III (banded), Gastropathyportalhypertension.



Fig. (3): Box plot showing stiffness of spleen according to grade of EV.



Fig. (2): ROC curve showing predictability of SWE for splenic stiffness among cirrhotic patients.



Fig. (4): ROC showing SWE diagnostic ability for high-risk varices.

Discussion

Portal hypertension is a severe consequence of liver cirrhosis because it leads to the occurance of sever clinical symptoms and increases mortality in patients [1].

A promising technique for expecting the existence of gastroesophageal varices and clinically severe portal hypertension is the transient elastography spleen stiffness test [9]. Since it was believed that spleen stiffness and PH were intimately connected [10]. In order to check the accuracy of Spleen stiffness assessment assessed by 2D-SWE for ruling out the presence of HRV with the gold standard (esophagogastroduodenoscopy), we conducted a case control study with 22 patients with liver cirrhotic and 24 healthy individuals as control.

Current study showed, the cases showed higher Kpa in SWE with *p*-value 0.0001, greater PV diameter (p 0.0001), larger spleen length (p 0.0001), and considerably smaller liver length (p 0.048). These results are supported by the fact that chronic liver disease caused the liver to shrink, which is indicative of a decrease in liver length (III,I2I and that chronic liver disease is linked to a dilated portal vein (\geq 13mm), which is primarily explained by the fibrotic blocks of cirrhotic liver pulling against the PV walls (II3).

Our results demonstrated that, with a Cutoff value of 29, shear wave elastography can detect splenic stiffness in cirrhotic patients with 81.8% sensitivity, 87.5% specificity, 84% NPV, 85.7% PPV, 84.8% diagnostic accuracy, 80% AUC, and *p*-value of 0.0001. SWE was used by Grgurevic et al. [14] to asses hepato-splenic stiffness in 123 patients. The study's findings demonstrated that spleen stiffness, with a cutoff of 24 kpa, can significantly predict liver cirrhosis with a *p*-value <0.05, sensitivity 66.7%, specificity 86.7%, and AUC 82.1%.

A comprehensive meta-analysis carried out by Song et al. [15] revealed that splenic stiffness can accurately predict liver cirrhosis with high PHT, with 88% sensitivity and 84%, specificity, and an AUC of 92%. Nevertheless, they also noted a remarkable degree of Variability among the included research.

Age was shown to be positively weakly associated with high shear wave elastography values in the current investigation, as indicated by the correlation matrix (p=0.046). With a p-value of 0.0001, the length of the spleen showed a substantial and positive correlation with high shear wave elastography results. Our results were in line with those of Grgurevic et al. [14], who used SWE and found a substantial association (p=0.0002) between spleen stiffness and size.

Our findings demonstrated a statistically significant difference in SWE kpa based on EV grade, with a *p*-value of 0.011 connecting higher grade with greater spleen stiffness. With a *p*-value of 0.256 and an AUC of 67.1%, sensitivity analysis revealed that SWE is not a significant predictor of high risk esophageal varices.

Karagiannakis et al. [16] found a remarkable difference in splenic stiffnessstatistically based on EV grade; however, their results indicate that SWE can significantly predict high-risk EV with an AUC of 79.2% and a cutoff point of 33.7 kPa (specificity 60%, sensitivity 91.7%). Our findings partially corroborate their findings. The primary reason for the differences between our results and those of Karagiannakis and colleagues is that they included all cirrhotic patients including those with cholestatic liver disease without requiring a control group.

Using a multivariate binary regression model, we were able to determine that liver cirrhosis may be independently predicted by age and SWE of >29 kpa, with *p*-values of 0.016 and 0.002, correspondingly, and an odds ratio of 27.2 (95% confidence interval 3.3-220.3) for SWE. These results disagreed with those of Grgurevic et al. [14], who noted that spleen size and obesity could be confounding variables when utilizing splenic stiffness by SWE as a diagnostic tool for liver cirrhosis.

Lastly, we advise carrying out a large-scale study to measure spleen stiffness in cirrhotic patients and correlate it with factors including age, gender, spleen size, EV grade, and portal vein pressure gradient. Validation of a SWE procedure for EV and splenic stiffness evaluation in patients with liver cirrhosis. Verification of a trust worthy threshold for splenic stiffness.

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دور الموجات فوق الصوتية فى قياس مرونة أنسجة الطحال فى حالات ارتفاع ضغط الوريد البابى

يعد ارتفاع ضغط الوريد البابى الكبدى نتيجة خطيرة لتليف الكبد لأنه يؤدى إلى تطور أعراض اكلينيكية خطيرة وهـذا يؤدى إلى زيادة عدد وفيات لهـؤلاء المرضـى.

تم تقديم قياس صلابة الطحال عبر التصوير الإلستوجرافى العابر كطريقة واعدة للتنبؤ بارتفاع ضغط الوريد البابى الكبدى ووجود دوالى المرئ. يتمتع قياس مرونة أنسجة الطحال باستخدام القص الموجى بالموجات فوق الصوتية، وهى تقنية أحدث، بمعدلات نجاح أعلى من التصوير المرن العابر.

وتستهدف هذه الدراسة أن إذا كان قياس مرونة أنسجة الطحال يمكن أن يستبعد وجود دوالى شديدة الخطورة فى مرضى تليف الكبد، يمكننا من تجنب استخدام منظار الجهاز الهضمى العلوى.

الدراسة الحالية عبارة عن دراسة حالة ضابطة شملت ٢٢ مريضًا من مرضى تليف الكبد و٢٤ أصحاء. تم إحضار المرضى إلى وحدة الموجات فوق الصوتية فى قسم الأشعة فى قصر العينى من العيادات الخارجية أو أقسام المرضى الداخليين فى الفترة من ديسمبر ٢٠٢١ إلى أبريل ٢٠٢٢ حيث أجريت دراستنا.

تم إخضاع جميع المرضى لفحص الموجات فوق الصوتية التقليدية وفحص المرونة القصية.

ونستخلص من هذه الدراسة أن تصلب الطحال الذي تم قياسه باستخدام القص الموجى بالموجات فوق الصوتية هـو طريقة واعدة لتشخيص تليف الكبد وما يترتب عليه من إرتفاع ضغط الوريد البابى الكبدى.