International Journal of Innovation Scientific Research and Review
Vol. 03, Issue, 10, pp.1795-1802, October, 2021
Available online at http://www.journalijisr.com
SJIF Impact Factor 4.95

IJISRR

ISSN: 2582-6131

Research Article

CORRELATION BETWEEN 3 TYPE OF HEPATIC SHEAR WAVE ELASTOGRAPHY AND TRANSIENT ELASTOGRAPHY IN PREDICTION OF LIVER FIBROSIS

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Received 03th August 2021; Accepted 06th September 2021; Published online 10th October 2021

ABSTRACT

Background: Various type of non-invasive tests for the evaluation of liver fibrosis have been proposed, including transient elastography and shear wave elastography. Transient elastography (TE) is widely accepted modality but the correlation between TE and shear wave elastography (SWE) is still unclear. This study aims to evaluate the performance of 3 shear wave elastography methods in comparison with transient elastography within the same patient**. Material and method:** 198 patients with chronic liver disease who underwent multiple methods of elastography were retrospectively studied. The liver stiffness measurement (LSM) were obtained using 2D-SWE (LOGIQ9E), 2D-SWE ElastQ and P-SWE (ElastPQ) and compared to transient elastography (TE), which is used as the reference standard. **Results and conclusion:** The two 2D-SWE (LOGIQ9E and ElastQ) showed higher technical reliability rate of 98.3 % and 83.3%, respectively, in contrast with P-SWE (ElastPQ) (69.2%). 2D-SWE (LOGIQ9E) had better correlation with TE than 2D-SWE (ElastQ) and P-SWE (ElastPQ) with correlation value of 0.84, 0.61, and 0.61, respectively. The receiver operating characteristic (ROC) curve analysis for predicting significant fibrosis (> F2) yielded area under the ROC curve (AUROC) value base on TE of 0.77-0.87 indicating a strong correlation between these tests. The cut off value of 4.7 kPa for 2D-SWE (ElastQ), and 4.6 kPa for P-SWE (ElastPQ) could provide 81.1% sensitivity for the diagnosis of significant liver fibrosis (F≥ 2). Our study showed high reliability rate between all type of elastography. Among the 3 type, 2D-SWE (LOGIQ9E and ElastQ) provide a better reliability rate and correlation with TE than P-SWE.

Keywords: liver fibrosis, liver stiffness, transient elastography, shear wave elastography.

INTRODUCTION

Chronic liver disease (CLD) and cirrhosis is a worldwide health problem with estimated mortality of 1.32million[1], causing a high rate of disability and increase healthcare burden and utilization[2]. By definition, chronic liver disease (CLD) is the set of diseases with decrease hepatic function as a result of chronic inflammation or chronic liver injury. The advanced stage of CLD often leads to the development of cirrhosis, which defined as the irreversible distortion architecture by fibrosis, scar and abnormal nodule[3, 4]. The proper evaluation of staging liver fibrosis is very important for treatment, prognosis assessment and long-term follow up[5]. For many years, liver biopsy has been the gold standard for evaluating the degree of fibrosis. The procedure is invasive, costly, and has limitation in the diagnostic utility and accuracy due to inadequate sampling. As a result, noninvasive modalities for liver assessment are now being increasingly used. Non-invasive assessment of liver fibrosis can be performed by biological test[64] or by elastography measurement. Recently, the European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB)[7, 8] and the Canadian Association for the Study of the Liver (CASL) have recommended elastography as a method for assessment of liver fibrosis. Elastographic methods can be divided into two main types: displacement techniques and shear wave speed techniques. The former includes Transient Elastography (TE); fibroscan (EchoSens, Paris, France) while the latter include point shear wave elastography (PSWE); the ElastPQ technique; Acoustic Radiation Force Impulse elastography (ARFI); and shear wave elastography imaging which included 2D and 3D-SWE[9-12].

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Transient elastography (Fibroscan, Echosens) is an ultrasound base method using a vibrator mounted to an ultrasound transducer which creates low frequency wave. The shear wave speeds is calculated into tissue elasticity using Young's modulus and displayed as kilopascals (kPa)[6]. Is has been widely used since 2003[13], and now accepted as a reference for liver stiffness evaluation. However, TE has limitation to measure liver stiffness in patients with as cites and has carry up to 20% failure rate, especially in patients with a high body mass index[4]. Acoustic Radiation Force Impulse (ARFI) quantification, which measured the speed of the shear wave in a small region has been developed in 2008[14],and classified by the European federation of societies for ultrasound in medicine and biology (EFSUMB) [7] as point shear wave elastography (PSWE). This technology provided quantitative elastography which is embedded in a conventional ultrasound machine. In 2012, a real time SWE technique for liver stiffness quantification has been implemented in Supersonic Imagine by Aixplorer[15, 16], which provide bidimensional elastography information called real time 2D SWE[16]. SWE has various benefits above TE in the evaluation of liver fibrosis in patient with as cites. Many studies have reported usefulness of both TE and SWE for the evaluation liver stiffness but few studies have directly compared TE and SWE results obtained using various ultrasound device in the same patients. In this study, we measured liver stiffness by TE and three various methods SWE and compare the result, reliability and correlation between TE and each SWE measurement in the same patients within one month.

MATERIAL AND METHOD

This was a single-center cross-sectional study conducted in a tertiary center. Matched patients from the hepatobiliary and Gastroenterology units between September 2017 and August2018 who received

transient elastography (fibroscan) and ultrasound of the upper abdomen in the Radiology department less than one month were included. All transabdominal ultrasonographic procedures were performed by single experienced radiologist while the transient elastography was performed by experienced nurse certificated in performing Transient elastography. In fasting condition, the patient was placed in the supine position with right arm in maximum abduction, after which measurements were taken of the right lobe of the liver through the intercostals spaces while subjects held their breath for a few seconds. Transient elastography was performed with Fibroscan device (EchoSens, Paris, France), which incorporates a 1.5-MHz ultrasound transducer probevibrator in order to generate a more complete and painless vibration (50 Hz frequency and 2 mm amplitude)to induce elastic shear wave propagation through the skin and subcutaneous tissue to the liver. The wave velocity was tracked by a coaxial ultrasound transducer and was calculated by the device and expressed in kilopascals. For each patient, 10 valid TE measurements were performed. Reliable measurement was defined as success rate (SR = ratio of the number of successful acquisitions divided by the total number of acquisitions) > 60% and interquartile range interval (IQR = the difference between the 75th and 25th percentile; essentially, the range of the middle 50% of the data) <30%. After this, the median values of the 10 valid measurements were calculated.

Shear wave elastography

After ultrasound examination of the upper abdomen, elastography was performed using the EPIQ7 ultrasound system (Philips Healthcare, Bothell, WA, USA) with convex broad base probe (ElastPQ technique, figure 1). After finished evaluation with P-SWE (ElastPQ technique then the patient rest on the table then evaluation with 2D-SWE (ElastQ technique, figure 2)with same probe and near the same position till have finished. Then patients were moved to another machine. After 10minute rest, the evaluation by 2D shear wave elastography using GE LOGIQ 9E (GE Healthcare, Wauwatosa, WI, USA, figure 3) was carried out in the same session.

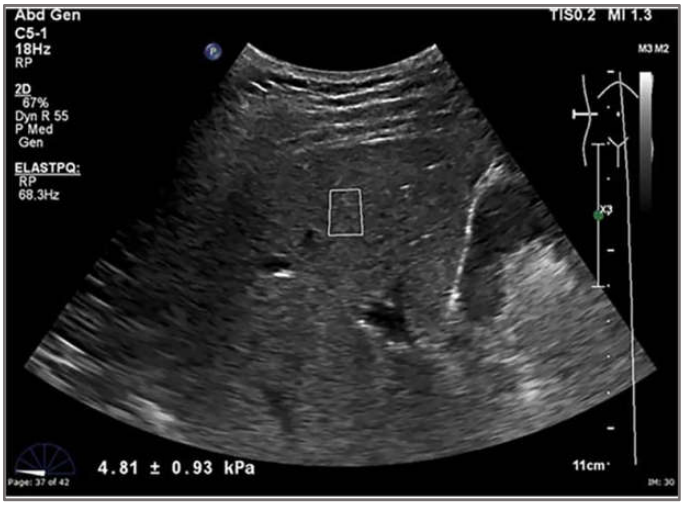

Figure 1: Point shear wave elastography (P-SWE) by Phillips (ElastPQ). The figure illustrated point swear wave elastography performed on the patient. The box (center) represented the shear wave measurement area and is expressed below the obtained elasticity measurement of 4.81 kPa.

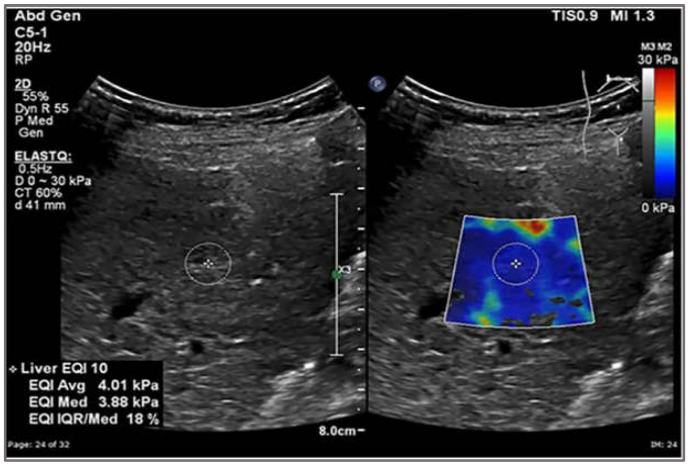

Figure 2: 2D-SWE by ElastQ. The figure illustrated the method of 2D-SWE by Phillips. The color box(center) represented the elastogram and the circle represented the ROI where the elastic modulus (LSM, liver stiff ness measurement) of the liver was acquired, the blue color indicated soft liver tissue, as semi-quatatively presented by the colour scale to the right.

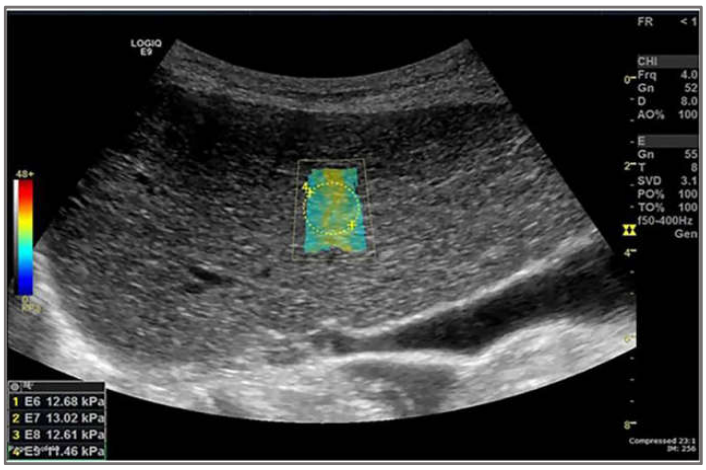

Figure 3: 2D-SWE by LOGIQTM E9. The figure illustrated the method of 2D-SWE by GE. The color box (center) represent the elastogram and the circle represent the ROI where the elastic modulus (LSM, liver stiff ness measurement) of the liver is acquire, the blue color indicates soft liver tissue, as semi-quatatively presented by the colour scale to the left.

ElastPQ technique

The method, point shear wave elastographyusing EPIQ7 with ElastPQ technique generates shear waves inside the liver using radiation force from a focused ultrasound beam. The ultrasound machine monitors the shear wave propagation and the measurement of the velocity of the shear waves which was displayed in meters per second (m/s) or in kilopascal (kPa). The region of interest (ROI) was set using real time imaging to select the vessel-free area and at least 1.5 cm deep from the liver capsule. The fixed region of interest size of 0.5x1.5 cm was set with the patients holding their breath, and then 10 valid measurements were performed. The machine automatically calculated the mean and median values and the IQR of the valid measurements, and a homogenous area with IQR of less than 30% was considered a valid measurement[17, 18].

2D-shear wave elastography with ElastQ technique (2D-SWE ElastQ)

2D shear wave elastography by Philips EPIQ7, ElastQ technique (2D-SWE ElastQ) was performed in the patient which provides a

quantitative assessment of tissue stiffness, using ARFI to create multiple shear wave pulses through the soft tissue. ElastQ imaging provided a large color-coded map in real time. The ROI represented an area of interest to assess change in tissue stiffness. In each case, region of interest (ROI) was placed at least 1.5 to 2 cm below the liver capsule and free of vessel, and repeated for 10 samples.

2D shear wave elastography (2D-SWE LOGIQ™ E9)

2D shear wave elastography was performed by LOGIQ 9E (GE Healthcare, Wauwatosa, WI, USA) using R5.1.0 software and a C1-6-D probe to obtain a quantitative elasticity map of the medium. An ultrafast, ultrasonic scanner was used to generate a mechanical shear wave by focusing ultrasound at the given location and imaging the medium during the wave propagation at a high frame rate, and tissue elasticity was displayed in units of velocity, meters per second (m/s) or converted into kilopascal. The region of interest (ROI)was located at least 1 cm below the liver capsule and clear of the vessels. Using circular measurement, approximately 1 cm in diameter, 10 measurement regions were placed on different shear wave images, and then the system calculated the mean and median values and the IQR of valid measurements. Measurements in homogenous areas with IQR less than 30% were considered valid. We calculated the sample size based on the previous study of Castera L et al, with the success rate of about 60 percent. The calculated sample size was done.

Statistical analysis

Demographic data and clinical history were summarized using descriptive statistics, and analysis was performed using SPSS, version 17.0 (IBM statistics). Categorical variables were reported as number of patients (percent). Student's t-test and pairedt-test were used for group comparison of continuous variables (the results of liver stiffness measurement)with normal distribution. Pearson's correlation coefficient (r) was used to assess the correlation of median LS measurement by point shear wave elastography (PSWE using ElastPQ) and 2D shear wave elastography (2D-SWE by GE LOGIQ 9E) with Fibroscan.

RESULTS

Baseline characteristics

Abdominal ultrasound and elastography were performed in 810 patients. Nine patients were excluded due to hearing problem, and difficult to control respiration causing technical difficulty in performing the elastography procedure. Finally, 801 patients who successfully received both Shear wave elastography of both 2D-SWE (LOGIQ™ E9 and ElastQ) and point shear wave elastography P-SWE were analyzed. Among 198 patients who received both fibroscan and shear wave elastography, 93 (47%) were female and 105 (53%) were male with mean age of 49.87±12.02 years. With the Mean body weight of 65.18±13.94 kg and mean height of 162.74±7.9 cm, the calculated Body mass index was considered normal in 59.6%, overweight (BMI 25 to 30 kg/m^2) in 27.3% and obese (BMI >30 kg/m^2) in 13.1%. based on the Asian BMI criteria. The causes of chronic liver disease were hepatitis B (44.9%), hepatitis C (29.3%), alcoholic hepatitis (2.3%), fatty liver (fatty liver, NASH and NAFLD) (9.6%). Patient's characteristics were presented on Table 1.

Table 1: Patients' characteristics (n=198)

Characteristic	Number (mean ± SD)	percent
Age (years)	49.87+12.02	
Gender		
Male	105	53
Female	93	47
Weight	65.18+13.93	
Height	162.74+7.9	
AST: SGOT (IU/L)	42.47 ± 40.19	
ALT: SGPT (IU/L)	41.49±38.04	
BMI		
Normal (<25)	118	59.6
Overweight (25-30)	54	27.3
Obese (>30)	26	13.1
Underlying		
Hepatitis B	89	44.9
Hepatitis C	58	29.3
Fattyliver (NASH, NAFLD)	19	9.6
Alcoholic	10	5
Coinfection (hepatitis B,C+HIV)	5	2.5
Other	17	8.6

AST= Aspartate aminotransferase; ALT= Alanine transaminase; BMI = Body mass index; NASH = Nonalcoholic steatohepatitis; NAFLD = Nonalcoholic Fatty Liver Disease; HIV = Human immunodeficiency virus.

Diagnostic performance of elastography and Fibroscan®

Among 198 patient who had been examined with Fibroscan® and shear wave elastograhy, the median liver stiffness evaluated by Fibroscan, 2D-SWE by LOGIQ™ E9, 2DSWE ElastQ, P-SWE (ElastPQ) were 6.55± 9.93, 6.44±4.65, 4.97±3.71 and 5.32± 23.2, respectively. The IQR/Median of Fibroscan®, 2D-SWE (ElastQ) and P-SWE (ElastPQ) of less than 0.3 are about 100 percent, while for 2D-SWE LOGIQ™ E9 was about 99.9%. All methods have success rate over 60 percent. The median of level of stiffness measured by Fibroscan® is higher than measurement by 2D-SWE by LOGIQ™ E9, 2D-SWE ElastQ significantly. On other hand, the median level of stiffness measured by 2D-SWE (ElastQ) was less than 2D-SWE LOGIQ™ E9 and -SWE (ElastPQ) significantly.

The reliability of Fibroscan® and each type of shear wave elastography 2D-SWE LOGIQ™ E9, 2D-SWE (ElastQ), P-SWE (ElastPQ) were 97.5, 98.5, 83.3 and 69.2 percent, respectively. When compare among two type of shear wave elastography,2D-shear wave elastography has reliability better than point shear wave elastography. The operation time of Fibroscan, 2D-SWE by LOGIQ™ E9, 2D-SWE ElastQ, P-SWE (ElastPQ) were 246.16± 256.06, 118.03± 518.21, 148.32± 768.67 and 355.47± 2561.53 minutes, respectively. The procedure time was longest in point shear wave elastography and shortest in 2D-SWE LOGIQ™ E9. (Table 2). The comparison between each type of elastography is demonstrated in table 3.

Table 2: Liver stiffness measurement (kPa), success rate for different techniques (n = 198)

	TE Fibroscan	2D-SWE LOGIQ™ E9	2D-SWE(ElastQ)	P-SWE (ElastPQ)
Liver stiffness measurement (kPa)				
Mean	10.51	7.93	6.46	10.54
Median	6.55	6.44	4.97	5.32
Standarddeviation(SD)	9.93	4.65	3.71	23.2
Reliability (IQR/median>30% and success rate 60%)				
Reliable	193(97.5%)	195(98.5%)	165(83.3%)	137(69.2%)
Non reliable	5(2.5%)	3(1.5%)	33(16.7%)	61(30.8%)
Procedure-time (Minutes) (mean + SD)	246.16±256.06	118.03±518.21	148.32±768.67	355.47±2561.53

Table 3: Sensitivity and comparison of success rate, Operation time of shear wave elastography technique and fibro scan

Comparison type	Sensitivity N=193	Average of success rate (mean±SD)	p-value	Operation time(second)	p-value
2D-SWE LOGIQTM E9TE	190	97.86+12.13	0.727	242.60+251.79	0.003*
VS Fibroscan	(98.4%)	88.86+14.87		118.03+518.20	
2D-SWE(ElastQ)	162	97.86+12.13	<0.001*	242.60+251-79	0.090
VS Fibroscan	(83.9%)	76.45+24.02		148.32+768.66	
P-SWE (ElastPQ)	136	97.86+12.13	<0.001*	242.60+251-79	0.003*
VS Fibroscan	(70.5%)	97.56+8.54		355.47+2561.53	
2D-SWE LOGIQTM E9	162	88.86+14.87	<0.001*	118.03+518.20	0.652
VS 2D-SWE(ElastQ)	(83.1%)	76.45+24.02		148.32+768.66	
2D-SWE LOGIQTM E9	136	88.86+14.87	<0.001*	118.03+518.20	0.205
Vs P-SWE (ElastPQ)	(69.7%)	97.56+8.54		355.47+2561.53	
2D-SWE(ElastQ)	119	76.45+24.02	<0.001*	148.32+768.66	0.278
Vs P-SWE (ElastPQ)	(86.9%)	97.56+8.54		355.47+2561.53	

TE=Transient elastography, P-SWE = Point shear wave elastography, 2D-SWE = 2D shear wave elastography * = Significant at p<0.05

Table 4: Comparison liver stiffness value of shear wave elastography technique and fibroscan

Elastography technique	liver stiffness (kPa)	Correlation (p-value)	t-test	p-value for paired t-test
2D-SWE LOGIQ™ E9 TE (Fibroscan)	7.93±4.65 10.51±9.93	0.84 (<0.001*)	5.581	<0.001*
2D-SWE(ElastQ) TE (Fibroscan)	6.46±3.71 10.51±9.93	0.61 (<0.001*)	6.951	<0.001*
P-SWE (ElastPQ) TE (Fibroscan)	10.54±23.20 10.51±9.92	0.61 (<0.001*)	-0.019	0.985
2D-SWE(ElastQ) 2D-SWE LOGIQ™ E9	6.46±3.71 7.93±4.64	0.61(<0.001*)	5.831	<0.001*
P-SWE (ElastPQ) 2D-SWE LOGIQ™ E9	10.54+23.20 7.93+4.64	0.58(<0.001*)	-1.764	0.079
P-SWE (ElastPQ) 2D-SWE(ElastQ)	6.46+3.71 10.54+23.20	0.41(<0.001*)	-2.619	0.009*

* = Significant p < 0.05

Correlation and comparison of liver stiffness value by each type of elastography.

The correlations of LS measurements are presented in Table 3. 2D-SWE LOGIQ™ E9 showed slightly better correlation with TE than 2D-SWE (ElastQ) and P-SWE (ElastPQ). When compare between 2D-SWE techniques, 2D-SWE LOGIQ™ E9 had better correlation with fibroscan than 2D-SWE (ElastQ). The mean liver stiffness measurement of each technique mostly provided the different result except for the point shear wave elastography (Elast PQ), which was not significantly difference with fibroscan and 2D-SWE LOGIQ™ E9 as shown in table 4.

Correlation between TE and SWE values

The correlation between TE-fibroscan values and 2D-SWE LOGIQ™ E9 value showed a strong relationship with r = 0.8 (p<0.001) (see supplement data). The regression equation between TE-Fibroscan and 2D-SWE LOGIQ™ E9 was TE (kPa)= 1.8x (2D-SWE LOGIQ™ E9) -3.73. The correlation between TE-fibroscan values and 2D-SWE (ElastQ) value showed moderate relationship, with r= 0.6 (p<0.001). The regression equation between TE-Fibroscan and 2D-SWE (ElastQ) was TE (kPa)=1.63x (2D-SWE (ElastQ)) +0.02 The correlation between TE-fibroscan values and P-SWE (ElastPQ) value also showed moderate relationship, with r = 0.6 (p<0.001). The regression equation between TE-Fibroscan and P-SWE (ElastPQ) was TE (kPa) = 0.68x (P-SWE (ElastPQ)) + 2.56. The summary of ROC curve demonstrating correlation between 3 types of shear wave elastography and Fibroscan is shown in figure 4.

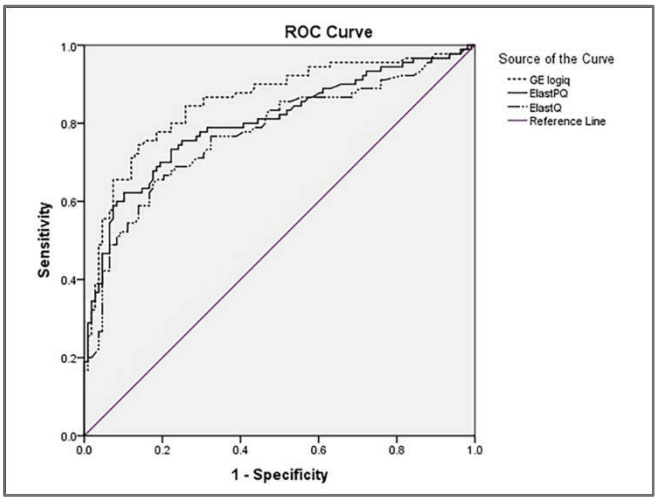

Figure 4: Summery receiver operation characteristic curve (SROC) of for diagnosis significant fibrosis F ≥ 2 by transient elastography (TE) and swear wave elastography using various ultrasound devices :2D-SWE LOGIQ™ E9, 2D-SWE (ElastQ), P-SWE (ElastPQ)

The value liver stiffness measurements (LSM) for diagnosis significant fibrosis vary according to the suggestion from manufacturers as shown in table 5. For TE, the reference cut off value for the prediction of significant fibrosis (F2) is 7 kPa. With different cut off point in each SWE modality, different sensitivity and specificity were provided (table 5). If using cut-off point for liver stiffness measurement with 2D-SWE LOGIQ™ E9was 8.29 kPa the sensitivity and specificity was 62% and 92.6%, respectively. On the other hand, if the cutoff point is set at 6 kPa, the sensitivity increased to 86.67% and negative predictive value increased up to 86.21%. The AUROC valued of 2D-SWE LOGIQ™ E9 was 0.86 (p = 0.029) corresponding to moderate diagnostic ability. If using the cut off point for liver stiffness measurement for significant fibrosis (F>2) for ElastQ and ElastPQ at 5.7 kPa, the Which provide sensitivity and specificity is 64.4% and 93.3%, when using ElastQ and 73.3% and 78.8% for ElastPQ for the diagnosis of significant fibrosis, respectively. On the other hand, is the cut off value is set at 4.7 kPa for 2D-SWE (ElastQ), and 4.6 kPa for P-SWE (ElastPQ), the sensitivity could be increased up to 81.1% in both tests as shown in table 5. The AUROC valued of 2D-SWE (ElastQ) and P-SWE (ElastPQ) was 0.80 (p=0.011) and 0.77 (p= 0.387), respectively, both corresponding to moderate diagnostic ability.

Table 5: Sensitivity, specificity, positive predictive value, negative predictive value and accuracy in different shear wave elastography for prediction significant fibrosis (F2) using Fibroscan of ≥ 7 kPa as reference (data presented as % (95% confidence interval).

	2D-SWE LOGIQ™ E9		2D-SWE(ElastQ)		P-SWE (ElastPQ)	
	< 6	≥ 6	< 4.7	≥ 4.7	< 4.6	≥ 4.6
Fibroscan (< 7)	75	33	58	50	60	48
Fibroscan (≥ 7)	12	78	17	73	17	73
sensitivity	86.67%(77.87-92.92)		81.11%(71.49-88.59)		81.11%(71.49-88.59)	
specificity	69.44%(59.84-77.95)		53.70%(43.85-63.35)		55.56%(45.68-65.12)	
Positive predictive value	70.27%(63.75-76.06)		59.35%(53.80-64.67)		60.33%(54.64-65.76)	
Negative predictive value	86.21%(78.43-91.48)		77.33%(68.24-84.42)		77.92%(69.02-84.83	
accuracy	77.27%(70.80-82.91)		66.16%(59.11-72.72)		67.17%(60.16-73.66)	

Correlation of TE-Fibroscan and 3 SWE-method in difference etiology

When considered the etiology of liver disease, patients with fatty liver (NASH, NAFLD) have similar correlation with TE in all 3 SWE methods. For other etiologies, 2D-SWE (ElastQ) showed lower correlation than 2D-SWE LOGIQTM E9 and P-SWE (ElastPQ) (table 6).

Table 6: Correlation shear wave elastography and Fibroscan classified by etiology

Correlation with Fibroscan	2D-SWE LOGIQ™ E9	2D-SWE(ElastQ)	P-SWE (ElastPQ)
Hepatitis B infection	0.645 (P-value=0.000)	0.430 (P-value=0.000)	0.695 (P-value=0.000)
Hepatitis C infection	0.750 (P-value=0.000)	0.443 (P-value=0.000)	0.780 (P-value=0.000)
Alcoholic	0.891 (P-value=0.000)	0.545 (P-value=0.000)	0.983 (P-value=0.000)
Fatty liver	0.958 (P-value=0.000)	0.894 (P-value=0.000)	0.943 (P-value=0.000)

DISCUSSION

Assessment staging of liver fibrosis is important for treatment consideration and long-term follow up for many liver diseases. Liver biopsy is still considered the gold standard but the utility of this method is limited due to its invasiveness and carry significant risk for severe complication. With the development of newer technology, non-invasive method are increasingly used and now accepted as an alternative for percutaneous liver biopsy. In this study, all 3 methods SWE had high success rates and feasibility. All of them had high reliability rates[19] similar to TE[20], with similar reliability between TE and 2D-SWE (94.2% vs 95.8%). The previous study shows ElasQ technique was more reliable and can be performed faster than ElastPQ27. In the current study, the value of liver stiffness measured by TE-fibroscan and SWE (2D-SWE LOGIQ™ E9, 2D-SWE (ElastQ), P-SWE (ElastPQ)) showed different value. The liver stiffness value of SWE is slightly lower than TE which is similar to the report by Bonde.[26]Among the SWE, P-SWE (ElastPQ) and 2D-SWE (ElastQ) also provided difference result. The LSM by ElastQ is lower than Elast PQ which is different from the study of Lee, which showed higher value in ElastQ[21]. Most of study focus on direct comparison of diagnostic capability of SWE from various machine suggested that different SWE technique should not be used interchangeably[22-24]. The Radiological Society of North America Quantitative Imaging Biomarker Alliance conducted a phantom study using various commercial SWE systems and found statistically significant differences in SWE estimates among systems and this finding varies depends on the depth of ROI into the phantom[25]. That phantom study concluded that there are several sources of bias and variance that should be addressed to improve the consistency of measurements[25]. The variability of SWS measurements among different SWE technologies may occur due to shear-wave vibration frequency and bandwidth, as well as the software used to calculate relative shear-wave arrival time andspeed[11]. Despite good inter- and intra- observer agreement in human study[26], a significant difference was found between the two type of SWS measurements obtained using 2D-SWE and P-SWE. Further studies to identify the source(s) of errors to enable the interchangeable use of different SWE techniques in clinical practice are warranted. Many previous studies for comparison of 2D-SWE and P-SWE have been controversial [27-30]. A report by Ren demonstrated that both 2D-SWE and P-SWE showed similar ability to distinguish advance fibrosis which was significantly higher than fibroscan[31]. In this study, good correlation of all techniques was seen similar to another study that showed strong correlation between TE and SWE[32]. This current study compared the utility of 2D-SWE installed in difference machine (2D-SWE logiq9 and ElastQ Philip) and 2d-SWE and P-SWE in same machine (Philip ElastQ and Elast PQ) using the same subject. Although the procedure could not be performed within the same day, we minimize the temporal change by limit the timing of both procedures to be less than one month. The baseline AST and ALT in all patients were less than 3 times from upper normal limit which implement that there was no active hepatitis which might have causes fluctuation of the TE result. We found that the result of LS value is difference in all 3 techniques, even when using the same technique or same machine. As a result, LS is not interchangeable, with moderate correlation demonstrated for TE and all 3-techniques. The operation time for liver stiffness measurement using shear wave elastography (SWE) is slightly shorter than TE, but not significantly difference according to the study by Ahmed[33][39]. 2D-SWE could be performed in a shorter time than P-SWE within the same machine[21]. This study showed significant correlation between shear wave elastography using 2D-SWE LOGIQ™ E9, 2D-SWE (ElastQ) and P-SWE (ElastPQ) when using fibroscan as reference, with r= 0.84, 0.61 and 0.61, respectively. The AUROC for diagnosis significant fibrosis ($F \geq 2$) for these SWE were 0.87,0.80 and 0.77, respectively, not different with the previous study. The study of Cassin to which compared the efficacy of TE and earlier version of SWE, Supersonic Shear Imaging (SSI), demonstrated significant correlation of LSM by TE, 2DSWE.SSI, P-SWE with histological fibrosis score, with r = 0.70, 0.79,0.64, $p<0.001$ respectively[34] [40]. In our study, the AUROC for diagnosis of $F\geq 2$ of transient elastography,2DSWE.SSI (2D-SWE), and P-SWE were 0.82,0.86 and 0.77 respectively. Another study showed cut off value for prediction fibrosis $F \geq 2$ were 6.2 for TE and 6.3 for 2D-SWE.SSI[35][41]. Another meta-analysis comparing 2D-SWE.SSI with liver biopsy also shows good to excellent performance in LS assessment in patient with HCV,HBV and NAFLD for diagnosis significant fibrosis $F \geq 2$, with AUROCs of86.3, 91.6 and 85.9%, respectively[35]. As compare to performance of shear wave elastography 2D-SWE (ElastQ) and point shear wave elastography (ElastPQ) in the same machine, the reliability rate and operation time of 2D-SWE were significantly better than P-SWE (reliability rate 83.3% Vs 69.2 percent $p<0.001$) and operation time(148.32 seconds Vs355.47) $p<0.00$. In our report, the median value for LSM in ElastQ is lower than Elast PQ, 4.97 versus 5.32 kPa, respectively. While the reliability and operation time of 2D-SWE is better than SWE same as previous study, the LSM level measured by these methods were contrast to study by Lee[21]. As the gold standard of liver fibrosis measurement such as liver biopsy is considered invasive and carry significant complication[36-38], various non-invasive tests have been developed and validated in clinical practice. Apart from fibroscan, other noninvasive methods such as biomarker or fibrotest or are also available. Virtual technique (Fibroscan) is worldwide use for a long time and accepts in guideline for management but still has limitation in patients with as cites, with variable cut off point in many literatures and guidelines. By general recommendation, the cutoff point of liver stiffness for significant fibrosis($F\geq 2$) using fibroscanis 7 kPa. For other type of shear wave elastography, there has been no cut off point for

LSM that equal to Metavir F≥2.The study estimated the LSM of shear wave elastrography for F ≥2: 2D-SWE LOGIQ™ E9= 6 kPa., 2D-SWE Elast Q= 4.7kPa, P-SWE Elast PQ=4.6 kPa., which lower than previous study. Our study demonstrated that shear wave elastography is reliable technique, has lower level of LSM but still has high correlation with fibroscan. However, LSM by 2D-SWE and P-SWE are not interchangeable. There are still several limitations of this study. Apart from being a single-center study and small sample size there has been no histological confirmation. However, the area of liver parenchyma that could be examined by liver biopsy specimen is always smaller than measurement area by elastography. As a result, we used transient elastography as reference. Moreover, the TE was performed using only one size of probe, which might cause some error in the examination. Future studies with a large sample size with histologic confirmation of the fibrosis grade should be performed.

CONCLUSION

Our study showed that shear wave elastography had good correlation with fibroscan and take less examination time than fibroscan. Difference method and difference machine give difference liver stiffness value. We proposed the cut off point for detection of significant fibrosis using 2D-SWE LOGIQ™ E9 = 6 kPa., 2D-SWE ElastQ = 4.7kPa, P-SWE ElastPQ = 4.6 kPa. When compared between types of SWE,2D shear wave elastography has better reliability than point shear wave elastograhy.

Acknowledgement

The Authors would like to thanks Mrs.Thanaya Techasirioangkun and Mrs.Kamontip Sirithadajaroen for their assistance in performing TE.

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