Success Rate of Liver Stiffness Measurement Using Transient Elastography in Non-alcoholic Fatty Liver Disease Patients with Obesity and Its Influencing Factors

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ABSTRACT

Background: *Percentage of patients who had liver stiffness measurement failure using transient elastography varied between 2-10%; mainly caused by obesity. XL probe is expected to increase the success rate of liver stiffness measurement in patients with obesity. The objective of this study is to evaluate the success of liver stiffness measurement using M and XL probes and its influencing factors.*

Method: *Patients who fulfilled the inclusion criteria were included in this study. Examination results were then analysed using statistical analysis unpaired t-test or Mann-Whitney and McNemar statistical tests.*

Results: *From 92 non-alcoholic fatty liver (NAFLD) patients with obesity who were studied, the proportion of success in measuring liver stiffness using M probe was 57.6%, while that of XL probe was 88.0%. This difference was statistically significant ($p < 0.001$). Body mass index (BMI), skin to liver capsule distance (SCD), and thoracic circumference were associated with success in measuring liver stiffness using M probe, with p value of 0.007, 0.001, and 0.001 respectively. The results of Mann-Whitney statistical test revealed median value of BMI and SCD of patients who had liver stiffness measurement failure using M probe were 32.7 kg/m^2 and 2.6 cm respectively. T-test results showed that the mean value of thoracic circumference of patients who had liver stiffness measurement failure using M probe was 97.8 cm.*

Conclusion: *Proportion of success in measuring liver stiffness in NAFLD patients with obesity using XL probe was better compared to the M probe. BMI, SCD, and thoracic circumference were associated with the success of measuring liver stiffness using M probe. The same variables were not associated with XL probe.*

Keywords: *Transient elastography, M probe, XL probe, obesity*

ABSTRAK

Latar belakang: *Persentase pasien yang gagal dalam pengukuran kekakuan hati menggunakan transient elastography bervariasi antara 2-10%, umumnya disebabkan oleh obesitas. Probe XL, diharapkan dapat*

meningkatkan keberhasilan pengukuran kekakuan hati pada pasien dengan obesitas. Tujuan penelitian ini adalah untuk menilai keberhasilan pengukuran kekakuan hati dengan menggunakan probe M dan XL serta faktor yang mempengaruhinya.

***Metode:** Pasien yang memenuhi kriteria inklusi diikutsertakan dalam penelitian ini. Hasil pemeriksaan kemudian dianalisis dengan menggunakan uji statistic unpaired t-test atau Mann-Whitney dan uji statistik McNemar.*

***Hasil:** Dari 92 pasien penyakit perlemakan hati non-alkohol dengan obesitas yang diteliti, Proporsi keberhasilan pengukuran kekakuan hati menggunakan probe M adalah 57,6 %, sedangkan dengan probe XL 88,0%. Perbedaan ini bermakna secara statistik ($p < 0,001$). Faktor indeks massa tubuh (IMT), skin to liver capsule distance (SCD), dan lingkar toraks berhubungan dengan keberhasilan pengukuran kekakuan hati dengan menggunakan probe M, dengan nilai p masing-masing 0,007,0,001 dan 0,001. Hasil uji statistik Mann-Whitney didapatkan nilai median dari IMT dan SCD yang tidak berhasil dilakukan pengukuran kekakuan hati dengan menggunakan probe M adalah masing-masing 32,7 kg/m^2 dan 2,6 cm. Hasil uji statistik T-test didapatkan nilai Mean dari lingkar toraks yang tidak berhasil dengan pengukuran kekakuan hati dengan menggunakan probe M adalah 97,8 cm.*

***Simpulan:** Proporsi keberhasilan pengukuran kekakuan hati pada pasien NAFLD dengan obesitas dengan menggunakan probe XL lebih baik dibandingkan dengan probe M. Faktor IMT, SCD dan Lingkar Toraks berhubungan dengan keberhasilan pengukuran kekakuan hati dengan menggunakanan probe M. Variabel yang sama tidak berhubungan dengan probe XL.*

***Kata kunci:** Transient elastography, probe M, probe XL, obesitas*

INTRODUCTION

Non–alcoholic fatty liver disease (NAFLD) is one of the chronic liver diseases commonly found in the world. NAFLD is strongly associated with metabolic syndrome, including insulin resistance, diabetes, dyslipidaemia, and obesity. NAFLD may develop into liver cirrhosis and hepatoma. Prevalence of NAFLD is quite high in individuals with obesity, type 2 diabetes mellitus, and dyslipidaemia. NAFLD occurs in 60-95% obese patients, 28-55% type 2 diabetes mellitus patients, and 27-92% dyslipidaemia patients.[1] Liver biopsy remains a gold standard in determining the degree of NAFLD. However, liver biopsy frequently could not be performed in NAFLD patients due to some factors, such as: high cost, bleeding risk, and there is still no consensus to determine the histopathological criteria of NASH and differences in the degree of NAFLD. Currently, there are many modalities which can be used to detect the presence of steatosis.

Liver fibrosis can be evaluated non-invasively based on biological and physical approach. Biological approach means that by measuring biological markers which are measured from patients' serum and physical approach is performed by measuring the degree of liver stiffness by using transient elastography (TE).[2-4] TE is the most recent non-invasive diagnostic modality to evaluate liver fibrosis by liver stiffness measurement (LSM).[5-10] TE has high accuracy rate and can detect the presence of bridging fibrosis in patients with chronic liver disease. TE can also be applied in several chronic liver diseases, such as NAFLD, hepatitis B, primary biliary cirrhosis, sclerosing cholangitis, autoimmune hepatitis, alcoholic steatosis, and haemochromatosis.[11-16]

Liver stiffness measurement using TE is initiated by placing ultrasound transducer (probe) in the position in line with the vibrator axis. Vibrator will produce sound wave with low amplitude and frequency (50 Hz) which triggered the presence of elastic shear wave which later propagates as it traverses the underlying tissue. The degree of liver stiffness can be obtained from measuring sound wave velocity and its reflections; the louder or stiffer a tissue is; the faster sound wave is propagated. Liver stiffness measurement using TE has several advantages compared to other modalities. First, TE is a non-invasive examination that can be performed quickly and painlessly. Second, TE may include tissue volume 100 times as big as liver biopsy tissue sample, thus it can picture the liver parenchyma condition more accurately. Third, fibrosis or liver cirrhosis detection using TE is not influenced by extrahepatic abnormality, thus it does not need measurement results adjustments.[17] However, not all patients can give out liver stiffness measurement results using TE, due to the limitations it has. The main limitation of TE is associated with the characteristic of sound wave that can be muted by fluid, thus the propagation of elastic shear wave may stop before it

reaches liver tissue. Therefore, the success of TE will decrease in patients with ascites. Additionally, in obese patients, the skin to liver capsule distance (SCD) is larger; the subcutaneous tissue thickness can cause deviation of elastic shear wave before it reaches the liver tissue. This can decrease the accuracy and success in liver stiffness examination in patients with obesity.[18]

Currently, new probe has been developed, which is XL probe. This new probe has undergone a series of clinical tests, which is believed may increase the success of liver stiffness measurement (LSM) particularly in patients with obesity. XL probe is designed specifically for patients with obesity and has lower frequency, larger amplitude of vibration, more sensitive transducer, and better depth of underskin measurement. A study showed that XL probe could increase the validity of measurement results than M probe, which was 45% to 76% ($p < 0.001$).[19] Factors influencing the success in LSM using M probe include patient's age > 50 year old and BMI > 30 kg/m^2; while the success with XL probe is influenced by SCD and BMI > 30 kg/m^2. However, to diagnose the presence of fibrosis, both probes could not show the significant difference.[20] In the last six months, Hepatology Division Cipto Mangunkusumo Hospital found 27 patients who experienced failure of LSM from a total of 265 patients who underwent the examination. Therefore, the role of XL probe is expected to increase the success of LSM, although currently there is no study about XL probe in Indonesia. Therefore, a study to evaluate the success rate of liver stiffness measurement using XL probe in patients in Indonesia, particularly in the Division of Hepatology Cipto Mangunkusumo Hospital, is needed.

METHOD

The study design being used was cross sectional in NAFLD patients with obesity. Study was performed in Hepatology Division, Internal Medicine Department FMUI/Cipto Mangunkusumo Hospital Jakarta from 12 March 2013 until 12 June 2013. Target population in this study was all NAFLD patients with obesity, while accessible population was all NAFLD patients with obesity who visited Hepatology Polyclinic Cipto Mangunkusumo Hospital. Samples or subjects in this study were all NAFLD patients with obesity who visited Hepatology Polyclinic, Cipto Mangunkusumo Hospital from 12 March 2013 until 12 June 2013. Inclusion criteria were: (1) Study subjects who fulfilled obese criteria, which is BMI > 25 kg/m^2; (2) Study subjects fulfilled NAFLD criteria, which were from USG results fatty liver was found and from anamnesis there was no history of alcohol consumption or alcohol consumption not exceeding 70 g/week for female and 140 g/week for male; (3) Study subjects were willing to participate in the study. Exclusion criteria were: (1) Presence of ascites from the abdominal USG results; (2) Study subjects had skin disease and thus, transient elastography was not possible to be performed to them; (3) Presence of mass in the chest wall or local abnormality in the liver tissue including liver abscess or hepatoma.

Sample collection was performed by total sampling, which was by including all patients who fulfilled the criteria in the general subject group in the determined period. The minimum sample size was 67 patients. Because the same subject received two interventions, which were fibroscan using M and XL probes, the control group was the same group. Therefore, the minimum sample size in this study after the additional 10% for drop outs were 56 patients or was rounded to 60 patients. All obese patients who visited the Hepatology Polyclinic FMUI/Cipto Mangunkusumo Hospital from 12 March 2013 to 12 June 2013. In a consecutive manner, to these patients, several examinations were performed, including body weight, body height, body mass index, abdominal USG, SCD, and thoracic circumference. Further, patients underwent fibroscan examination using M and XL probes. Examination was performed to patients on supine position (dorsal decubitus) by placing probe on the intercostal space that faced the central part of the right lobe of the liver, which was 8-10th intercostal space in the axillary line by positioning the right arm in the maximal abduction position. Probe in the perpendicular position towards the skin surface. Examination was considered to be successful if there were ten valid measurement results with the success rate > 60% and IQR/M < 0.3.

Data collected from this study were then analysed and presented in tabular and figure forms. Data analyses were performed through analytic descriptive using SPSS computer programme version 11.5. To compare quantitative data variables between groups, unpaired t-test or Mann-Whitney U-test, while to compare categorical data variables between groups, Chi-square test was used if data fulfilled the criteria and absolute test. Fisher's exact-test was used if data did not fulfil the criteria. To compare categorical data variables in the same study subjects receiving 2 different interventions, McNemar statistical test was used. Obese patients who visited the Hepatology Subdivision FMUI/Cipto Mangunkusumo Hospital

consecutively underwent several examinations, including antopometric examination (body weight, body height, and thoracic circumference) and abdominal USG which were then followed with TE examination using M and XL probes.

RESULTS

During the period of this study, we obtained 92 respondents of NAFLD patients with obesity who fulfilled the study criteria. Further, examinations were performed according to the study pathway. We found that there were more female patients (82.6%) compared to male (17.4%), average patients' age 44.3 ± 10.2 years old. The median value of BMI and SCD were 31.5 kg/m^2 and 2.3 cm, respectively. The mean value of thoracic circumference was 94.7 S ± 8.2 cm. These data were presented in Table 1.

Table 1. Respondents' characteristics

Variables	n (%)	Mean ± SD	Median	Range
Sex				
Male	16 (17.4%)			
Female	76 (82.6%)			
Age		44.3±10.2		
Influencing factors:				
Skin to liver capsule distance (SCD)			2.3	1.4 – 4.3
Thoracic circumference		94.7±8.2		
Body mass index (BMI)			31.5	25.5-54.1

The proportion of success rate in the liver stiffness measurement using M probe was 57.6% (53 patients), while the proportion of success rate in liver stiffness measurement using XL probe was 88% (81 patients). This was shown in Table 2.

Table 2. Proportion of liver stiffness measurement

Liver stiffness measurement	n (%)
M probe	
Succeed	53 (57.6)
Not succeed	39 (42.4)
XL probe	
Succeed	81 (88.0)
Not succeed	11 (12.0)

To know the proportion comparison of the success rate in liver stiffness measurement using M and XL probes, we performed McNemar statistical test. The obtained result was p value < 0.001. This could be seen in Table 3.

Table 3. Proportion comparison on the success rate of liver stiffness measurement based on probe

M Probe	XL Probe		*p* value
	Succeed	Not succeed	
Succeed	51(96.2%)	2 (3.8%)	< 0.001
Not succeed	30 (76,3%)	9 (23,1%)	

In concordance with the objectives, in this study, we performed examinations towards some factors thought to be associated with the success of liver stiffness measurement using M and XL probe. Factors being studied include BMI, SCD, and thoracic circumference. To identify the difference of mean in 2 groups, we performed t-test statistical test for group with normal distribution and Mann-Whitney for group with not normal distribution. After normality test using Kolmogorov-Sminov was performed, we found that thoracic circumference had normal distribution and therefore, further analysis was conducted using t-test. Meanwhile, because BMI and SCD did not have normal distribution, further analysis was performed using Mann-Whitney test. The results of this analysis could be seen in table 4 for M probe and table 5 for XL probe.

Table 4. Factors associated with the success of liver stiffness measurement using the M probe

Variables	Probe M		p value
	Succeed	Not succeed	
Body mass index	30.85 (25.1-41.5)	32.7 (28.2-54.1)	0.007
Skin to liver capsule distance (SCD)	2.16 (1.4-4.3) 92.4	2.6 (1.7-4.1)	0.001
Thoraric circumference	2 (SD 7.3248)	97.8 (SD 8.4)	0.001

From Table 4, it could be seen that BMI, SCD, and thoracic circumference were associated with the success of liver stiffness measurement using M probe. Statistically, this was significant, with the p value of 0.007, 0.001 and 0.001, respectively. The mean value of thoracic circumference to which liver stiffness measurement was not succeed to be performed using the M probe was 97.8 cm. In addition, the median value of BMI and SCD to which liver stiffness measurement was not succeed to be performed using M probe was 32.7 kg/m^2 and 2.6 cm.

Table 5. Factors associated with the success of liver stiffness measurement using the XL probe

Variables	XL Probe		p value
	Succeed	Not succeed	
Body mass index	31.4 (25.1-43.6)	32.5 (28.9-54.1)	0.321
Skin to liver capsule distance (SCD)	2.32 (1.4-4.30)	2.5 (1.7-3.8)	0.817
Thoraric circumference	94.3 (SD 7.6788)	97.6 (SD 11.6)	0.216

From table 5, it could be seen that BMI, SCD, and thoracic circumference factors were not associated with the success of liver stiffness measurement using XL probe with p value of 0.327, 0.817 and 0.216, respectively. Based on the data from the available study results and for clinical purpose, researcher performed further analyses. Factors associated with

success of liver stiffness measurement were BMI, SCD, and thoracic circumference based on category (BMI ≤ 30.85 and > 30.85, SCD ≤ 2.16 and SCD > 2.16, and thoracic circumference ≤ 92.42 and > 92.42. Analyses were performed using Chi-square statistical test which results could be seen in Table 6 and 7.

DISCUSSION

This study is performed to determine the success rate of liver stiffness measurement in NAFLD patients with obesity in Division of Hepatology, Internal Medicine Department Cipto Mangunkusumo Hospital. From this study, we obtained 17.4% male patients and 82.6% female patients. The median value of BMI, SCD, and thoracic circumference were 31.53 kg/m^2, 2.32 cm and 95 cm, respectively. The results of this study were different with other studies which have been performed by previous researchers. The results of a study by Ledinghen et al that studied 99 obese patients reported 27.2% male patients and 72.8% female patients.[16] The median value of BMI and SCD were 40.5 kg/m^2 and 2.8 cm. Myers et al studied 276 CLD patients with 63% of them were male patients.[31] The median value of BMI, SCD, and thoracic circumference were 30 kg/m^2, 2.20 cm, and 105 cm, respectively.

The percentage of patients whose liver stiffness measurement were unreliable using transient elastography varied from 2% to 10%, generally caused by obesity. In this study, the proportion of failure in liver stiffness measurement using M probe was 42.4% (39 patient). This could possibly be caused by the obese criteria used in this study (BMI > 25), therefore this failure was associated with the subcutaneous fat tissue and connective tissue thickness which were located between the probe and the liver.[19,23] In this study, failure of liver stiffness measurement using XL probe was 12% (11 patients). Six from those eleven patients had BMI > 30 and 3 patients among them had SCD > 3.5.

This was in line with the fact that XL probe was suggested to be used in SCD > 2.5 cm and < 3.5 cm.[18] Four patients whose measurement failed using the XL probe had body height < 150 cm; the failure could be associated with the narrow intercostal space. In this study, the success of liver stiffness measurement using XL probe was higher (88%) compared to the M probe (57.6%). This difference was statistically significant. This was consistent with the advantage of XL probe which minimize the influence of subcutaneous tissue (with lower frequency, higher amplitude, and larger depth of measurement), thus could increase the success of liver stiffness measurement in obese patients.

This study obtained the success rate of liver stiffness measurement with the proportion of XL probe as much as 88% and proportion of M probe was 57.6%. Different from previous study by Ledinghen et al who studied 99 obese patients with BMI > 30, in which the results were success in liver stiffness measurement using M probe 45% and 75% in XL probe.[16] This could possibly happen due to the higher average value of BMI and SCD in the study conducted by Ledinghen et al compared to the values obtained in this study, which were BMI 40.5 kg/m^2 and SCD 2.8 cm. The results of this study was not of much difference with

Table 6. Relationship between BMI, SCD, and thoracic circumference based on category towards the success rate of liver stiffness measurement using M probe

Variables	M Probe		OR	p value
	Succeed	Not succeed		
Body mass index				
≤ 30.85	26 (72.2%)	10 (27.8%)	2.732	0.042
>30.85	27.0 (48,2%)	29 (51.8%)	(1.138-8.356)	
Skin to liver capsule distance				
≤ 2.16	27 (79.4%)	7 (20.8%)	4.742	0,003
>2.16	28 (44.82%)	32 (55.2%)	(1.783-12.639)	
Thoracic circumference				
≤ 92.42	28 (70.0%)	12 (30.0%)	2.520	0.056
>92.42	25 (48.12%)	27 (81.9%)	(1.058-6.002)	

Table 7. Relationship between BMI, SCD, and thoracic circumference based on category towards the success of liver stiffness measurement using XL probe

Variables	XL probe		OR	p value
	Succeed	Not succeed		
Body mass index				1.000
≤ 30.85	32 (88.9%)	4 (11.1%)	1.143	
>30.85	49 (87.5%)		(0.30-4.222)	
Skin to liver capsule distance				0.527
≤ 2.16	29 (85.2%)	5 (14.7%)	0.669	
>2.16	52 (89.7%)	6 (10.3%)	(0.138-2.365)	
Thoracic circumference				1.000
≤ 92.42	35 (87.5%)	5 (12.9%)	0.913	
>92.42	46 (83.5%)	6 (11.5%)	(0.258-3.237)	

the studies performed by Myers et al, Lesmana CA et al, and Wong et al.[31,32,33]

In this study, we found that BMI, SCD, and thoracic circumference factors were related with the success of liver stiffness measurement using M probe. Statistically, they were significantly related with p value of 0.007, 0.001, and 0.001, respectively. These results were different with the study conducted by Ledinghen et al, in which only SCD and thoracic circumference were associated with the success of liver stiffness measurement using M probe.[16] This could possibly be caused by the different obesity criteria being used in the study. In this study, we used the Asia Pacific criteria, which was obesity if BMI > 25 kg/m^2, while in the study performed by Ledinghen et al, they used WHO criteria, which was obesity if BMI > 30 kg/m^2. Therefore, the average value of BMI was higher, particularly 40.5 kg/m^2. Similar with the study done by Foucher et al, in which the results were BMI factor > 28 which was associated with failure of liver stiffness measurement with p value = 0,001.[23] Different results were also found in the study conducted by Ledinghen et al, in which age and BMI > 30 were associated with the success of liver stiffness measurement using M probe and only BMI > 30 factor was associated the success of liver stiffness measurement using XL probe.[20] Results of study by Wong GL et al reported that BMI ≥ 28.0 and central obesity were factors associated with the failure of liver stiffness measurement. [33]

In this study, it was revealed that BMI, SCD, and thoracic circumference factors were not significantly associated with the success rate of liver stiffness measurement using XL probe with p value of 0.321, 0.817 and 0.216, respectively. This was because in this study 88% patients (81 patients) succeed to undergo liver stiffness measurement using XL probe. Therefore, in this study, those factors could be overcome by XL probe. This condition showed that XL probe in this study was better in measuring liver stiffness compared to M probe in NAFLD patients with obesity. The results of this study were different from the study performed by Ledinghen et al.[19] This study revealed that SCD factor was associated with the success rate of liver stiffness measurement using the XL probe. This could possibly be caused by the higher average value of SCD obtained in their study, which was 2.8 cm. From t-test statistical test as shown in Table 4, we found that the mean of thoracic circumference to whom liver stiffness measurement failed to be obtained using M probe was 97.8 cm. Using the Mann-Whitney test, also as shown in Table 4, we found that the median value of BMI and SCD to whom liver stiffness measurement failed to be obtained using the M probe were 32.7 kg/m^2 and 2.6 cm, respectively. This was in concordance with the fact that liver stiffness measurement using M probe performed in patients with BMI with normal body weight and SCD < 2.5 cm and in SCD from 2.5-3.5 were suggested to use the XL probe.

CONCLUSION

The success rate of liver stiffness measurement using XL probe was better and was significantly different compared to the M probe. Factors that influenced the success of liver stiffness measurement by using TE were BMI, SCD, and thoracic circumference. To increase the success of liver stiffness measurement, in NAFLD patients with obesity whose BMI, SCD, and thoracic circumference were more than 32.7 kg/m^2, 2.6 cm and 97.8 cm, it would be better to use the XL probe. The results of this study could be used as a baseline for further studies in larger research scale to determine the cut-off and predictor model towards factors which influenced the success of liver stiffness measurement.

REFERENCES

1. Abenavoli L, Corpechot C, Poupon R. Elastography in hepatology. Can J Gastroenterol 2007;21:839-42.
2. Angulo P . Non-alcoholic fatty liver diseases. New England J Med 2002;346:1221-31.
3. Obika M, Noguchi H: Diagnosis and evaluation of non alcoholic fatty liver diseases. Experimental Diabetes Research 2012;2012:145754.
4. Castera L. Non-invasive methods to asses liver diseases in patients with hepatitis B or C. Gastroenterology 2012;142:1293-302.
5. Sandrin L, Fourquet B, Hasquenoph JM, et al. Transient elastography: a new non-invasive method for assessment of hepatic fibrosis. Ultrasound In Medicine Biology 2003;29:1705-13.
6. Nguyen-Khoc E, Capron D. Non-invasive diagnosis of liver fibrosisby ultrasonic transient elastography (Fibroscan). Eur J Gastroenterol Hepatol 2006;18:1321-5.
7. De Ledinghen V, Verginiol J.Transient elastography (Fibroscan). Gastroenterologie Clinique et Biologique 2006;6:58-67.
8. Scott DR, Levy MT. Liver transient elastography (Fibroscan): a place in the management algorithm of chronic viral hepatitis. Antiviral Therapy 2010;15:1-11.
9. Boe RC, Cho HJ, OH JT, Lee EK, Heo J, Shin Y et al.Clinical factor influencing liver stiffnesson in measured by transient elastography (Fibroscan) in patient with chronic liver diseases. Korean J Hepatol 2010;16:123-30.
10. Gomez-Dominiguez E, Mendoza J, Rubio S, et al. Transient elastography: a valid alternative to biopsy in patients with chronic liver diseases. Alimen Pharmacol Ther 2006;24:513-8.
11. Fung JYY, Lai CL, Yuen MF. clinical application of transient

elastography (Fibroscan) in liver diseases. The Hongkong Medical Diary 2009;14:22-5.
12. Lamproye A, Belaiche J, Delnaide J. The fibroscan: a new non-invasive method of liver fibrosis evaluation. Revue Medicicale De liege 2007;68-72.
13. Verveer C, De Kneght RJ. Non-invasive measurement of liver fibrosis: application of the fibroscan in Hepatology. Scan J gastroenterol 2006;243:85-8.
14. Wong VW-S, Verginol J, Wong GL-H et al. Diagnosis of fibrosis and cirrhosis using liver stiffness measurement in nonalcoholic fatty liver diseases. Hepatology 2010;51:454-62.
15. Rust MF, Zeuzem. Transient elastography (fibroscan) for the non-invasive assessment of liver fibrosis: current status and perspectives. Zeitschrift fur gastroenterology 2007;45:387-94.
16. Carrion JA. Utility of fibroscan in the evaluation of liver fiobrosis. Gastroenterologia Y Hepatologia 2009;32:415-23.
17. Abenavoli L, Corpechot C, Poupon R. Elastography in hepatology. Canadian J Gastroenterol 2007;21:839-42.
18. Laurent S, Jennifer O, Cecile B, et al. Non-invasive assesment of liver fibrosis by vibration controlled transient elastography (fibroscan). In Tech 2011:293-314.
19. De LV, Verginol J, Foucher J. Feasibility of liver transient elastography with fibroscan using a new probe for obese patients. Liver International 2010;30:1043-8.
20. De LV, Wong VW, Vergniol J. Diagnosis of liver fibrosis and cirrhosis using liver stiffness measurement: comparison between M and XL probe of Fibroscan. J hepatol 2012;56:833-9.
21. Castera L, Forns X, Alberti A. Non-invasive evaluation of liver fibrosis using transient elastography. J Hepatol 2008;48:835-47.
22. Ingiliz P, Chhay KP, Munteanu M. Aplicability and variability of liver stiffness measurement according to probe position. World J Gastroenterol 2009;15:3398-404.
23. Fouccher J, Castera L, Bernard PH. Prevalence and factor associated with failure of liver stiffness measurement using fibroscan in a prospective study of 2114 examinations. Eur J Gastroenterol Hepatol 2006;18:411-2.
24. Ziol M , Handra-Luca A, Kettaneh A. Non-invasive assessment of liver fibrosis by measurement of stiffness in patients with chronic hepatitis C. Hepatology 2005;41: 48-54.
25. Lucidarme D, Foucher J, Le BB. The ratio interquartile range/ median value of liver stiffness measurements is a key factor of accuracy of transient elastography (Fibroscan) for the diagnosis of liver fibrosis. Hepatology 2007;46:318A.
26. Yilmaz Y. Review article : is non-alcoholic fatty liver diseases a spectrum, are steatosis and NASH distinct condition? Alimen Pharmacol Ther 2012;36:815-29.
27. Sugondo S. Obesitas. Buku Ajar Ilmu penyakit dalam. In: Sudoyo AW, Setyohadi B, Alwi I, Simadibrata M, Setiati S. 4th ed. Jakarta: Interna Publ 2006.p.1941-7.
28. Obesity. Availabe at: URL: wikipedia.upl.http.www. En. Wikipedia.org/wiki/obesity
29. Lesmana LA. Penyakit perlemakan hati non-alkoholik. In: Sulaiman A, Akbar N, Lesmana LA, Noer MS, eds. Buku ajar ilmu penyakit hati. 1st ed. Jakarta: Interna Publ 2007.p.301-5.
30. Wong VW-S, Verginol J, Wong GL-H. Liver stiffness measurement using XL Probe in Patients With non-alcoholic fatty liver diseases. Am J Gastroenterol 2012;10:1862-71.
31. Myers RP, Pomier-Layrargues G, Kirsch R. Feasibility and diagnostic performance of the fibroscan XL Probe for liver stiffness measurement in overweight and obese patients. Hepatology 2012;55:199-208.
32. Lesmana. CAR liver stiffness measurement using M and XL probe in high body mass index patients with and without chronic liver diseases: a single center experience 2011. Available at: URL: http://liverlearning.aasld/2011/ thelivermeeting/ 13499/ careercenter. aasld.org/ careercenter. aasld.org.
33. Wong GL-H, Wong VW-C, Chim AM. Factors associated with unreliable liver stiffness measurement and its failure with transient elastography in the chinese population. J Gastroenterol Hepatol 2011;26:300-5.