

X-CUBE 90

Attenuation Imaging (ATI)

Attenuation imaging Overview

Background

The four major liver diseases are HBV, HCV, nonalcoholic fatty liver disease (NAFLD) and alcoholic liver disease. Currently, the incidence of nonalcoholic steatohepatitis (NASH), which is defined as hepatic steatosis with combined fibrosis and inflammation, is increasing. It is known that about 20% of patients progress to liver cirrhosis and then liver cancer. It is important to detect and quantify hepatic steatosis for a early to prevent the progressing to severe liver disease.

Ultrasound attenuation

ATI is a feature that quantifies fatty liver disease using the attenuation coefficient (dB/cm/MHz) of B-mode ultrasound. The ultrasound wave pulse transmitted in the body gradually spreads and it converts into heat, absorbed by tissue and occur scattering and attenuation. Attenuation of ultrasound signals depends on the acoustic characteristics and the tissue structure. Attenuation is shown the signal intensity as figure 2. Fatty liver typically represents ultrasound images with increasing attenuation.

Advantages

- Clinical benefits for steatosis stage
- Potential to reduce the need for elevated liver biochemistry (ALT, AST) and MRI (PDFF)
- Non-invasive method and cost effective
- Easy & short exam time
- Quantification, Objectification result value

The ATI provides quickly calculated value with high reproducibility for diagnosis efficiency. In addition, by automatically excluding vascular of liver, the reliability of the results and work efficiency are increased.

ATI cut-off values for steatosis grading:

Stage		Cutoff (dB/cm/MHz)
S0	No Steatosis	< 0.605
S1	Mild Steatosis	0.605 – 0.75
S2-S3	Significant & Severe Steatosis	> 0.75

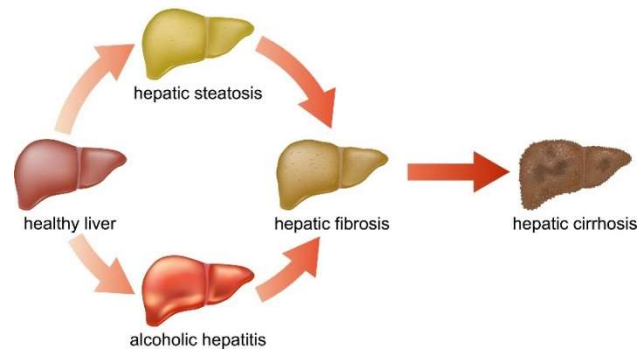


Figure 1. Stage of liver disease

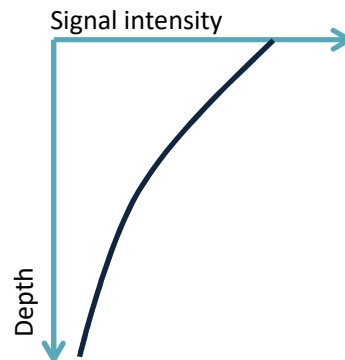


Figure 2. Attenuation Beam profile



Figure 3. X-CUBE 90 Ultrasound Machine

Attenuation Imaging (ATI) evaluation for diagnosis of liver steatosis and validation of cut-off value for each stage of liver steatosis

Objectives

This study aimed to validate the performance and cutoff value for the detection of liver steatosis with the Attenuation Imaging (ATI) technology

Method

This study included sixty-two individuals who Liver MRI, including MRI-PDFF, has been or will be performed on a Siemens Skyra MRI machine at Seoul National University Hospital within the last 3 months due to liver disease or suspected liver disease. and evaluated the correlation between ATI in the X-CUBE 90 (ALPINION Medical Systems), MRI, and ATI in the Aplio i800 (Canon) with Seoul National University Hospital.

First, the liver parenchymal eco level and quality were evaluated by B-mode using the X-CUBE 90. After identifying a suitable site for ultrasonography through the intercostal or subcostal space, the ATI examination was performed.

The measurement target was the anterior segment of the right hepatic lobe of the liver, and the ATI was measured 5 times in a similar ROI at a depth of 1.5 to 2 cm from the hepatic capsule, avoiding blood vessels shown on ultrasound images (Figure 1.).

To check the efficacy 1) perform five ATI measurement at the same location with a comparison device (Aplio i800, Canon Medical Systems) 2) calculate the correlation (Pearson correlation coefficient) and diagnostic ability (sensitivity, specificity, area under the curve, standard error, 95% CI) with MRI-PDFF.

Result

Sixty-two individuals (41 male and 21 female; mean age, 58.1 ± 14.3 years; mean body mass index, 22.9 ± 3.2 kg/m²) were enrolled in the study. All ATI values were obtained with an IQR/median of less than 30%. Liver steatosis was present in 16 of 62 (25.8%) individuals with MRI-PDFF results available.

Table 1 reports the results of the correlation analysis. The correlation coefficients ATI in the X-CUBE 90 with the MRI-PDFF was slightly higher than that in the Aplio i800 ($r=0.662$ versus 0.659).

The diagnostic performance of ATI in the X-CUBE-90 and the Aplio i800 is reported in Table 2. The AUROCs, of ATI in the X-CUBE 90 and Aplio i800 for steatosis S0 vs. S1 or higher were 0.88 (95% confidence interval, 0.77-0.95), 0.87 (0.77-0.94), respectively, and for steatosis S1 or less vs. S2 or higher were 0.95 (0.86-0.99), 1.00 (0.95-1.00), respectively.

The cutoffs of ATI in the X-CUBE 90 and Aplio i800 for steatosis S0 vs. S1 or higher were 0.605 higher, 0.61 higher, respectively, and for steatosis S1 or less vs. S2 or higher were 0.75 higher, 0.74 higher, respectively.

In the performance result of ATI in the X-CUBE 90, the validity was secured with a high AUC and the sensitivity value was higher than the comparison device, but the specificity was lower than the comparison device.

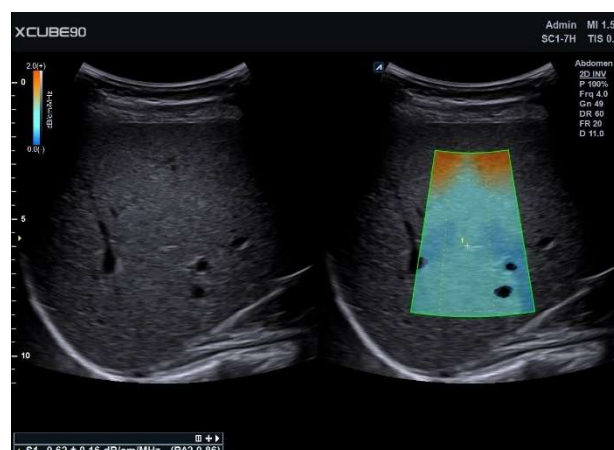


Figure 1. Measurement of the attenuation coefficient with the ATI in the X-CUBE 90

Conclusion

To evaluate the validity of the ATI in the X-CUBE 90, we conducted a cross-validation with the Aplio i800 and obtained significant results. The ATI value in the X-CUBE 90 device showed a higher correlation with MRI than the comparison device, confirming the high similarity of the results with MRI, and the AUC, which can determine the test accuracy of the ATI, also obtained a high value of more than 0.9 on average, which can be considered validated [1].

Ultrasound is able to provide a fast, non-invasive and cost efficient assessment tool for mild liver steatosis(> 5%) diagnosis [2], which is important for patient management from early liver steatosis.

Therefore, the ATI function of the X-CUBE 90 is a reliable tool for diagnosing liver steatosis and an affordable diagnostic solution for the increasing of NAFLD.

Table 1. Correlations Between X-CUBE 90 ATI, i800 ATI, and MRI-PDFF Values Analyzed by the Pearson r Correlation

	X-CUBE 90 ATI	Aplio i800 ATI
MRI-PDFF	0.662	0.659

Table 2. Diagnostic performance of ATI for liver steatosis

Device	Stage	Cutoff (dB/cm/MHz)	AUC (95% CI)	Sensitivity (%)	Specificity (%)
X-CUBE 90	S0 vs. \geq S1	> 0.605	0.88 (0.77-0.95)	93.8	71.7
Aplio i800		> 0.61	0.87 (0.77-0.94)	88.24	88.46
X-CUBE 90	\leq S1 vs. \geq S2	> 0.75	0.95 (0.86-0.99)	100.00	91.53
Aplio i800		> 0.74	1.00 (0.95-1.00)	100.00	100.00

Diagnostic accuracy of each variable in association with steatosis stage. The performance of the selected best cutoff values was indicated.

AUC=the area under the receiver operating curve

Reference

[1] Muller, Matthew P, et al. “ Can Routine Laboratory Tests Discriminate between Severe Acute Respiratory Syndrome and Other Causes of Community-Acquired Pneumonia?” Clinical Infectious Diseases 2005;40:1079-86.

[2] Computed Tomography Scans in the Evaluation of Fatty Liver Disease in a Population Based Study: The Multi-Ethnic Study of Atherosclerosis, RSNA Radiology, 2021

[3] KASL clinical practice guidelines: Management of nonalcoholic fatty liver disease, The Korean Association for the Study of the Liver, 2013, p327

[4] Performance of the Attenuation Imaging Technology in the Detection of Liver Steatosis, Journal of Ultrasound in Medicine 2021; 40:1325-1332