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Research Article

Evaluation of Liver Stiffness in Obesity: A Comparison of Canon Aplio i800 2d-Shear Wave Elastography and Siemens Sequoia Point Shear Wave Elastography

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Abstract

Introduction: Accurate assessment of liver fibrosis is essential for clinical management of patients with chronic liver disease. This study aimed to compare the diagnostic performance and agreement between two different ultrasound elastography systems, Canon Aplio i800 (2D-SWE) and Siemens Sequoia (pSWE), in an obese population with various liver pathologies and to identify factors influencing measurement discrepancies. *Methods:* In this prospective cross-sectional study, 89 adult patients with an increased risk of fatty liver disease underwent liver stiffness measurements using the Canon Aplio i800 (2D-SWE) and Siemens Sequoia (pSWE) systems. Patients were categorized into fibrosis stages (F0-F4) according to the established cut-off values. Agreement between systems was assessed using correlation coefficients, Bland-Altman analysis, and Cohen's kappa. Regression analysis was performed to identify the factors influencing measurement variability. *Results:* The study included 63 males and 25 females (mean age, 52 years; mean BMI: 29.5 kg/m ^{2}). The overall correlation between systems was moderate (r=0.68, 95% CI: 0.54-0.77), with a stronger correlation in F4 patients (r=0.575) than in non-F4 patients (r=0.237). For the F4 classification, both systems showed excellent sensitivity (97.5%), but Sequoia demonstrated superior specificity (100% vs. 79.6%) and overall accuracy (98.9% vs. 87.9%). The mean difference between measurements was -1.44 kPa overall, with larger discrepancies in F4 patients (-5.79 kPa) than in non-F4 patients (0.60 kPa). Multivariate analysis identified the skin-to-capsule distance and shear wave dispersion as the most significant factors affecting measurement variability, particularly for the Aplio system. *Conclusion:* Although both systems demonstrated high diagnostic performance for advanced fibrosis, the Sequoia system showed superior specificity and accuracy in the obese population. Measurements between systems are not directly interchangeable, particularly in patients with advanced fibrosis, increased subcutaneous fat, or liver inflammation. The Society of Radiologists in Ultrasound "rule of four" remains appropriate for liver stiffness classification, but system-specific considerations are necessary for accurate clinical interpretation.

Keywords

Liver Stiffness, Liver Fibrosis, Metabolic Associated Steatotic Liver Disease (MASLD), 2D Shear Wave Elastography, Point Shear Wave Elastography

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1. Introduction

Non-alcoholic fatty liver disease (NAFLD) and its progressive form, non-alcoholic steatohepatitis (NASH), have become increasingly prevalent health concerns worldwide, particularly in populations with obesity and metabolic disorders [1-3]. Recent nomenclature changes have introduced metabolic dysfunction-associated steatotic liver disease (MASLD), reflecting the evolving understanding of this condition [4, 5]. The global rise in obesity has paralleled the increasing prevalence of MASLD, with estimates suggesting that up to 25% of the general population may be affected, with higher percentages in those with obesity or diabetes [6, 7]. Contemporary studies from 2021-2025 have highlighted the growing burden of MASLD, particularly in Asian populations where prevalence rates have reached epidemic proportions [8, 9]. Accurate assessment of liver fibrosis is crucial for patient management, prognosis, and treatment planning, as the degree of fibrosis is the most important predictor of liver-related complications and mortality [10, 11].

While liver biopsy remains the gold standard for fibrosis staging, its invasive nature, sampling error risk, and procedural complications have prompted the development of non-invasive alternatives [12]. Among these, ultrasound-based shear wave elastography (SWE) has emerged as a valuable non-invasive tool for assessing liver fibrosis [13, 14]. Recent advances in elastography technology have led to improved accuracy and reproducibility, with multiple vendors offering different SWE technologies, including point shear wave elastography (pSWE) and two-dimensional shear wave elastography (2D-SWE), each with proprietary algorithms for measuring liver stiffness [15, 16].

A critical clinical concern is whether measurements obtained from different elastography systems are comparable and interchangeable, particularly in challenging patient populations, such as those with obesity [17-19]. Recent studies have emphasized the importance of understanding inter-system variability, especially given the increasing prevalence of obesity-related liver disease [20, 21]. Increased subcutaneous fat, altered tissue properties, and technical challenges in obtaining high-quality measurements may affect the reliability and accuracy of elastography in patients with obesity [22, 23]. The Society of Radiologists in Ultrasound (SRU) has proposed the "rule of four" with standardized cut-off values for fibrosis staging across different vendors; however, the applicability of these recommendations in obese populations remains uncertain and continues to be evaluated in recent literature [24].

This cross-sectional prospective study aimed to evaluate the correlation, agreement, and diagnostic performance of two different SWE systems, Canon Aplio i800, using 2D-SWE and Siemens Sequoia version 2.0, using acoustic radiation force imaging (ARFI) point SWE, in patients with an increased risk of fatty liver disease, with particular focus on those with elevated BMI. Additionally, we sought to identify factors that might influence measurement discrepancies between these two systems and provide clinical guidance for the interpretation of elastography results in the obese population.

2. Methods

2.1. Study Population

Approval for the study was obtained from the local ethics review board (Aerb040624) and all participants provided informed consent. Power analysis was performed to obtain a power factor of 0.9 with a p-value of 0.05, for which a minimum of 87 patients were needed to complete the study. A total of 89 patients were enrolled in this single-center cross-sectional prospective study from July to November 2024.

The inclusion criteria were undiagnosed adults aged > 25 years with an increased risk of fatty liver disease, such as diabetes, abnormal liver enzymes, overweight and obesity, or a history of treated hepatitis with adequate breath-holding. Exclusion criteria included pregnancy, malignancy, chronic alcoholism with a daily intake of more than 200 ml/day, and severe comorbidities with inadequate breath holding.

Height, weight, and clinical data were recorded, and BMI was calculated to correlate the demographic data. The patients ranged in age from 25 to 80 years and presented with clinical presentations of MAFLD, NASH, Advanced chronic liver disease (ACLD), and isolated increased liver transaminases. All patients fasted for at least 4 hours prior to the examination.

2.2. Elastography Technique

Canon Aplio i800 (2D-SWE)

The patients were positioned supine on the examination bed, and routine gray-scale ultrasound of the liver was performed by experienced sonologists with 30 and 15 years of experience in sonography and elastography, respectively. After grayscale examination, the 2D-SWE mode was selected using a convex 5C probe (1-6.2 MHz). A 3 × 3 cm box was positioned in the right liver lobe, at least 1.5-2 cm below the liver capsule, avoiding large vessels, bile ducts, and the gallbladder.

A propagation box showing parallel shear waves was displayed, and all vessels and artifacts were filtered out. Ten measurements were recorded along the propagation plot, and the region of interest (ROI) was determined at points where the shear wave plot showed minimal wave separation with maximum parallel lines. The median value was obtained in kilopascals (kPa) along with IQR/Median, and a value less than 0.30 was considered optimal. The shear wave dispersion (SWD) in m/s (kHz) was also recorded.

Siemens Sequoia (pSWE)

For Siemens Sequoia measurements, patients maintained

the same positioning with maximum right arm abduction to fully expose the intercostal space. After the initial grayscale assessment, pSWE measurements were performed using a deep abdominal transducer (DAX, 1.0–3.5 MHz). The manufacturer predefined a fixed ROI depth and size (1.5 cm from the liver capsule, 10 mm × 10 mm).

The horizontal positioning line was aligned with the liver capsule to ensure an accurate measurement depth, and data were collected in the breath-hold position. Five measurements were obtained, and the median was calculated as the final liver stiffness value (kPa). Skin-to-liver capsule distance (SCD) was measured in all patients.

For both systems, the following fibrosis grading scale was applied according to the vendor guidelines:

1. F0: < 5.5 kPa
2. F1: 5.5-7.0 kPa
3. F2: 7.1-9.5 kPa
4. F3: 9.6-13.5 kPa
5. F4: > 13.5 kPa

2.3. Statistical Analysis

All data were organized in Excel spreadsheets and analyzed using Analyze and XLStat software. Descriptive statistics, including the mean, median, and standard deviation, were calculated for all variables. A heat map was generated to compare the distribution of fibrosis between the Aplio and Sequoia systems.

The correlation between measurements from both systems was assessed using Spearman's correlation test, and agreement was evaluated using the Bland-Altman analysis. The ANOVA test with post-hoc Tukey's test was used to determine the statistical significance of differences across fibrosis stages.

The diagnostic performance for identifying F4 fibrosis was assessed by calculating the sensitivity, specificity, accuracy, and area under the receiver operating characteristic curve (AUC) for both systems. Cohen's kappa coefficient was used to evaluate the agreement in fibrosis staging between systems.

Multivariate regression analysis was performed to determine the effects of variables including age, sex, BMI, skin-to-capsule distance (SCD), and shear wave dispersion (SWD) on liver stiffness measurements. Lasso regression with cross-validation was conducted to identify the most influential factors affecting the measurement variability between systems.

3. Results

Patient Demographics and Characteristics

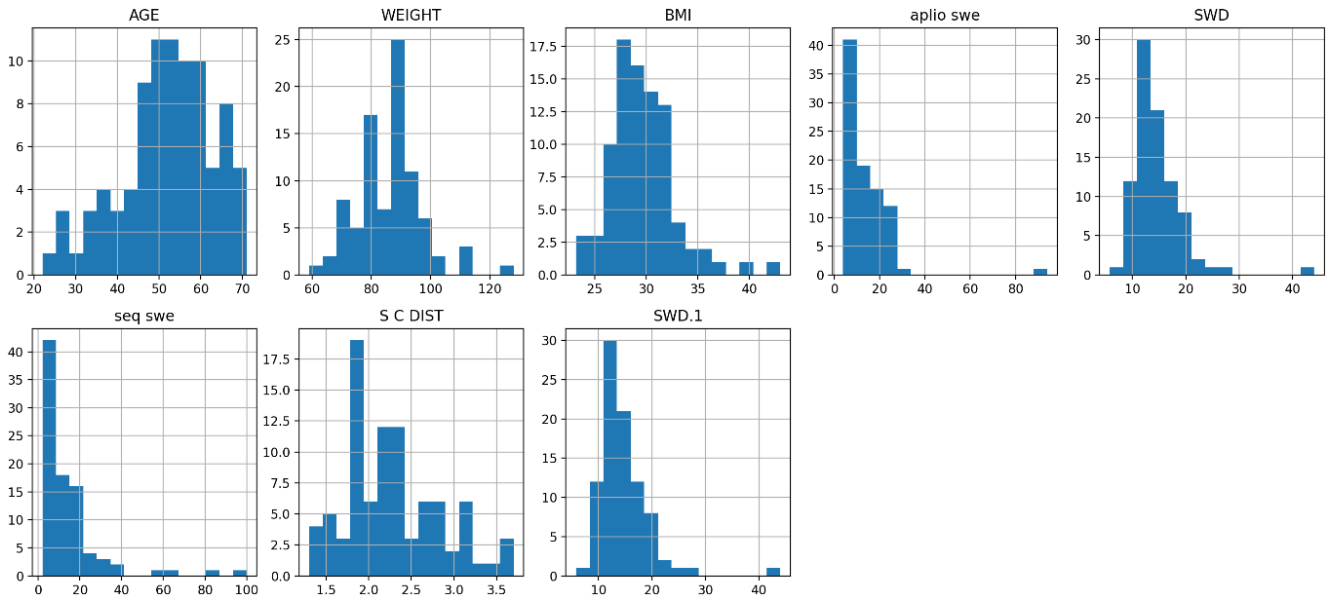


Figure 1. *Histogram plots of demographic and elastographic variables by Aplio and Sequoia.*

The study included 88 patients, of whom 63 were male and 25 were female, showing a clear male predominance (71.6% vs. 28.4%) in the study population. The mean age of the patients was 52 years (range: 22–80 years). The mean BMI was 29.5 kg/m ^{2}(range: 27.3-32.9 kg/m ^{2}) with a slight right-sided skew in distribution. Most patients were in the overweight category (n=53, 60.2%), followed by the obese category (n=32, 36.4%), while only four patients (4.5%) had a normal BMI, and there were no patients in the underweight category.

The skin-to-capsule distance (SCD) showed a relatively normal distribution, with a median of 2.19 cm (range: 1.78-3.7 cm) (Figure 1). The most common clinical diagnoses in this cohort were MASLD (n=31, 35.2%) and advanced chronic liver disease (ACLD) (n=29, 33.0%).

Liver Stiffness Measurements and System Correlation

Both systems were able to categorize patients into F0-F4 categories based on SWE values and showed a comparable distribution (Figure 2).

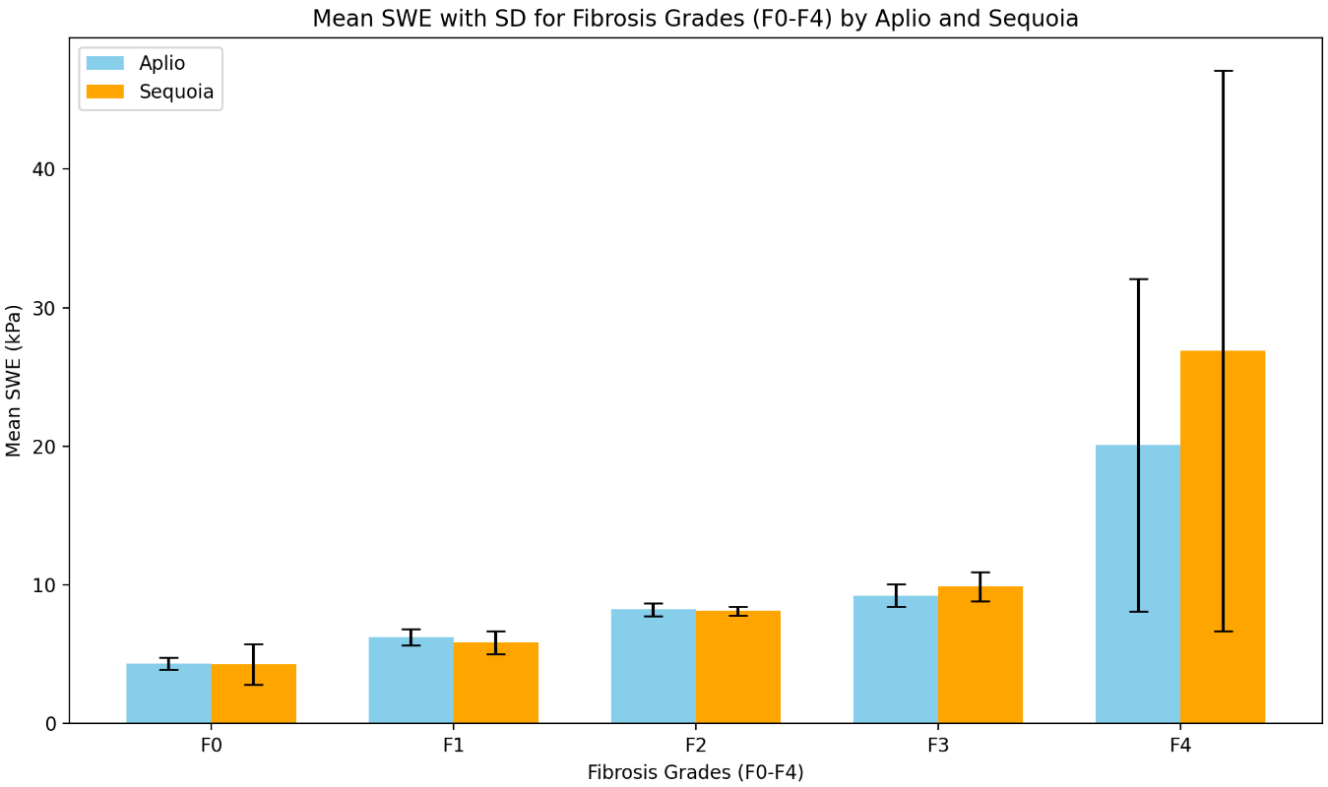


Figure 2. *Box plot distribution of fibrosis grades by Aplio and Sequioa.*

The intra-system correlation coefficient between both systems across all patients showed a Pearson correlation coefficient of 0.68 (95% CI: 0.54-0.77) with a standard deviation of differences of 11.85 kPa. The mean difference (Aplio SWE - Sequoia SWE) was -1.44 kPa, and the coefficient of variability (CV) of the differences was 8.24, which was large relative to the mean difference.

Subgroup analysis revealed the following important differences:

F4 Group:

1. Pearson correlation: 0.575 (95% CI: 0.282-0.769)
2. Variance of differences: 294.44 (95% CI: 189.25-520.43)
3. Mean difference (Aplio SWE - Sequoia SWE): -5.79 kPa

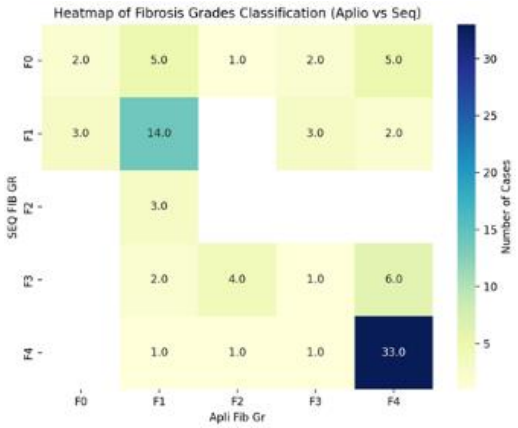
Non-F4 Group:

1. Pearson correlation: 0.237 (95% CI: -0.064-0.499)
2. Variance of differences: 5.91 (95% CI: 4.04-9.49)
3. Mean difference (Aplio SWE - Sequoia SWE): 0.60 kPa

These results indicate that in the F4 group, there was a moderate positive correlation but higher variability in the differences between systems, whereas in the non-F4 group, the correlation was weaker, but the variability was substantially lower.

The heat map analysis of the fibrosis grade distribution (Figure 3) showed that the maximum number of cases was observed in the F4 category for both systems, demonstrating a moderate to strong positive correlation ($r = 0.665$, $p < 0.001$). ANOVA and Tukey's post-hoc analysis confirmed that the differences in SWE across F0-F4 were statistically significant ($p < 0.001$) in both systems.

The Bland-Altman plot analysis showed good agreement between the two methods, with most measurements falling within the 95% limits of agreement. The mean difference was 0.352 kPa, with 95% limits of agreement between -2.324 and 3.029 kPa, suggesting some variability in measurements between the two systems.



Fibrosis	Aplio Cases	Mean SWE	SD	25-75% CI	Sequoia cases	Mean SWE	SD	25-75%CI
F0	5	4.32	0.45497	3.9-4.7	15	4.44	1.57734	3.9-5.5
F1	25	6.13571	0.64246	5.7-6.4	22	6.49642857	3.19739	4.9-7
F2	6	8.17143	0.43861	7.9-8.4	3	5.64285714	2.27805	4.45
F3	7	9.6	0.82462	9.2-10.1	13	10.2285714	2.88485	9.3-12.1
F4	46	20.6725	12.609	15.1-22	36	23.38	20.2018	12.9-23.2
TOTAL	89				89			

Figure 3. *Heat map of fibrosis grade classification by Aplio and Sequoia and the mean SWE along with standard deviation and 95% confidence interval chart.*

Diagnostic Performance for Advanced Fibrosis

For the Aplio system, there were 43 true-negative patients who did not have F4 fibrosis, 10 false-positive F4 cases, 1 false-negative, and 35 true-positive cases. For the Sequoia system, 53 patients were true negative for F4 fibrosis; there were no false positives, 1 was false negative (with ascites), and 34 were true positive.

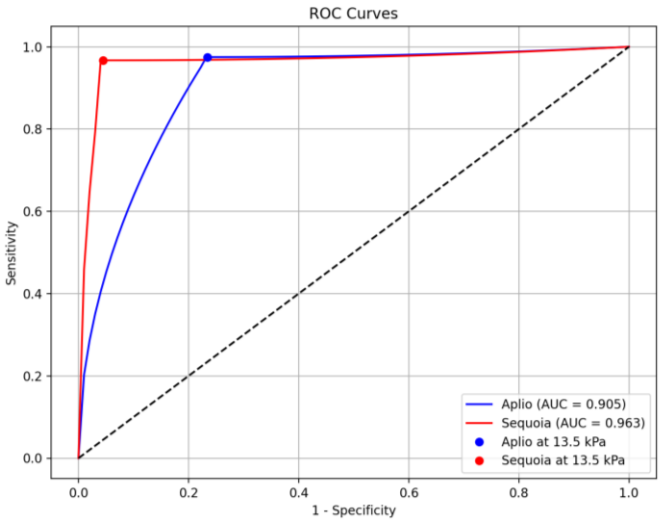
The diagnostic performance metrics for F4 classification are shown (Figure 4).

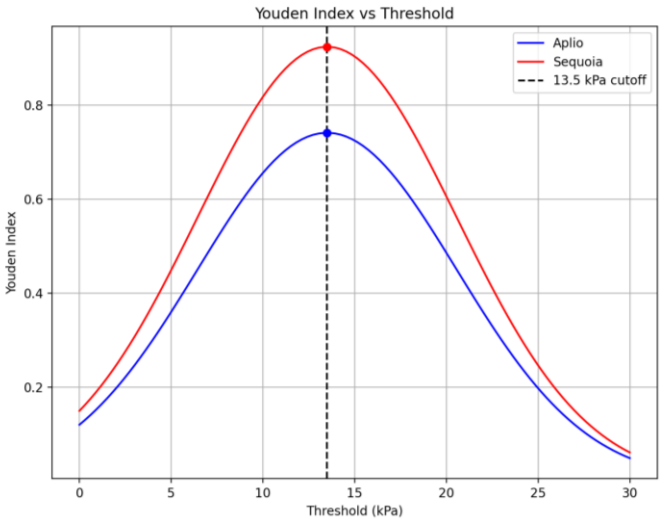
Aplio System:

1. Sensitivity: 97.8%
2. Specificity: 79.6%
3. Accuracy: 87.9%
4. Area under curve (AUC): 0.90
5. Youden Index: 0.76

Sequoia System:

1. Sensitivity: 97.8%
2. Specificity: 100%
3. Accuracy: 98.9%
4. Area under curve (AUC): 0.96
5. Youden Index: 0.97





Parameter	Aplio	Sequoa
Sensitivity	0.978	0.971
Specificity	0.796	1.000
PPV	0.800	1.000
NPV	0.977	0.981
Accuracy	0.879	0.989

Figure 4. *Area under curve analysis for F4 vs non F4 grades by Aplio and Sequoia along with the diagnostic analysis table.*

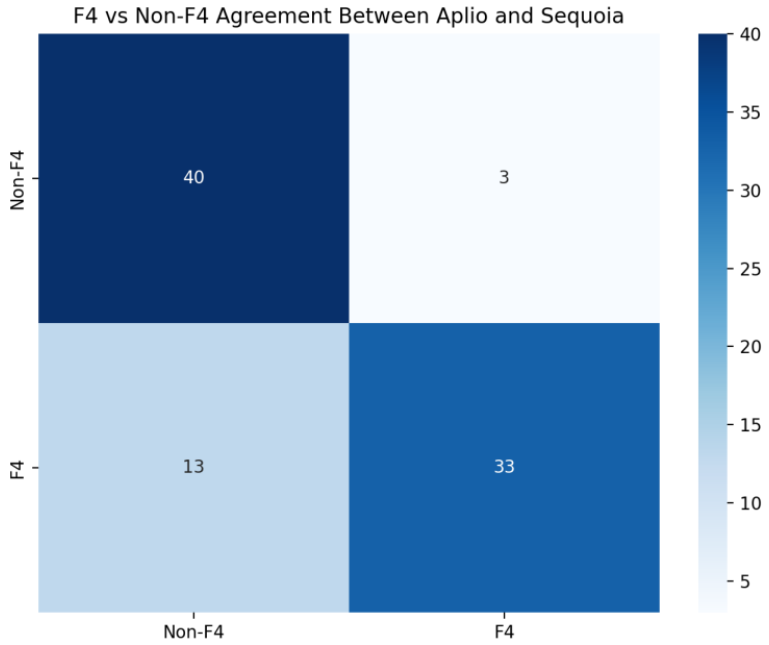


Figure 5. *Heat map matrix of the correlation of F4 vs non F4 cases of Aplio and Sequoia.*

Cohen's Kappa analysis for F4 classification showed a Kappa score of 0.643, confirming substantial agreement between Aplio and Sequoia for F4 classification (Figure 5) with an overall agreement of 82.0%. The sensitivity for F4 was identical at 97.8% for both systems, whereas the specificity was significantly higher for Sequoia (100%) than for Aplio (79.6%).

Agreement in Non-F4 Fibrosis Staging

In contrast to the good agreement for the F4 classification, the agreement in the non-F4 categories was poor, with a Cohen's kappa of only 0.09. The heat map matrix (Figure 6) revealed that most of the disagreements (15 cases) were within 1 stage difference, whereas there were six cases with a 2-stage difference and two cases with a 3-stage difference.

The stage-wise agreement varied significantly: F1 showed the highest agreement (58.3%), followed by F0 (40.0%), F3 (16.7%), and F2 (0.0%). The Aplio system tended to classify patients at higher fibrosis stages than Sequoia.

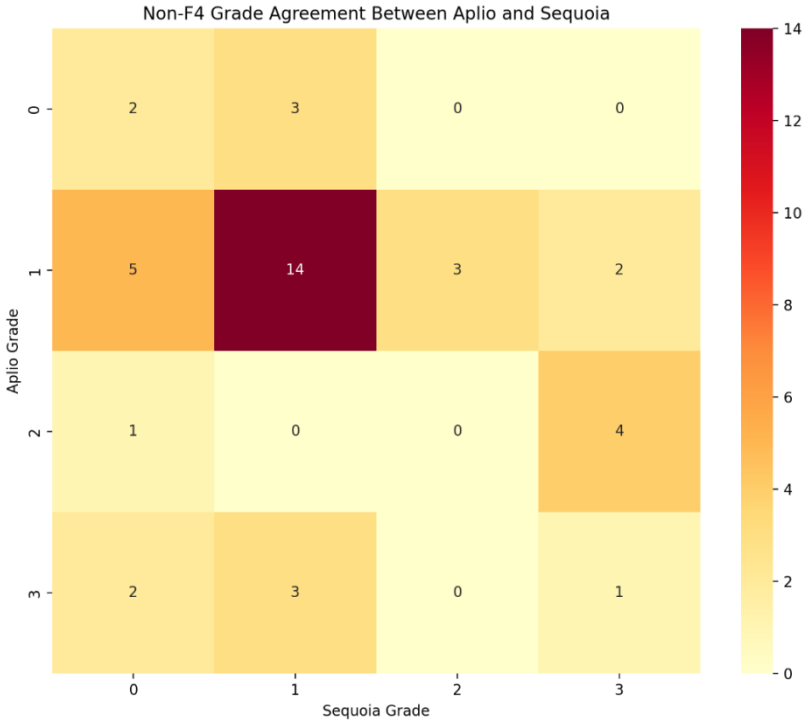


Figure 6. *Heat map matrix of correlation of Non F4 cases of Aplio and Sequoia.*

Factors Influencing Measurement Discrepancies

Multivariate regression analysis for age, sex, BMI, skin-to-capsule distance (SCD), and shear wave dispersion (SWD) variables revealed that SCD and SWD were the most influential predictors in both models, with standardized coefficients as follows:

Aplio Model:

1. Age: 0.022
2. Sex: 0.082
3. SCD: 0.513
4. SWD: 0.482
5. BMI: 0.009

Sequoia Model:

1. Age: -0.071
2. Sex: 0.243
3. SCD: 0.333
4. SWD: 0.778
5. BMI: 0.207

The Sequoia model showed a slightly better overall performance, but both models had relatively low R-squared values, indicating that there may be additional factors influencing the fibrosis grade predictions (Figure 7).

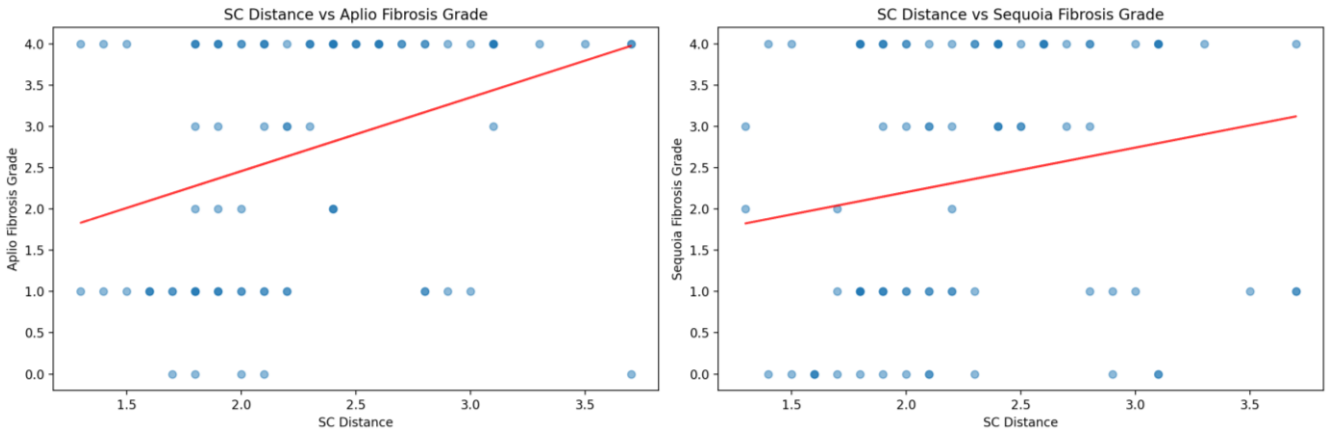
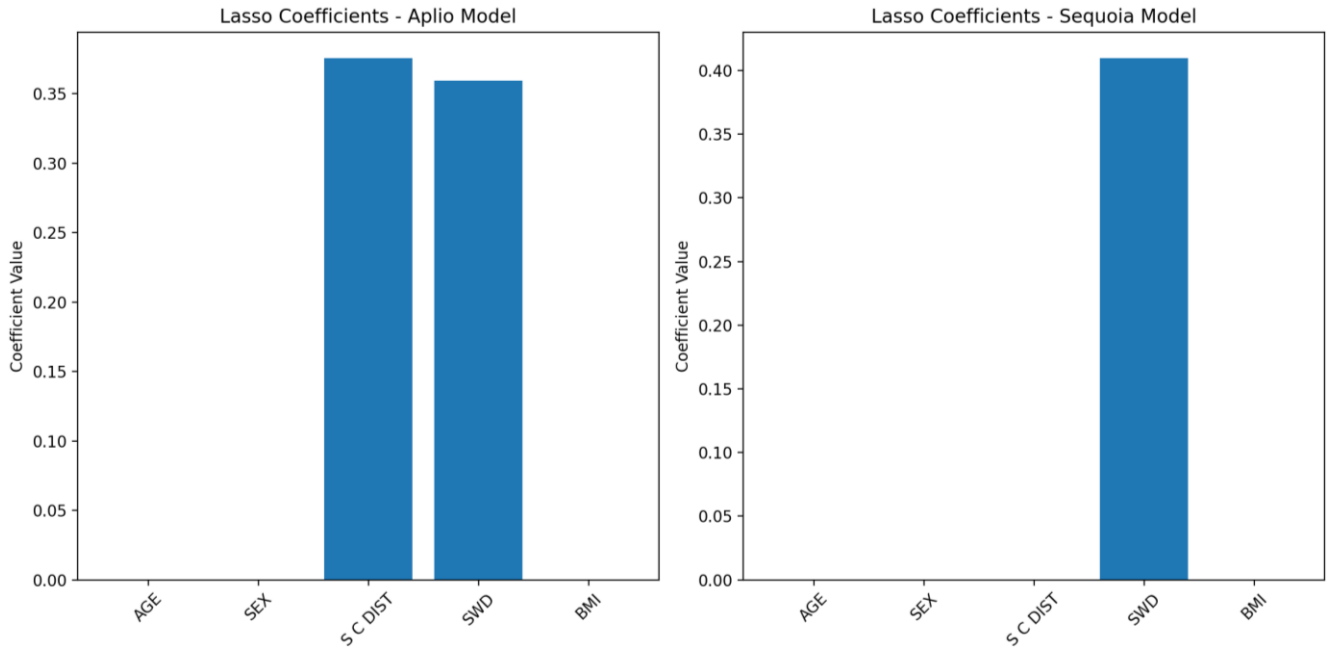


Figure 7. *Regression plots of SC distance for Aplio and Sequoia showing R2 of 0.11 and 0.03, respectively, with p-values of 0.001 and 0.07.*

LASSO regression confirmed that SWD and SCD were the most important variables for Aplio, whereas SWD alone was the determinant variable for Sequoia. Analysis of the 10 discordant cases classified as F4 by Aplio but non-F4 by Sequoia revealed a mean SCD of 2.5 cm and mean SWD of 16.0 db/cm/Hz, which were statistically significant factors in these false-positive classifications (Figure 8).



Sno.	Predictor	Aplio_Coef.	Sequoia_Coef.
0	AGE	0.0	0.0
1	SEX	0.0	0.0
2	S C DIST	0.3755532049	0.0
3	SWD	0.3593854444	0.4097025111
4	BMI	0.0	0.0

Figure 8. *Lasso regression coefficients of various predictors with Aplio and Sequoia with a bar chart.*

4. Discussion

The aim of our study was to determine the correlation between classifications based on liver stiffness using two different elastography systems, Canon Aplio i800 (2D-SWE) and Siemens Sequoia (pSWE), in obese patients with varying etiologies and to evaluate whether significant differences exist between liver stiffness values obtained using these techniques.

Earlier studies done by Barr et al [25], Dietrich et al [26], Ferraiolo et al [27, 28] showed that there are differences between various system measurements especially as there is increase in liver stiffness increases and propose different cut-off values for various 2D-SWE systems. Recent comparative studies from 2021-2025 have further emphasized these inter-system variations, particularly in specific patient populations [29, 30]. Regarding the values in cirrhotic patients, Ferraiolo et al [28] obtained a median value of 12 kPa (equivalent with 2 m/s) and respectively a mean value of 10.8 kPa (equivalent with 1.9 m/s) for TE and 2DSWE using Elasto PQ system. More recent studies have validated these findings with larger cohorts and extended follow-up periods [31-33]. This results in substantial burden of confusion for hepatologists in clinical practice. Hence The SRU recommended a vendor-neutral "rule of four", which gives 5 LSV thresholds for interpreting liver stiffness measured by different systems [25]. Recent validation studies from 2022-2024 have supported the continued use of these standardized cut-offs while highlighting the need for system-specific considerations [34, 35]. So, we used the same cut off to divide patients into F0-F4 classes and then determined if the intersystem correlation holds good.

Correlation and Agreement Between Systems

Our study demonstrated a moderate overall correlation between liver stiffness measurements obtained by both pSWE and 2D-SWE techniques (r=0.68). However, the correlation strength varied significantly between patient subgroups, with stronger correlation in F4 patients (r=0.575) compared to non-F4 patients (r=0.237). This finding suggests that the agreement between systems may be influenced by the underlying severity of liver disease. Recent studies have reported similar patterns of correlation variability across different fibrosis stages [36, 37]. Aplio had lower specificity than Sequoia and the reason could be due to effect of Sc-distance which was the only variable in the obese cohort of patients which influenced the Aplio model. Our study also showed that the LS values assessed by Aplio were significantly lower than those obtained by Sequoia elastography in the entire cohort of subjects. Similar results were seen by other comparative studies [38-40] regarding LS assessment, with contemporary research from 2023-2024 confirming these systematic differences between platforms [41, 42].

ElastPQ; another platform for LS assessment was shown to have variation in values in healthy volunteers ranging between 3.3 kPa and 3.8 kPa, higher values being obtained in men [43]. Our study showed however statistically non-significant effect of gender in Sequoia model only similar to earlier reported studies [40-43]. This difference between LS values obtained in men vs. women was also observed in Transient Elastography and 2D-SWE (Aixplorer® system), but not in ARFI elastography in which gender did not influence the LS values [43-45]. Recent large-scale studies from 2022-2024 have provided additional evidence supporting these gender-related differences in specific elastography platforms [46-48].

The mean difference in liver stiffness values between the two systems evaluated by us was relatively small in the overall cohort (-1.44 kPa), but the magnitude of this difference increased substantially in patients with advanced fibrosis. In the F4 group, the mean difference increased to -5.79 kPa, while in the non-F4 group, it was only 0.60 kPa. This pattern aligns with previous comparative studies by Ferraioli et al [27, 28], who reported that the mean difference in liver stiffness between 2D-SWE systems was 0.55 kPa in patients with little or no fibrosis (<15 kPa), increasing to 2.43 kPa in patients at a more advanced disease stage. Recent meta-analyses have confirmed this trend across multiple elastography platforms [49].

Despite these differences, paired t-tests revealed no statistically significant differences between Aplio and Sequoia measurements in either the F4 group (p=0.0657) or the non-F4 group (p=0.1077). This finding supports the continued use of the SRU "rule of four" reference model for both groups, which

establishes standardized cutoff values for fibrosis staging across different elastography systems. Contemporary validation studies have reinforced the clinical utility of these standardized thresholds [50, 51].

Diagnostic Performance in Advanced Fibrosis

A key finding of our study was the excellent sensitivity of both systems (97.8%) in detecting advanced fibrosis (F4), but with marked differences in specificity. The Sequoia system demonstrated perfect specificity (100%), while the Aplio system had a lower specificity (79.6%), resulting in 10 false-positive F4 classifications. This difference in specificity translated to superior overall accuracy for the Sequoia system (98.9% vs. 87.9%). Recent comparative studies have reported similar performance differences between pSWE and 2D-SWE systems in challenging patient populations [52, 53].

The higher false-positive rate with the Aplio system has important clinical implications, as misclassification of patients as having advanced fibrosis could lead to unnecessary follow-up, increased patient anxiety, and potential overtreatment. Our analysis of these discordant cases identified increased skin-to-capsule distance (mean 2.5 cm) and elevated shear wave dispersion (mean 16.0 db/cm/Hz) as significant contributing factors to false-positive results with the Aplio system. This high confounding factor has not been highlighted in obese patients in earlier studies but has been increasingly recognized in recent literature focusing on obesity-related challenges in elastography [54, 55].

Factors Influencing Measurement Variability

Our multivariate analysis identified two key factors influencing elastography measurements: skin-to-capsule distance (SCD) and shear wave dispersion (SWD). The impact of these factors varied between the two systems, with SCD having a stronger influence on Aplio measurements (standardized coefficient 0.513) compared to Sequoia measurements (0.333). Conversely, SWD had a more pronounced effect on Sequoia measurements (0.778) compared to Aplio measurements (0.482). Recent studies have provided similar insights into the differential impact of anatomical and technical factors on various elastography platforms [56, 57].

The differential impact of SCD on the two systems may be explained by their underlying technical approaches. The Aplio system uses continuous shear wave propagation, which can be distorted by increased abdominal wall thickness or fat, potentially resulting in falsely elevated stiffness values. Similar findings have been reported by Cassinotto et al [58] and Lee et al [39, 40], who demonstrated that 2D-SWE methods are more influenced by abdominal wall thickness than pSWE techniques. Contemporary research has further elucidated these technical differences and their clinical implications [59, 60].

The relative immunity of the Sequoia system to SCD effects may be attributed to its use of a deep abdominal (DAX) probe, which provides better sound wave transmission and shear wave quality with reduced attenuation from subcutaneous fat. This technical advantage may explain the superior specificity and overall diagnostic performance of the Sequoia system in our predominantly overweight and obese study population. Recent studies have specifically validated the advantages of DAX probe technology in obese patients [61, 62].

Shear wave dispersion, which reflects concurrent liver inflammation, was the most influential factor for both systems but had a particularly strong impact on the Sequoia measurements. Increased inflammation may result in elevated stiffness values and could affect the concordance of results, especially in patients with advanced fibrosis, similar to the high stiffness values observed in patients with acute hepatitis. Recent research has provided new insights into the relationship between inflammation and elastography measurements [61, 62].

Agreement in Non-F4 Fibrosis Staging

While both systems showed substantial agreement in classifying F4 fibrosis (kappa=0.643), the agreement in non-F4 categories was poor (kappa=0.09). The majority of disagreements were within one stage difference, but several cases had two or three-stage differences, which could lead to significant clinical misinterpretation. Recent studies have reported similar patterns of inter-system agreement across different fibrosis stages [63, 64].

The Aplio system consistently classified patients at higher fibrosis stages compared to Sequoia, with the greatest discrepancies observed in F2 and F3 classifications. This tendency toward upstaging by the Aplio system is concerning, as it may result in overestimation of disease severity and potentially unnecessary interventions or monitoring. Studies comparing LS by different vendor platforms have been done earlier but such discrepancies based on the basis of Non F4 and F4 groups have not been evaluated earlier [65, 66]. The findings of current study are important for the fact that in Non F4 patients these may not have bearing on the clinical management however in F4 patients it has the potential to alter patient management. Recent clinical guidelines have begun to address these inter-system variations and their implications for patient care [67, 68].

Technical Considerations and Limitations

Several technical factors could influence elastography measurements in our study population. Inadequate fasting (less than 4 hours) may have resulted in falsely elevated stiffness values, particularly with the Aplio system. Other confounding factors included obesity, duodenal gas, and colonic interposition, which can affect measurement quality and reliability. Recent technical advances have addressed some of these limitations, but challenges remain in obese populations [69, 70].

The presence of ascites was identified as a potential cause of false-negative results, with three cases misclassified as non-F4 by both systems. This finding highlights the known limitations of elastography in patients with ascites and underscores the importance of considering clinical context when interpreting elastography results. Contemporary research has

explored novel approaches to overcome these technical limitations [71, 72].

Clinical Implications

Our study has several important clinical implications. First, while both Aplio and Sequoia systems demonstrated strong diagnostic capabilities for advanced fibrosis assessment, they cannot be considered fully interchangeable, particularly in patients with increased subcutaneous fat or liver inflammation. Clinicians should be aware of these potential discrepancies when interpreting results or comparing measurements across different systems. Recent clinical practice guidelines have begun to incorporate these considerations [73, 74].

Second, the Sequoia system demonstrated superior performance in our predominantly overweight and obese population, with better specificity and overall accuracy for F4 classification. This finding suggests that pSWE techniques may be preferable in obese patients, particularly when using the DAX probe, which appears to mitigate the effects of increased abdominal wall thickness. Contemporary evidence supports these findings in similar patient populations [75, 76].

Third, our study supports the continued use of the SRU "rule of four" with standardized cutoff values for liver stiffness classification. Despite differences between systems, the overall agreement in F4 classification was substantial, and the established thresholds appear appropriate for clinical decision-making. Recent validation studies have reinforced this recommendation [77, 78].

Finally, our findings highlight the importance of considering technical factors that may influence elastography measurements, particularly in challenging patient populations. Awareness of these potential confounders can improve the accuracy of interpretation and guide appropriate clinical management. Current research continues to address these technical challenges and develop solutions [79, 80].

Limitations

Our study has several limitations that should be acknowledged. First, the lack of a histological reference standard (liver biopsy) prevents definitive validation of the true fibrosis stage. Second, our study population was predominantly male (71.6%), which may limit the generalizability of our findings to female patients. Third, the cross-sectional design precludes assessment of longitudinal changes or prognostic implications of elastography measurements. Finally, our study focused on two specific elastography systems, and the findings may not extend to other vendors or technologies.

5. Conclusion

While both Aplio and Sequoia systems demonstrated strong diagnostic capabilities for liver fibrosis assessment, the Sequoia system showed superior overall performance with equivalent sensitivity but significantly better specificity in our predominantly overweight and obese population. Two key factors influenced the measurements: skin-to-capsule distance and shear wave dispersion, with their impact varying between the two systems.

Our study confirms that the Society of Radiologists in Ultrasound (SRU) recommendation of the "vendor-neutral rule of four" with five thresholds is appropriate for interpreting and classifying liver stiffness. However, the results from the two systems are not entirely interchangeable due to inherent variations, particularly in patients with increased subcutaneous fat and/or liver inflammation.

Clinicians should be aware of these potential discrepancies when interpreting elastography results or comparing measurements across different systems, especially in challenging patient populations such as those with obesity. Further research with histological validation is needed to better define system-specific adjustments that may improve the accuracy and concordance of liver stiffness measurements in diverse patient populations.

Abbreviations

MASLD	Metabolic Associated Steatotic Liver Disease
2D SWE	2dimensional Shear Wave Elastography
pSWE	Point Shear Wave Elastography
SCD	Skin to Capsule Distance
SWD	Shear Wave Dispersion
DAX	Deep Abdominal Probe
NAFLD	Non Alcoholic Fatty Liver Disease
NASH	Non Alcoholic Steatohepatitis.

Conflicts of Interest

The authors declare no conflicts of interest.

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