

# **Shear Wave Elastography in the Liver: Analysis of Specific Clusters of the Elastographic Images Using Fuzzy C-Means Clustering discriminates Healthy from Chronic Liver Disease Patients**

**Ilias Gatos**

Department of Medical Physics, School of Medicine, University of Patras  
GR 26504, Rion, Patras, Greece  
gatose1981@gmail.com

**Stavros Tsantis**

Department of Biomedical Engineering, Technological Educational Institute of Athens  
GR 12210, Egaleo, Athens, Greece  
stsantis@teiath.gr

**Aikaterini Skouroliakou**

Department of Energy Technology Engineering, Technological Educational Institute of Athens  
GR 12210, Egaleo, Athens, Greece  
kskourol@teiath.gr

**George C. Kagadis**

Department of Medical Physics, School of Medicine, University of Patras  
GR 26504, Rion, Patras, Greece  
gkagad@gmail.com

## **Extended Abstract**

Ultrasound Shear Wave Elastography (SWE) is a relatively new imaging modality with promising results towards Chronic Liver Disease (CLD) staging evaluation as shown by Carey et al. (2010) Most SWE studies have correlated Liver Fibrosis Stages to Liver Stiffness values. For each group of patients examined, a mean value of one, three or ten measurements in kilopascals (kPa) per patient is taken by selecting a circular Region Of Interest (ROI) on the elastographic area (trapezoid SWE-QBox) superimposed on B-Mode Ultrasound and measuring the mean stiffness within the ROI. Sporea et al (2014) used a similar method for their study.

A ROC Analysis is then performed on these mean stiffness values and optimal cut-off values for each Fibrosis Stage as Sporea et al (2014) used in their study (usually Metavir F0-F4 staging is used with F0 showing no fibrosis, F1 mild fibrosis, F2 significant fibrosis, F3 severe fibrosis and F4 indicating Cirrhosis (Goodman et al. (2007))). Although many studies have been published using this protocol, there are no specific guidelines for the examiners indicating the criteria of a reliable measurement and optimal ROI selection as mentioned in Deffieux's et al (2015) and Pellot-Bakarat's et al (2014) studies. The purpose of this study is to compare the existing method to a more objective method using Fuzzy C-Means (FCM) Clustering and choosing the most representative cluster for taking the mean stiffness measurement.

## **Materials & Methods**

The clinical dataset comprised of 32 subjects, 16 Healthy (F0) and 16 with CLD (F1, F2, F3 and F4)

employing histological examination as ‘Gold Standard’. An experienced Radiologist performed the SWE measurement placing a ROI on each patient’s right lobe acquiring the stiffness values for the manual selection procedure. Subsequently, Fuzzy C-Means clustering was performed on every SWE image utilizing 5 clusters. Mean value and number of pixels of each cluster were then calculated. The mean value of the cluster with maximum number of pixels for each patient is employed for ROC analysis.

## Results

Examiner’s measurements (manual ROI selection) showed a Sensitivity value of 0.8125 employing cutoff value of 7.1 kPa according the current literature. ROC analysis of the proposed algorithm showed an Area and the Curve (AUC) value of 0.8633, Optimum Cut-off value: 7.5 kPa with Sensitivity Specificity values of 0.8438 and 0.875 providing a balanced Accuracy of 0.8594 which outperformed the manual ROI selection.

## Conclusion

The study showed that a new automatic algorithm was implemented with more objective criteria of defining optimum elasticity cut-off values for discriminating fibrosis stages in Shear Wave Elastography. As a next step of our study other histogram features such as Median, Standard Deviation or Sample Kurtosis can be evaluated for this discrimination. More patients are needed in order to define if this algorithm is an objective tool against manual ROI selection.

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