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ORIGINAL ARTICLE
ORİJİNAL ARAŞTIRMA

The Potential Role of Sonoelastography in the Differential Diagnosis of Ascites

Asit Ayırıcı Tanısında Sonoelastografinin Potansiyel Rolü

Osman Dere[1], Çağrı Kesim[1], Abdurrahman Sabuncu[2], İbrahim Bayhan[3], Mehmet Sidar Güler[4], Ahmet Uyanıkoğlu[5]

[1]Baskent University School of Medicine, Department of Radiology, Konya, Turkey
[2]Harran University Faculty of Medicine, Department of Radiology, Şanlıurfa, Turkey
[3]Harran University Faculty of Medicine, Department of Internal Medicine, Şanlıurfa, Turkey
[4]Mehmet Akif Inan Training and Research Hospital, Department of Internal Medicine, Şanlıurfa, Turkey
[5]Harran University Faculty of Medicine, Department of Gastroenterology, Şanlıurfa, Turkey

ABSTRACT

Aim: The aim of this study was to demonstrate the role of shear wave elastography (SWE) in the differantial diagnosis of ascites.

Material and Method: Fifty four patients with abdominal ascites due to different etiologies were included in this single-center prospective study. SWE was performed on the ascitic fluid of patients who were scheduled for paracentesis. Mean elastography values were recorded. According to clinical, radiological and laboratory results, patients were divided into two groups: portal hypertension-related (PHR) ascites and nonportal hypertension-related (NPHR) ascites. The relationship between ascites etiology and elastography values was investigated.

Results: Of the 54 patients studied, 34 had PHR ascites and 20 had NPHR ascites. There was no difference between the two groups in terms of mean age and gender. The mean±SD elastography value of the PHR ascites group was calculated 20.57±5.53 (10.58–31.1), where as the mean±SD elastography value of the NPHR ascites was calculated as 23.74±5.55 (14.–31.32) ($P < 0.05$). The receiver operating characteristic (ROC) analysis showed that sensitivity and specificity were found as 55% and 91.2%, respectively, when the cutoff value was selected as 25.8 kPa in the differentiation of the PHR and NPHR ascites.

Conclusion: Sonoelastography was found to be useful in discriminating PHR ascites from NPHR ascites.

Keywords: Ascites, elastography, portal hypertension

ÖZ

Amaç: Bu çalışmanın amacı, asit ayırıcı tanısında shear wave elastografinin (SWE) rolünü ortaya koymaktır.

Gereç ve Yöntem: Bu tek merkezli prospektif çalışmaya farklı etiyolojilere bağlı batında asit gelişen 54 hasta dahil edildi. Parasentez planlanan hastaların asit sıvısına SWE uygulandı. Ortalama elastografi değerleri kaydedildi. Klinik, radyolojik ve laboratuvar sonuçlarına göre hastalar portal hipertansiyonla ilişkili (PHR) asit ve portal hipertansiyonla ilişkili olmayan (NPHR) asit olarak iki gruba ayrıldı. Asit etiyolojisi ile elastografi değerleri arasındaki ilişki araştırıldı.

Bulgular: İncelenen 54 hastanın 34'ü PHR asit grubunda ve 20'si NPHR asit grubundaydı. İki grup arasında ortalama yaş ve cinsiyet açısından fark yoktu. PHR asit grubunun ortalama±SD elastografi değeri 20.57±5.53 (10.58–31.1), olarak hesaplanırken, NPHR asit grubunun ortalama±SD elastografi değeri 23.74±5.55 (14.–31.32) olarak hesaplandı ($P < 0.05$) . Yapılan ROC analizinde PHR ve NPHR asit ayrımında kesim değeri 25.8 kPa seçildiğinde duyarlılık ve özgüllüğün sırasıyla %55 ve %91.2 olduğu görüldü.

Sonuç: Sonoelastografinin PHR asit grubundaki hastaları NPHR asit grubundaki hastalardan ayırmada faydalı olduğu bulundu.

Anahtar Kelimeler: Asit, elastografi, portal hipertansiyon

Corresponding Author: Osman Dere
Address: Department of Radiology, Baskent University School of Medicine. 42080 Konya, Turkey.
E-mail: drderectf@hotmail.com

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INTRODUCTION

Ascites is a pathological fluid accumulation in the peritoneal cavity that can occur in a variety of peritoneal or extraperitoneal disease (1). The etiologies of ascites are generally divided into two groups. In the first group, approximately 85% of the cases are related to portal hypertension, predominantly cirrhosis patients. The second group includes disorders that unrelated to portal hypertension, such as renal failure, malignancy, pancreatitis, and peritoneal tuberculosis (1,2). Capillary permeability increases in portal hypertension-related (PHR) ascites as a result of sinosoidal portal hypertension. Consequently, there is fluid accumulation in the peritoneal cavity in the form of transudate. Nonportal hypertension-related (NPHR) ascites is generally in exudative form. In these patients, vascular permeability due to inflammatory processes, tumoral invasion or trauma are the causes of ascites formation (3,4).

The differential diagnosis of ascites is a significant clinical issue. The history, physical examination, radiological and biochemical evaluation and ascitic fluid investigation are used to determine the etiology of ascites. The most commonly used tool is the serum acid-albumin gradient (SAAG), which has been shown to be 97% accurate in differentiating PHR and NPHR ascites (5).

Ultrasonography (US) is a noninvasive, accessible and reliable imaging method that is commonly used in the evaluation of ascites patients. Elastography is a US-based imaging technique used to assess tissue stiffness (6). Strain Elastography (SE) and Shear Wave Elastography (SWE) are the two types of US elastography. In SE, external pressure with the help of a US probe is implemented to create mechanic stimulation. In SWE, mechanic stimulation is created with share waves produced by the imaging device. In both methods, the elasticity properties of the tissues are evaluated according to the response to the implemented mechanic stimulation (7). The tissue elasticity is measured in kilopascal units or with share wave velocity (SWV). The real-time quantitative measurement of the tissue elasticity, repeatability, and non-dependence to an operator are the advantages of SWE (8).

Certain abnormalities on US can help demonstrate the etiology of ascites. On US imaging, the echotexture of ascitic fluid, the distribution of ascites, the presence of peritoneal implants and omental cake, are particularly helpful in distinguishing benign from malignant ascites. Previous research demonstrated the importance of ultrasonography in classifying ascitic fluid as transudate or exudate. In a considerable percentage of cases, it also plays a role in identifying its etiology (9-11). There is no study in the literature that we are aware of that evaluates ascitic fluid using SWE.

The purpose of this study was to demonstrate the diagnostic role of SWE in the determination of ascites etyology with reference to final diagnosis obtained with clinical findings, diagnostic laboratory test, other imaging method, laparotomy, and pathology.

MATERIAL AND METHOD

This single center prospective study performed between February 2022 and January 2023. Approval for present study was obtained from the local ethics committee (27.12. 2021-HRU/21.23.24). The written informed consent form was signed by all patients. The study comprised 54 individuals with ascites who were hospitalized in the gastroenterology service. Elastography examination was performed before paracentesis. Paracentesis was performed under sterile settings. A blood sample was also taken immediately following the paracentesis. Ascitic fluid and blood samples were sent to the laboratory for analysis of ascitic albumin, cell count and differential as well as, serum albumin, and total protein. In addition, a part of the ascitic fluid sample was sent to the pathology unit for cytology. The serum and ascitic albumin values were used to calculate the SAAG. Demographic information,elastografi values, laboratory and cytology results, as well as other imaging findings and relevant clinical data, were all submitted in a form.

The patients were divided into two groups, PHR ascites and NPHR ascites group, according to the cause of ascites. The results of the physical examination, laboratory tests, radiological imaging and ascitic fluid analysis were used to diagnose PHR ascites group and NPHR ascites group. Patients with minimal ascites, or contraindication in terms of paracentesis were excluded from this study.

Ultrasound and Elastography Imaging

US and SWE imaging of ascitic fluid was conducted by a single radiologist. The Siemens ACUSON S2000 US system (Siemens Medical Solution, Mountain View, CA, USA) with a 9L4 probe was utilized for the examinations. First, the gray-scale US examination of ascites fluid was conducted, while the patients were in the supine position. In gray-scale examination, the sonographic appearance of ascitic fluid was recorded as transudate or exudate. After the gray-scale ultrasonography examination, the US probe was positioned on the lower abdominal quadrant with excess fluid at the transverse plane. The colour map of virtual touch image quantification (VTIQ) was obtained without any pressure application with the probe. In the colour map, high-quality sections were presented as green, intermediate-quality sections as yellow, and low-quality sections as orange. The elastography values was subsequently measured by ten fixed ROI (2 x 2 mm) using a high quality colour map. The elastography values of the ascites were

obtained in kilopascal and SWV (**Figure 1** and **Figure 2**). The mean value of ten elastografi measurements were used for the statistical analysis.

Figure 1. Elastography values in a 70-year-old patient with hepatitis-C virus related liver cirrhosis who was in the PHR ascites group.

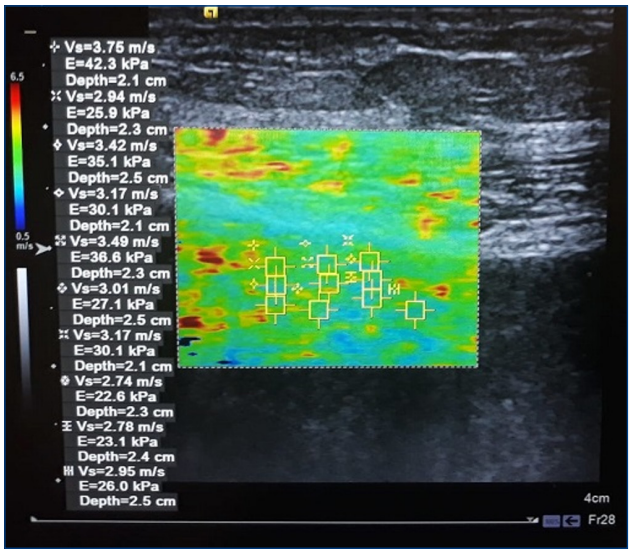

Figure 2. Elastography values in a patient in the NPHR ascites group with tuberculous peritonitis.

Statistical Analysis

Statistical analyses were performed using the SPSS 26.0 version (SPSS Inc, Chicago, IL) package program. Descriptive statistics were summarized as a number, percentage, mean and standard deviation. We assessed the normal distribution of a set of 54 data derived from a total of 540 measurements, using the Kolmogorov-Smirnov test. Next, we conducted an independent sample T-test to compare the mean elastography values of the PHR and NPHR ascites groups. Finally, we utilized ROC analysis to explore the presence of a cut-off value between the two groups. Statistical significance level was accepted as $p < 0.05$ in all statistical analyses.

RESULTS

The 54-patient group included 23 males and 31 females, with a mean age of 57.07±17.25 years. The youngest patient was 19, while the oldest was 88. In the PHR ascites group, there were 34 patients (15 males, 19 females) with a mean age of 58.74±16.7 years. In the NPHR ascites group, there were 20 patients (8 males, 12 females) with a mean age of 54.25±18.22 years. In the gray-scale examination, the sonographic appearance of the ascitic fluid was observed as transudate in all patients in the PHR ascites group. In the NPHR ascites group, the ascitic fluid appeared as transudate in 4 patients and as exudate in 16 patients.

Of the patients in the PHR ascites group, 11 had hepatitis-b virus related liver cirrhosis, 7 had cryptogenic liver cirrhosis, 4 had hepatitis-c virus related liver cirrhosis, 3 had heart failure, 3 had autoimmune hepatitis, 2 had toxic hepatitis . Of the patients in the NPHR ascites group, 4 had tuberculous peritonitis, 4 had ovarian ca, 3 had cholangiocellular ca, 3 had hepatocellular ca, 2 had lymphoma, 2 had pancreas ca, 1 had inoperable gastric ca and 1 had renal cell ca (**Table 1**).

Table 1. Demographic characteristics, sonographic appearance of ascitic fluid and the final diagnosis of study groups

	PHR ascites group	NPHR ascites group
Patients, n	34	20
Age, years	58.74±16.7	54.25±18.22
Sex, male/female (n/n)	15/19	8/12
Transudate/exudate (n/n)	34/0	4/16
Hepatit-b virus related liver cirrhosis	11	-
Cryptogenic liver cirrhosis	7	-
Hepatitis-c virus related liver cirrhosis	4	-
Heart failure	3	-
Autoimmune hepatitis	3	-
Toxic hepatitis	2	-
Tuberculous peritonitis	-	4
Ovarian ca	-	4
Cholangiocellular ca	-	3
Hepatocellular ca	-	3
Lymphoma	-	2
Pancreas ca	-	2
Inoperable gastric ca	-	1
Renal cell ca	-	1

The elastography values are presented in Table 2 and classified according to etiology. We conducted an Independent Samples T-test and found homogeneous variances between our two groups. The NPHR ascites group displayed significantly higher kPa values compared to the PHR ascites group ($t(52) = -2.03$, $p < 0.05$). In the following ROC analysis, area under the curve was determined to be 66. 1%. A threshold value above 25.8 kPa was significant for NPHR ascites group with 55% sensitivity and 91.2% specificity (**Figure 3**).

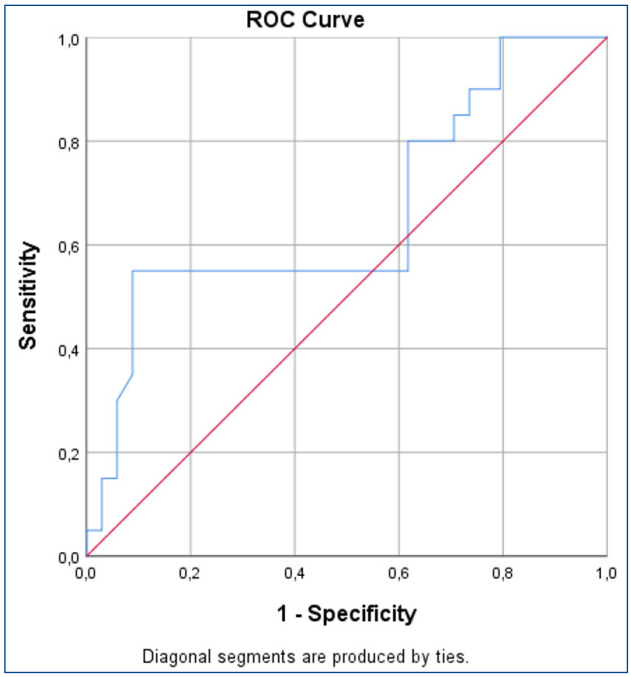

Figure 3. The receiver operating characteristic curve is used to differentiate ascites etiology. When the cutoff value was selected at 25.8, the ROC analysis revealed that the sensitivity and specificity were 55% and 91.2%, respectively.

DISCUSSION

Finding the underlying etiology of ascites is an enormous challenge in order to provide successful treatment. In clinical practice, many invasive and noninvasive methods can be utilized to make differential diagnoses. SAAG is an important marker for determining whether the etiology of ascitic fluid is related to portal hypertension. The SAAG should be 1.1 g/dl or more in the presence of portal hypertension and 1.1 g/dl or lower in the absence, with an accuracy of more than 95% (12). There are several studies in the literature that demonstrate that US is used to detect the etiology of ascites. In a study performed by Getnet et al. they showed that US was able to classify 100% of benign causes as transudate and 95% of malignant and inflammatory causes as exudates (13). Another study conducted by Alnumeri et al. they found that in benign conditions, there was 100% concordance between US characterisation and SAAG results, 77.8% in patients with malign etiologies, and 87.5% in inflammatory cases (11). Similarly, Edell et al. investigated the accuracy of ultrasonography in discriminating between transudative and exudative ascites in 65 patients. Ultrasound detected all 50 transudative patients and 11 of 15 exudative ascites (14).

US elastography is increasingly being utilized to diagnose both benign and malignant diseases. Elastographic studies reveal promising outcomes, particularly in disease that involve inflammatory alterations and fibrosis (15). In this investigation, we used SWE to assess ascitic fluid in patients with PHR ascites and NPHR ascites. In the present study, we observed that elastography values were higher in the NPHR ascites group than in the PHR ascites group. In general ascitic fluid has been observed to be transudate in PHR ascites patients and exudate in NPHR ascites patients. In our study, all patients in the PHR ascites group had transudate ascitic fluid according to gray scale examination. In the NPHR ascites group, 80% of patients had ascitic fluid in the form of exudate. We believe that ascitic fluid in the form of exudate increases elastisity. To the best of our knowledge, this is the first study to perform SWE in the differantial diagnosis of ascites. Pleural effusion was evaluated with SWE in a study conducted by Hou et al. and it was found to be a useful tool in discriminating between malignant and benign pleural effusion. However, false positives have been observed in tuberculous pleuritis and empyema (16). According to another study by Ozgokce et al. they performed SWE on pleural effusion and found it to be an effective method for differentiating between transudate and exudate pleural effusion. Elastography values were observed to be higher in patients with exudate pleural effusion in this research. (17). Elastography values in exudative ascites were statistically significantly higher than in transudate ascites in our study. These results support our hypothesis.

This study has some limitations. The primary limitation was the small number of cases. All examinations were performed by a single radiologist, and this study did not consider the possibility of interobserver variability. However, we consider that performing ten separate measurements on the ascitic fluid would result in a higher level of accuracy. In some of our patients the definitive diagnosis of the etiology of ascites was made using a combination of clinical, imaging, and laboratory results. It was unable to obtain a pathology diagnosis for all of the cases.

CONCLUSION

A differential diagnosis of ascites etiology is usually achievable by combining clinical data, laboratory tests, and imaging modalities. However, distinguishing PHR ascites from NPHR ascites can be challenging at times. This preliminary study show that SWE may be useful in this situation. Shear-wave elastography, a noninvasive, simple, and inexpensive procedure, could be utilized as an alternative to SAAG measurement for accurate ascites classification. To demonstrate and confirm these findings, additional multicenter clinical studies with larger sample sizes are required.

ETHICAL DECLARATIONS

Ethics Committee Approval: This study conformed to the principles of the 2008 Declaration of Helsinki and was approved by the local ethics committee of Harran University, Medical Faculty, Turkey. (HRU/21.23.24)

Informed Consent: All patients signed the free and informed consent form.

Referee Evaluation Process: Externally peer-reviewed.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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Author Contributions: All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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