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Noninvasive assesment in differentiating benign and malign pancreatic lesions with endosonographic elastography score and strain ratio

Benign ve malign pankreas lezyonlarının ayırıcı tanısının endosonografik elastografi skoru ve sertlik oranları ile noninvaziv değerlendirilmesi

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ABSTRACT

Background: We aimed to evaluate the diagnostic capability of endoscopic ultrasound elastography (EUS-EG) score and strain ratio (SR) for differentiating benign pancreatic lesions from the malign lesions

Material and Method: We retrospectively evaluated well collected data of patients who undergone EUS-EG in a single center during the period of January 2016-June 2019. Patients who had pancreatic disorders were further evaluated for the study. The final diagnosis of solid pancreatic lesions (SPL) was made by histopathologic examination. Control group consisted of patients with chronic pancreatitis (CP) who diagnosed according to Rosemont criteria. Elastography was evaluated by a qualitative (elastography scores) and a quantitative method SR.

Results: A total of 66 patients (42 (63.6%)female/24(63.6%)male) with mean age of 58.88±15.32 (19- 80) were included in the study. Thirty-eight patients had SLP, remain 28 patients were CP. In SPL group, 32 (84.2%) had adenocarcinomas and 6 (15.8%) had neuroendocrine tumors. Among 28 patients with benign pancreatic lesions, 23 (82.1%) had CP while five (17.9%) had autoimmune pancreatitis. Median SR values were significantly higher in patients with SPL than those with CP (44.0 (10.0-110.0) vs 7.0 (2.6-14.6), p<0.001). Elasticity scores were also significantly different between patients with SLP and CP (p<0.001). Elasticity scores were significantly different between adenocarcinomas and CP (p<0.001). A 14 cut-off value of SR had 97% sensitive and 100% specificity for SPL and receiver-operating characteristic curves showed an area under the curve of 0.99.6. Likelihood Ratio test revealed that SR appears as the best parameter in discrimination of lesion type either as benign or malignant (X2 = 54.031, p<0.001).

Conclusion: Our study suggested that EUS-elastography and SR scores are highly effective in differentiating malign-benign pancreatitis lesions

Keywords: Chronic pancreatitis, endoscopic ultrasound, elastography, solid pancreatic lesions, strain ratio

ÖZ

Amaç: Endosonografik elastografi skoru (EUS-EG) ve sertlik oranının (strain ratio (SR)) benign ve malign pankreatik lezyonların ayırıcı tanısındaki etkinliğini değerlendirmeyi amaçladık.

Gereç ve Yöntem: Ocak 2016-Haziran 2019 döneminde tek merkezde EUS-EG uygulanan hastaların verileri retrospektif olarak değerlendirildi. Çalışmada kronik pankreatit tanısı kesin olan hastaların endosonografik bulguları ile solid pankreatik lezyonların endosonografik bulguları karşılaştırıldı. Solid pankreas lezyonlarının (SPL) kesin tanısı histopatolojik inceleme ile konuldu. Kontrol grubunda biası önlemek için Rosement A kriterlerini karşılayan kronik pankreatitli (CP) hastalar değerlendirmeye alındı. Rosement B-C değerlendirmeye alınmadı. Elastografi kalitatif (elastografi skorları) ve kantitatif SR yöntemi ile değerlendirildi.

Bulgular: Ortalama yaş 58,8±15,3 (19-80) olan toplam 66 hasta (42 (%63,6) kadın / 24 (%63,6) erkek) çalışmaya dahil edildi. Otuz sekiz hastada SLP; 28 hastada CP vardı. SPL grubunda 32'sinde (%84,2) adenokarsinom, 6'sında (%15,8) nöroendokrin tümör vardı. Benign pankreatik lezyonu olan 28 hastanın 23'ünde (%82,1) CP, 5'inde (%17,9) otoimmün pankreatit vardı. SPL'li hastalarda medyan SR değerleri CP'li hastalardan anlamlı olarak daha yüksekti (44,0 (10,0-110.0) ve 7,0 (2,6-14,6), p<0.001). Sertlik skorları da SLP ve CP'li hastalar arasında anlamlı olarak farklıydı (p<0.001). Elastikiyet skorları adenokarsinom ve CP arasında anlamlı olarak farklıydı (p<0.001). Sertlik skoru için cut-off değeri 14 olarak belirlendi, SPL ve alıcı işletim karakteristik eğrileri için %97 duyarlı ve %100 özgüllüğe sahipti ve 0.99.6 eğrisinin altında bir alan gösterdi. Likelihood Ratio test, benign ve malign lezyonların ayırt edilmesinde en iyi parametrenin SR olduğunu göstermiştir (X^2=54,031, p<0.001).

Sonuç: Çalışmamız, EUS-EG ve SR skorlarının malign ve benign pankreatit lezyonlarını ayırmada oldukça etkin bir yöntem olduğunu göstermiştir.

Anahtar Kelimeler: Endosonografik-elastografi, kronik pankreatit, sertlik oranı, solid pankreas lezyonları

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INTRODUCTION

Endoscopic ultrasound (EUS) is currently thought of as the reference method in detecting to solid pancreatic lesions; this is particularly true for lesions measuring less than 2 cm in size (1). Although EUS has high specificity, its sensitivity is somehow less, ranging between 87% to 100% among studies. Moreover, EUS has a limited ability to differentiate benign lesions from malignant ones. EUS guided fine needle aspiration is used to provide a pathologic diagnosis for these lesions. However, the sensitivity of EUS-FNA also suffers from moderate sensitivity (78-94.3%) (2). Moreover, it is an invasive method with attendant complications and cannot be performed due to difficult locations of the target lesions. In addition, sampling error is always a problem with EUS-FNA. These shortcomings and limitations prompted the efforts to devise a noninvasive, real-time method with relatively high sensitivity and specificity to differentiate benign pancreatic lesions from malignant lesions.

Elastography is a novel technique that is based on the principle that benign and malignant lesions have distinct tissue properties in terms of hardness and stiffness (3). While malignant lesions are more heterogenous and hard, benign lesions tend to be softer and more homogenous. Elastography utilizes this innate feature of the lesions as applying pressure on the target tissue and representing tissue strain response as color-coded areas. However, this method is qualitative and is subject to considerable intra and interobserver variability. To overcome this subjectivity, a quantitative method, namely, strain ratio (SR), was developed. This method, by the help of dedicated software, compares the elasticity of a region of interest to the surrounding healthy tissue. A more objective technique so-called hue histogram further reduces subjectivity with computer-assisted calculation of the strain patterns (4). Nowadays, quantitative and qualitative elastography can be used with EUS. Thus, elastography offers an opportunity of noninvasively and accurately distinguishing benign from malignant pancreatic lesions in addition to its role as a reliable guide to FNA. In a meta-analysis that involved studies evaluating EUS-elastography in differentiating benign and malignant pancreatic lesions, the authors found the sensitivity and specificity of EUS elastography as 95% and 69%, respectively (2). It appeared that owing to its high sensitivity, EUS-elastography would be used to exclude malignancy and thus avoid unnecessary biopsies and consequent complications. On the other hand, the specificity of the EUS elastography was much lower than that of EUS-FNA.

Several studies to date assessed the diagnostic accuracy of EUS elastography techniques in differentiating benign pancreatic lesions from malignant lesions (1,5-7). However, to the best of our knowledge, the optimal cut-off values to distinguish malign and benign pancreas lesions have not been determined yet. Thus, we aimed to evaluate the diagnostic capability of EUS elastography along with strain ratio for differentiating benign pancreatic lesions from the malignant lesions and determined the optimal cut-off value to distinguish malign and benign pancreatic lesions.

MATERIAL AND METHOD

Patients and Design

This was a prospective chart review study in which patients who underwent endosonographic elastography (EUS-EG) at Kırıkkale University Faculty of Medicine Hospital between January 2016 and June 2019 were performed. The primary objective of the study was the assessment of the ability of EUS-EG in differentiating malign and benign pancreatic lesions. Of all included patients (n=636), 186 patients had CP, cystic and solid pancreatic lesions. The inclusion criteria were as follows: (1) having a solid pancreatic lesion that is diagnosed histopathologically based on the biopsy material obtained by endosonographic fine needle aspiration or surgery, (2) having chronic pancreatitis and fulfilling Rosemont criteria of "consistent with chronic pancreatitis" assessed by EUS. Exclusion criteria involved (1) having cystic pancreatic lesions and fulfilling Rosemont diagnostic criteria for "suggestive for CP" and "indeterminate for CP". Flow-chart of patient selection is depicted in **Figure 1**.

Ethical Declaration

Kırıkkale University Faculty of Medicine Ethics Committee approved the study protocol (Date: 07.08.2019, Ethics No: 2019.08.03).

Final Diagnoses of Chronic Pancreatitis and Malignant Pancreatic Masses

The final diagnosis of solid pancreatic lesions was determined via pathologic evaluation of the biopsy specimens that were obtained through EUS-FNA or surgery. Pancreatic lesion biopsies were examined by the same pathologist. Clinical history and medical records of the patients, along with pancreatic imaging findings (computed tomography,

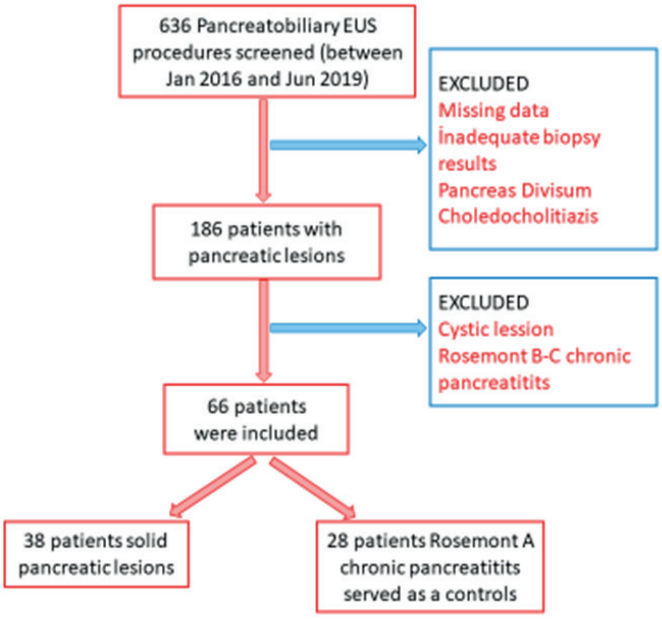

Figure 1. Flow Charts

endosonography and ultrasound) were used to diagnose chronic pancreatitis. Among the CP patients who underwent EUS, each patient who met the Rosemont diagnostic criteria for "consistent with chronic pancreatitis" were included in the study as the control group. Patients meeting the "suggestive for CP" or "indeterminate for CP" was not included to ascertain that we only recruited the patients with definite chronic pancreatitis. Rosemont chronic pancreatitis criteria are shown in **Table1** (8).

Table 1. Rosemont criteria for chronic pancreatitis

Major criteria A	1) Hyperechoic foci with shadowing (echogenic structure ≥2 mm length and width that shadow) 2) Lobularity with honeycombing (well circumscribed, ≥5 mm structures with enchaining rim and relatively echo pure center, contiguous ≥3 lobules) 3) Main pancreatic duct calculi (echogenic structure(s) within main pancreatic duct with shadowing)
Major criterion B	Honeycomb pattern of lobularity
Minor criteria	1) Lobularity without honeycombing (noncontiguous lobules) 2) Hyperechoic foci without shadowing 3) Cysts 4) Strands 5) Irregular pancreatic duct contour 6) Dilated side branches 7) Main pancreatic duct dilatation 8) Hyperechoic duct wall

Rosemont criteria denoting ''consistent with CP'' is defined as (1) 1 major A criteria and ≥3 minor criteria, (2) 1 major A and major B criteria, or (3) 2 major A criteria.

Endoscopic Ultrasound and Evaluation of Elasticity

Endoscopic Ultrasound

All EUS procedures were performed by the same endoscopist who had sufficient EUS-EG experience. EUS examination was performed by means of Pentax EG3830UT linear echo-endoscope (HOYA Corporation, PENTAX Lifecare Division, Showanomori Technology Center, Tokyo, Japan) connected to a Hitachi EUB-7000 HV ultrasound unit (Hitachi Medical Systems, Tokyo, Japan), which contain an elastography module. After identification of a solid pancreatic lesion and/or Rosemont diagnostic criteria for "consistent with chronic pancreatitis", EUS-EG was performed. The lesion was visualized in B-mode ultrasound, and then elastography mode was utilized with color-coded duplex features. B mode image at 7.5 MHz and an overlay mode image with elastography color scale are demonstrated simultaneously at the console.

Elastography Score and Strain Ratio

We evaluated elastic features of the pancreatic lesions by means of a qualitative and a quantitative scoring system. In the qualitative method, we adopted the "elasticity score" reported by Giovanni and colleague(9). In this scoring system, Elastography score 1 (ES_1) represented normal tissue and used when homogeneous green area was seen, ES_2 denoted inflammation or fibrosis and used when a heterogeneous green area was predominant, ES_3 denoted indeterminate for malignancy and used when a heterogeneous blue dominant area was seen, ES_4 represented malignant lesion and used when a homogeneous blue area was seen, and ES_5 represented necrosis in an advanced malignant lesions and used when a mainly dark (blue) tissue with areas of heterogeneous soft tissue (green, red) was seen.

The strain ratio method was used to evaluate the elasticity of the tissues quantitatively. Perception depth and the entire targeted area were set according to the lesion location for strain ratio value. Since elastography strain values are demonstrated corresponding to the adjacent tissue, which operates as an inner reference norm, we accepted a ratio of pattern to neighboring tissue of 1:1 in this study. The strain ratio was measured when a steady image of at least 5 seconds course was attained for quantitative measurement and final pattern description. Two distinct areas to the mass lesion and/or chronic pancreatic tissue (B) and normal adjacent tissue (A) were selected for quantitative elastographic measurement. To prevent selection bias of areas A and B, each measurement of elasticity was repeated three times in all patients. The mean value of three measurements was accepted as the final strain ratio value. We used the receiver-operating characteristic (ROC) curve to evaluate the best possible cut-off value of strain ratio to differentiate chronic pancreatitis lesions from neoplastic lesions.

Statistical Analysis

Chi-square test, Mann Whitney U test, and Kruskal Wallis test were used to making comparisons of non-parametric variables between the groups. In the comparisons of the paired groups, the Chi-square test and Mann Whitney U test were used. To evaluate differences between the groups involving parametric data, the Independent Samples t-test or One-Way Analysis of Variance (ANOVA) test were used, and in the post-hoc comparisons, the Tukey Multiple Comparisons test was used. ROC-Curve test was used to determine the sensitivity and specificity of the study parameters, which could predict the diagnosis. Likelihood-Ratio test was used to the variables for the prediction of the "best" diagnostic variable. A p-value <0.05 was deemed significant.

RESULTS

Patient Characteristics

A total of 66 patients, of whom 28 (42.4%) had chronic pancreatitis, and 38 (57.3%) had a SPLs, were included in the study. The majority of patients were male (63.6%). There were significantly more female patients in the SPLs group. The mean age of the patients with a SPL was significantly higher than that of patients with a CP (64.7±11.1 vs. 46.1±13.7, $p<0.001$). Of all malignant SPLs, 32 (48.5%) were adenocarcinomas, and 6 (9.1%) were neuroendocrine

Table 2. Mean age, gender distribution, pancreatic mass localization, elasticity scores and strain rations in patients with malignant mass and chronic pancreatitis

Variable		Total	Chronic pancreatitis	Malignant mass	p
Age (year)		58.8±15.3	46.1±13.7	64.7±11.1	<0.001*
Gender	Male	42 (63.6%)	22 (33.3%)	20 (30.3%)	0.030***
	Female	24 (36.4%)	6 (9.1%)	18 (27.3%)	
Localization	Head	20 (30.3%)	1 (1.5%)	19 (28.8%)	<0.001***
	Body	9 (13.6%)	1 (1.5%)	8 (12.1%)	
	Tail	4 (6.1%)	0 (0.0%)	4 (6.1%)	
	Uncinat	7 (10.6%)	0 (0.0%)	7 (10.6%)	
	Diffuse	26 (39.4%)	26 (39.4%)	0 (0.0%)	
Diagnotic methods	EUS-FNA	39 (59.1%)	5 (7.6%)	34 (51.5%)	<0.001***
	Surgery	4 (6.1%)	0 (0.0%)	4 (6.1%)	
	EUS+Imaging+Laboratory	23 (34.8%)	23 (34.8%)	0 (0.0%)	
Final Diagnosis	Adenocarcinoma	32 (48.5%)	0 (0.0%)	32 (48.5%)	<0.001***
	Neuroendocrine tumors	6 (9.1%)	0 (0.0%)	6 (9.1%)	
	Chronic pancreatitis	28 (42.4%)	28 (42.4%)	0 (0.0%)	
Elasticity Score	ES2	10 (15.2%)	9 (13.6%)	1 (1.5%)	<0.001***
	ES3	35 (53.0%)	18 (27.3%)	17 (25.8%)	
	ES4	21 (31.8%)	1 (1.5%)	20 (30.3%)	
Strain Ratio		21.8 (2.6-110.0)	7.0 (2.6-14.6)	44.0 (10.0-110.0)	<0.001**

(*) Independent Samples t test (**) Mann Whitney U test (***) Chi-square test

tumors. Among 28 patients with CPs, 23 (34.8%) patients had been following with chronic pancreatitis. Five patients (7.6%) who presented with pancreatic mass were diagnosed with autoimmune pancreatitis via EUS-FNA. The underlying causes of chronic pancreatitis were biliary pancreatitis in 8 patients, and alcoholic pancreatitis in 15 patients. In the malignant mass group, the most common location of the pancreatic mass was the head of the pancreas (50%). Mean age, gender distribution and characteristics of the pancreatic mass are depicted in **Table 2**.

Elastography Score and Strain Ratio

Median strain ratio values were significantly higher in malignant pancreatic mass compared with chronic pancreatitis (benign pancreatic mass) (44.0 (10.0-110.0) vs 7.0 (2.6-14.6), p<0.001) (**Table 2 and Figure 2**).

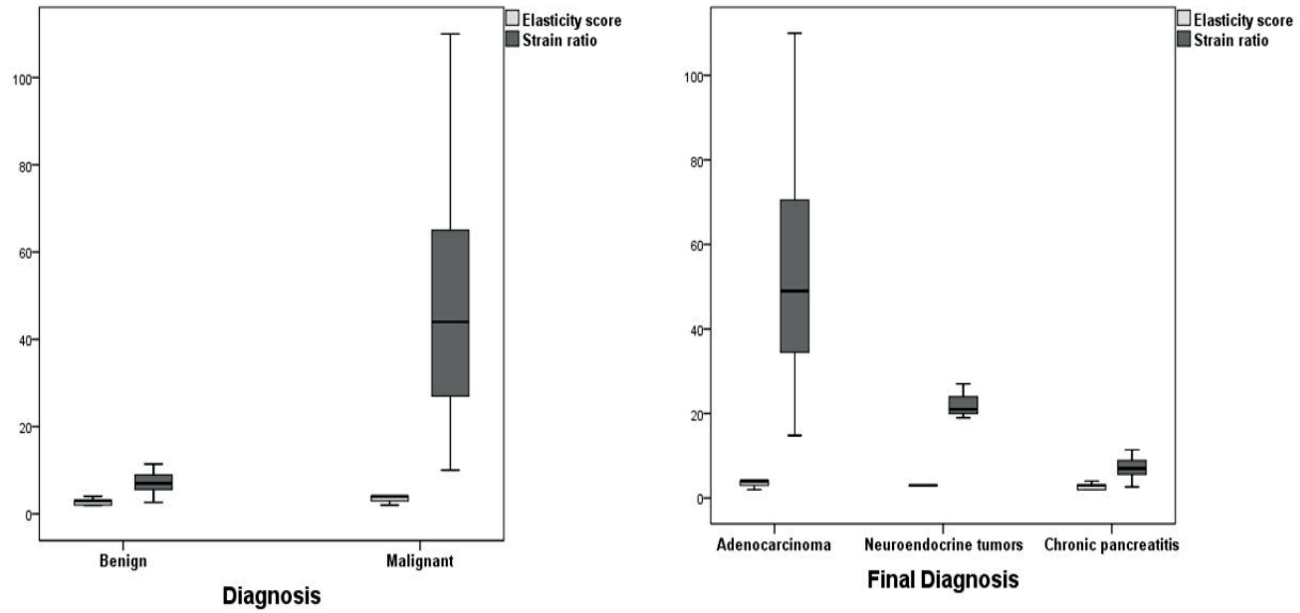

Figure 2. Comparison of strain ratio and elastography between chronic pancreatitis and solid pancreatic lesions. Comparison of strain ratio and elastography between chronic pancreatitis, adenocarcinomas and neuroendocrine tumors

Table 3. Mean age, gender distribution, elasticity scores and strain ratio in patients with adenocarcinoma, neuroendocrine tumor and chronic pancreatitis

Variable		Adenocarcinoma	Neuroendocrine tumors	Chronic pancreatitis	p
Age (year)		65.47±10.77 a	61.17±13.15 a,b	46.14±13.74 b	<0.001*
Gender	Male	18 (27.3%) a	2 (3.0%) a	22 (33.3%) a	0.054***
	Female	14 (21.2%)	4 (6.1%)	6 (9.1%)	
Localization	Head	16 (24.2%) a	3 (4.5%) a	1 (1.5%) b	<0.001***
	Body	5 (7.6%)	3 (4.5%)	1 (1.5%)	
	Tail	4 (6.1%)	0 (0.0%)	0 (0.0%)	
	Uncinat	7 (10.6%)	0 (0.0%)	0 (0.0%)	
	Diffuse	0 (0.0%)	0 (0.0%)	26 (39.4%)	
Diagnostic methods	EUS-FNA	28 (42.4%) a	6 (9.1%) a	5 (7.6%) b	<0.001***
	Surgery	4 (6.1%)	0 (0.0%)	0 (0.0%)	
	EUS+Imaging+Laboratory	0 (0.0%)	0 (0.0%)	23 (34.8%)	
Elasticity_Score	ES2	1 (1.5%) a	0 (0.0%) a,b	9 (13.6%) b	<0.001***
	ES3	12 (18.2%)	5 (7.6%)	18 (27.3%)	
	ES4	19 (28.8%)	1 (1.5%)	1 (1.5%)	
Strain Ratio		49.00(14.79-110.00) a	21.00 (10.00-89.00) b	7.00 (2.60-14.60) c	<0.001**

(*) One-Way Analysis of Variance (ANOVA) test (**) Kruskal Wallis test (***) Chi-square test

Elasticity scores were also significantly different between benign and malignant lesions (p<0.001). Out of 38 SPLs, only one is classified as ES2 (inflammation or fibrosis), and out of 28 chronic pancreatitis lesions, only one labeled as ES4 (malignant lesion). On the other hand, a considerable percentage of patients in each group was diagnosed as ES3 (indeterminate for malignancy) in both groups based on qualitative elastography (**Table 2**).

When malignant lesions are further characterized, median strain ratio values were 49.00(14.79-110.00) for adenocarcinomas and 21.00 (10.00-89.00) for neuroendocrine tumors (**Table 3**). Both values were significantly different from each other and from the chronic pancreatitis strain ratio values (p<0.001). Elasticity scores were significantly different between adenocarcinomas and chronic pancreatitis (p<0.001). However, there was no significant difference between neuroendocrine tumors and chronic pancreatitis. It should be emphasized once more that many cases were classified as ES3 bot in chronic pancreatitis and adenocarcinoma groups (**Table 3**).

The ROC-Curve test demonstrated that if the cut-off value for SR level were >14, it would be 97% sensitive and 100% specific in distinguishing the CP from the malignant tumor (area=0.996, p<0.001). Likelihood Ratio test revealed that strain ratio appears as the best parameter in discrimination of tumor type either as benign or malignant (X^2=54.031, p<0.001) (**Table 4 and Figure 3**).

Table 4. Receiver operating characteristic (ROC) analysis and likelihood test comparing differentiation of strain ratio and eastography scores in various diagnostic pairs.

		ROC-Curve				Likelihood Ratio	
Groups (I/J)	Variable	Area	p	Cut-off value		X^2	p
Bening/ Malignant	Elasticity Score	0.809	<0.001	>3.5	Sensitivity 53% Specificity 97%	0.400	0.527
	Strain Ratio	0.996	<0.001	>14	Sensitivity 97% Specificity 100%	54.031	<0.001
Adenocarcinoma/ Neuroendocrine tumor	Elasticity Score	0.701	0.123	-	-	0.628	0.428
	Strain Ratio	0.826	0.012	>29.00	Sensitivity 84% Specificity 83%	2.675	0.102
Adenocarcinoma/ Chronic pancreatitis	Elasticity Score	0.829	<0.001	>3.50	Sensitivity 60% Specificity 97%	0.000	0.985
	Strain Ratio	1.000	<0.001	>14.69	Sensitivity 100% Specificity 100%	55.683	<0.001
Neuroendocrine tumor/ Chronic pancreatitis	Elasticity Score	0.699	0.130		-	0.000	0.998
	Strain Ratio	0.976	<0.001	>16.80	Sensitivity 83% Specificity 100%	19.163	<0.001

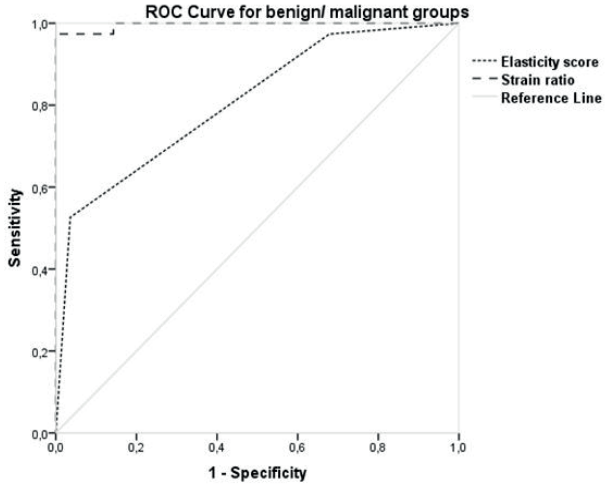

Figure 3. Receiver operating characteristic curve analysis of the strain ratio for the detection of benign pancreatic lesions and malign pancreatic lesions

On the other hand, receiver operating characteristics (ROC) Curve analysis demonstrated that when the ES cut-off value was taken >3.5, it was 60% sensitive and 97% specific in distinguishing the adenocarcinoma from chronic pancreatitis (area = 0.829, p <0.001). Furthermore, if SR level was >14.69, it could be 100% sensitive and 100% specific in distinguishing the adenocarcinoma from chronic pancreatitis (area=1.000, p<0.001, cut-off value = 14.69). Likelihood Ratio test revealed that SR value was determined to be the best parameter in making the decision for discrimination of adenocarcinoma from chronic pancreatitis (X^2=55.683, p<0.001) (**Table 2 and Figure 4**).

DISCUSSION

The salient finding of the present study was that strain ration, which is calculated using EUS-elastography, was a sensitive and specific method to differentiate malign pancreatic lesions from the benign ones with considerably high sensitivity and specificity. On the other hand, elasticity scores were not as robust as strain ratio in making this distinction. Many masses, both benign and malignant, were labeled as indeterminate with this method.

Distinguishing mass-forming chronic pancreatitis from pancreatic malignancy might be challenging owing to common features both have in imaging characteristics and clinical presentation. In many instances, only a combination of a number of imaging modalities can provide the differential diagnosis (10). Because of this difficulty, several studies tried to differentiate chronic pancreatitis related masses from malignant pancreatic masses by means of EUS elastography modalities. However, there was still enough data with this regard in a Turkish population.

Several studies have demonstrated that EUS has a higher sensitivity for the detection of small pancreatic masses compared with other imaging modalities such as computed tomography, magnetic resonance imaging, and positron emission tomography (11,12). EUS, along with EUS-guided FNA, is currently accepted as the gold standard method for the diagnosis of pancreatic masses. On the other hand, it might be problematic to differentiate malignant masses from the inflammatory masses seen in chronic pancreatitis by means of EUS alone (13). EUS-guided FNA of pancreatic masses has a 97% accuracy rate in the detection of malignant lesions (14). However, since sampling error is always an issue, it cannot be used to exclude malignancy when FNA results show benign changes. Moreover, as it is more invasive, although considered relatively safe by many authors, FNA is associated with some complications such as pancreatitis (15). Thus, it is an actual clinical need to be able to decide whether a pancreatic lesion is benign or malignant with sufficient accuracy without the need for FNA. Elastography is being considered by many to offer such an opportunity in the evaluation of pancreatic masses.

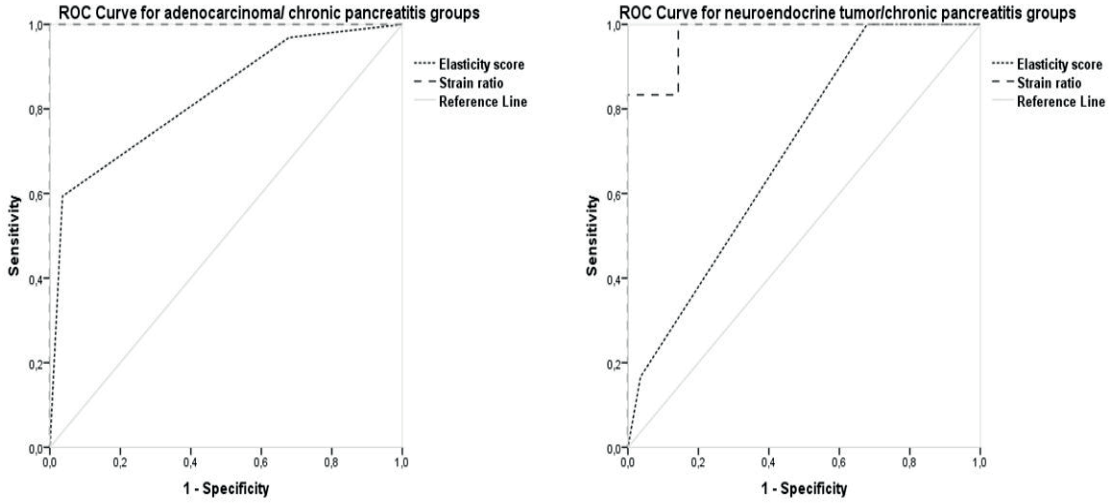

Figure 4. Receiver operating characteristic curve analysis of the strain ratio for the detection of (a)adenocarcinoma and chronic pancreatitis, (b) neuroendocrine tumors and chronic pancreatitis

The diagnostic value of EUS FNA may be increased by performing targeted biopsy with elastography. Thus, false negative results can be avoided.

Several meta-analyses have evaluated the value of different elastography techniques in differentiating benign from malignant pancreatic masses (16-18). The latest of these reported by Zhang and colleagues analyzed data of 1687 patients. The results showed that both qualitative and quantitative modalities of EUS elastography had high accuracy rates in the diagnosis of malignant pancreatic masses. The pooled analysis revealed that the sensitivity for the diagnosis of malignant pancreatic masses were 0.98 for qualitative EUS elastography, and 0.95 for quantitative EUS elastography, respectively. On the other hand, the specificity of both methods was around 60% (17). Thus, as in the previous meta-analyses, the authors concluded that EUS elastography cannot replace EUS-FNA but might be used in addition to it to avoid unnecessary biopsies in benign lesions owing to its considerably high sensitivity to detect malignant pancreatic masses.

The original method first introduced with elastography was based on the evaluation of color-codes reflecting different strain levels in the region of interest. While blue predominant areas represent harder tissues, hence with a more probability for malignancy, the green predominant areas mean that the imaged tissue is softer and more likely to be benign. Since this method is more subjective and operator dependent, new elastography modalities such as hue histogram and elasticity score were devised to render the methods more objective and reproducible. Although it seems counterintuitive, the sensitivity rates have been found to be similar for qualitative and quantitative elastography methods (16,17). In our study, the strain ratio method was more sensitive and specific compared with elastography scores. When a strain ratio value of 14 was taken as cutoff, the sensitivity and the specificity of the method was 97% and 100% respectively in differentiating benign lesion from the malignant ones. SR was less efficient in the differentiation of neuroendocrine tumors from adenocarcinoma. With a cutoff point of 29, the sensitivity and the specificity were 84% and 83%, respectively.

In a recent study, Kim et al. (7) evaluated the capability of the EUS elastographic strain ratio in differentiating malign pancreatic masses from focal pancreatic masses related to chronic pancreatitis. The authors found that the median SR for pancreatic cancer was 18 (13.1-26.6) whereas, the value was 15.1 (9.5-18.7) for mass-forming chronic pancreatitis. With an optimal cutoff value of 6.0 for strain ratio, the sensitivity and specificity for the diagnosis of pancreatic cancer were 97.8% and 86.7%, respectively. An older meta-analysis specifically included the studies that evaluated the accuracy of EUS elastography for distinguishing pancreatic adenocarcinoma from chronic pancreatitis associated inflammatory masses (18). The authors revealed that the pooled sensitivity and specificity were 0.99 (0.97-1.00), 0.76 (0.67-0.83), respectively, with qualitative EUS elastography. Hue histogram method had a sensitivity of 0.92 (0.89-0.95), and specificity 0.68 (0.57-0.78) to distinguish inflammatory lesions from malignant masses in the pancreas.

Some limitations of the current study deserve mention. First, our study was retrospective in nature. Second, our sample size was relatively small to provide a clear-cut cutoff value to measure the sensitivity and specificity of the differential ability of the compared diagnostic methods. Third, patients with diagnosis of CP who haven't inflammatory masses did not undergo FNA. These group was diagnosed with appropriate history, medical records, and a combination of imaging modalities.

In conclusion, our study showed that EUS elastography measurements when performed in experienced centers have strong diagnostic value with high sensitivity and specificity in differentiating benign and malignant pancreas lesions. Strain scores appeared to have a high accuracy rate with this regard. Larger studies to give more clear-cut cutoff values for differentiation based on elastography score are needed in the pancreas lesions.

DECLARATION OF INTEREST STATEMENT

All authors meet the ICMJE authorship criteria. The manuscript has not been published, accepted or under simultaneous review for publication elsewhere. The all authors declare that there is no conflict of interest.

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