DOI 10.4149/BLL_2024_27

Bratisl Med J 2024; 125 (3):
172–175

CLINICAL STUDY

Pancreatic stiffness and anthropometric parameters in healthy volunteers

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ABSTRACT
PURPOSE: The aim of this study was to define the values of percutaneous ultrasound shear-wave and strain elastography of the pancreas in healthy volunteers.
METHODS: This is a single-center prospective study conducted on volunteers who underwent examination of percutaneous point shear-wave elastography and strain elastography. Both the shear-wave speed (Vs) and strain histogram were measured 3 times and median values were evaluated. Relevant recorded clinical data were age, sex, and height.
RESULTS: From May 2020 to October 2021 a total of 90 patients (21 male, 69 female) were included in the study. Their average age was 26 years (from 22 to 65). The average SWM in kPa was 6.07 (2.58–17.29). The average value of SE was 134.44 (78.51–184.35). Most of the patients had BMI in the range of normal weight with an average value of 22.75 (17.5–28). The average depth of the localization of the pancreas was 4.5 cm. The effect of BMI on the strain histogram was significant ($p < 0.05$). We found a significant relationship between the strain histogram and the depth of localization of the pancreas ($p < 0.01$).
CONCLUSION: We described normal values for pancreatic stiffness using ultrasound elastography by 2D-SWE and strain elastography. Our results indicate changes in values depending on BMI and depth of the pancreas. *(Tab. 1, Fig. 5, Ref. 19)*. Text in PDF *www.elis.sk*
KEY WORDS: shear wave elastography, pancreatic stiffness, anthropometric parameters.

Introduction

Elastography is a relatively new imaging modality focused on non-invasive assessment of tissue stiffness (1, 2). It is becoming an increasingly employed method, especially in assessing the stage of liver fibrosis. Naturally, the extensive potential for using this method encourages its use in other indications. Ultrasound elastography of the pancreas replaces the examination by palpation of the organ but is limited by challenges related to deep localization of the organ and obtaining biopsy specimens for comparative analysis of the results. There are two main types of elastography, strain elastography and shear-wave elastography. Strain elastography (SE) uses both the endoscopic and transcutaneous routes, whereas shear wave-elastography is exclusively transcutaneous (3). Strain elastography measures displacement of physical tissue parallel to the applied stress (4). The examiner applies manual compression on the tissue with an ultrasound transducer. In contrast, shear-wave elastography generates dynamic stress in parallel or vertical dimensions (4). Evaluating the shear-wave speed (Vs) measurements within the region of interest (ROI) provides qualitative and quantitative values of tissue elasticity (5). 2D shear-wave elastography represents the latest advancement in shear-wave imaging. Therefore, determining the validity of these measurements can be challenging. So far, only one device on the market integrates a unique reliability index (VsN) into its system. It is a percentage of the net amount of effective shear-wave velocity (5). While recommendations have been published for both the endoscopic and the percutaneous approaches, the role of transcutaneous shear-wave elastography is less understood and its value is not as clear (2). The normal pancreatic tissue share-wave speed is about 1.4 m/sec (6).

This study aimed to define values of shear-wave elastography and strain elastography of the pancreas in healthy volunteers and to find correlations between measured values and anthropometric parameters.

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Acknowledgments: This study has been published with the support of the Integrated Infrastructure Operational Program for the project: Research and development of a telemedicine system to support the monitoring of a possible spread of COVID-19 in order to develop analytical tools used to reduce the risk of infection; ITMS: 313011ASX4; co-financed by the European Regional Development Fund.

Materials and methods

Study design

This single-center prospective study was conducted in accordance with the principles of the Declaration of Helsinky. Every patient provided informed consent and study was approved by Ethics Committee of Jessenius Medical Faculty, Comenius University under number EK 62/2019.

Study populations

The study population consists of healthy volunteers who after providing informed consent underwent percutaneous 2D shear-wave elastography (2D-SWE) and strain elastography (SE). We retrospectively reviewed 90 patients. Inclusion criteria were the absence of any history of pancreatic issues, and the ability to visualize the pancreas adequately. An exclusion criterion was the impossibility of performing adequate measurements.

Imaging technique

Conventional ultrasonography, strain elastography (Fig. 1) and shear-wave elastography (Fig. 2) were performed using a Hitachia Aloka Medical Ltd. 700 with a convex probe. Both strain elastography and shear-wave elastography were carried out in every patient. The ROI for SWE and also for SE was 1x1.5cm. Both, Vs and strain histogram were measured 3 times and median values were evaluated. The lowest acceptable VsN was ≥ 50 %. All volunteers were examined by two independent operators. Patients were examined in a supine position with their right arm extended. Due to difficulties in identifying the pancreas in some individuals, we selected ROI in the body of the pancreas while avoiding the pancreatic duct and vessels. Patients with incidental pathological findings (cysts etc.) were excluded. The examinations were performed through the epigastrium wall.

Anthropometric assessments

Clinical and anthropometric data were obtained prior to ultrasound examination. Relevant recorded clinical data were age, sex, height, and abdominal and hip circumference. Bioimpedance examination with Tanita MC–780MA P was realized and data on weight (in kilograms), BMI and percentage of body fat were collected.

Statistical analysis

The statistical software, SPSS version 25, was used for all analyses. Individual shear-wave speed measurements derived from multiple samples were expressed as medians. For the comparison of groups, Mann–Whitney U test and Wilcoxon signed rank test were used. Correlations between each variable were evaluated by Spearmanov's or Pearson's correlation coefficient. Values of $p < 0.05$ were considered significant.

Results

Demographics and baseline features

A total of 90 patients (21 male and 69 female) were included in the study. The average age was 26 years (ranging from 22 to 65 years). Successful detection of SWE of the pancreas was

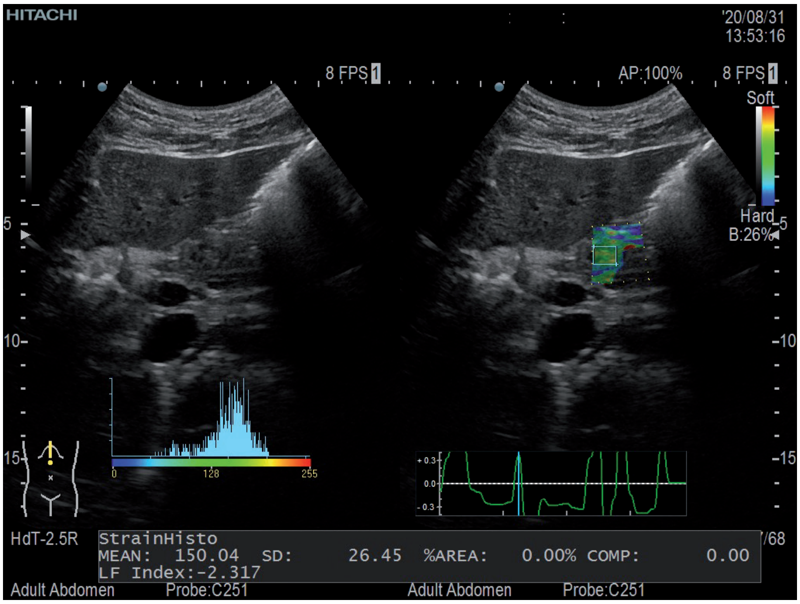

Figure 1. Strain elastography of the pancreatic body.

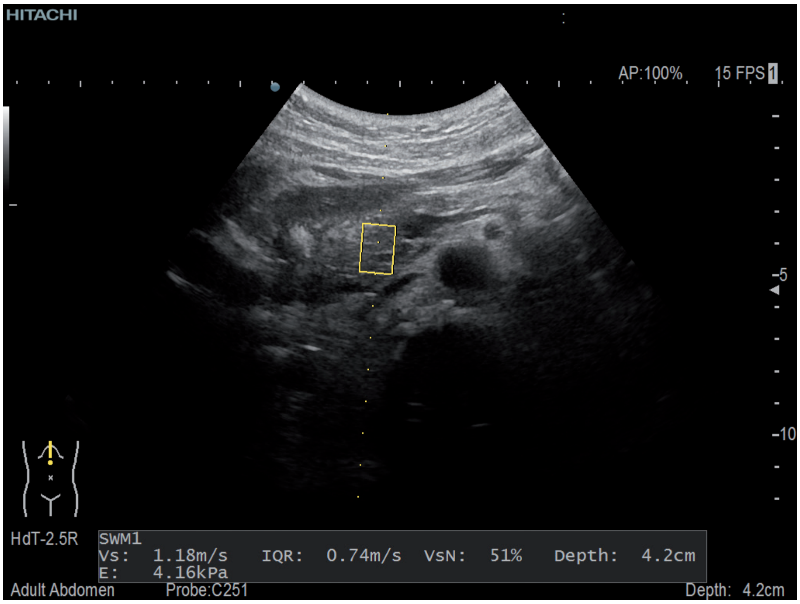

Figure 2. Shear-wave elastography of the pancreatic body.

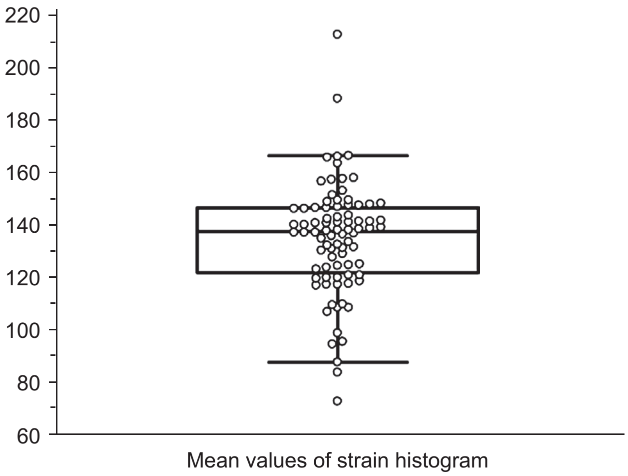

Figure 4. Strain histogram of pancreatic body in a healthy volunteer.

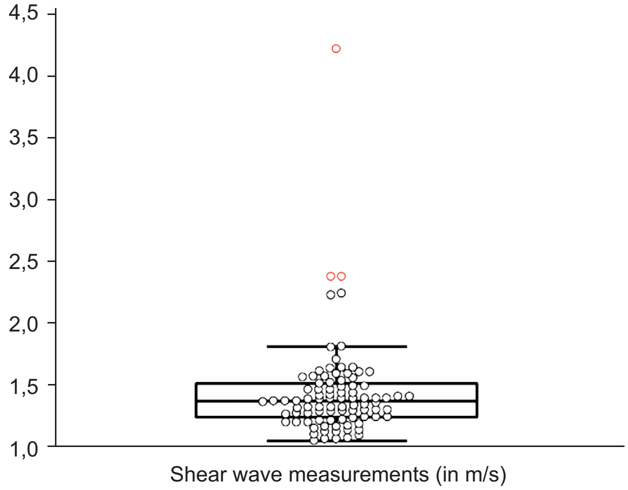

Figure 3. Shear-wave values of pancreatic body in healthy volunteers.

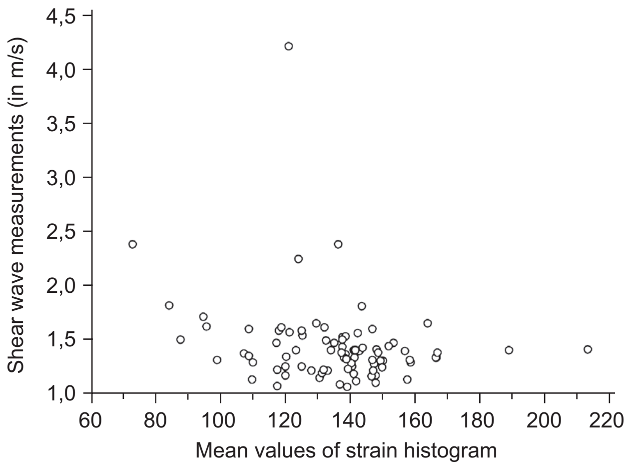

Figure 5. Correlation graph between strain histogram and shear-wave measurements.

achieved in 90 patients (100 %). SH was successfully detected in 86 patients (95.6 %), while in 4 patients, it was not feasible to collect the measurements due to inadequate pre-compression. Patients were excluded from the study when satisfactory measurements could not be obtained. The primary reason for measurement failure lied in excessive thickness of subcutaneous fat combined with the deep position of the pancreas.

The baseline and anthropometrics parameters are shown in Table 1.

The standard deviation (SD) for age was 6.96, and for BMI, it was 6.62. The mean Vs was 1.44 m/s (in range of 0.95–2.51). The mean SWM in kPa was 6.07 (in range of 2.58–17.29; Fig. 3). The mean value of SH was 134.44 (in range of 78.51–184.35; Fig. 4). Most patients had their BMI values in the range of normal weight with a mean value of 22.75 (in range of 17.5–28). The mean BMI in men was higher than in women (25.5 vs 21.83). The mean depth of the pancreatic head or tail was 4.5 cm. The correlation graph between strain histogram and shear-wave measurements is shown in Figure 5.

Influence of gender. We evaluated the effect of gender on shear-wave measurements and strain histogram. There was no significant difference between men and women for either method ($p > 0.05$).

Influence of BMI. The effect of BMI on the strain histogram was significant and weakly positive ($p < 0.05$). As the BMI value increases so does the value of strain histogram. However, this effect does not apply to shear-wave measurements.

Influence of fat percentage. The effects of fat percentage on shear-wave measurements and strain histogram were not significant ($p > 0.05$).

Influence of the depth. The relationship between strain histogram and depth of pancreas' position was found to be significant ($p < 0.01$). The strain histogram decreases with an increase in depth.

Discussion

The role of transabdominal ultrasound in studying pancreatic diseases is gaining momentum. In this study, we analyzed the impact of different anthropometric parameters on the shear-wave

Table 1. Clinical and baseline features.

	Sex		
	Female (n=69)	Male (n=21)	Total (n=90)
Age (years)	26.17	25.48	26
Height (cm)	169.8	182.57	173
Weight (kg)	66.8	79.09	70
BMI	21.83	25.5	22.75
Abdominal circumference	66.45	76.85	69
% of fat	19.9	12.93	18.26
Depth of pancreas' position (cm)	4.27	5.27	4.5
SWM Vs	1.39	1.58	1.44
SWM E (kPa)	6.05	6.09	6.07
SE	135.6	130.19	134.44

elastography and strain-ratio histogram of the pancreas of healthy volunteers. Shear-wave and strain elastography are relatively new techniques which are complementary to the normal ultrasonography and allow an objective evaluation of tissue elasticity (3, 7). There are some reports on the utility of this method for evaluating chronic pancreatitis, autoimmune pancreatitis or malignancies (8–13), however most of them are performed by EUS while the number of studies focused on the usage of transabdominal approach (14) or other approaches to measuring pancreatic elastography of the pancreas in healthy individuals is limited(15). For example, one study conducted by Ozturk et al on healthy children and adolescents shows that physiological values of healthy pancreas are 8.75–9.3 kPa (1.69–1.75 m/s). There was no difference in pancreatic stiffness relative to different localizations of the pancreas (head, corpus, tail) (16). This study also shows mild correlations between pancreatic stiffness and age, BMI and body weight. In our study, we noticed lower values of pancreatic elasticity, probably due to different age. The study conducted by Chantarojanasiti et al used strain transabdominal ultrasound and observed positive correlations between hyperechoic pancreas and age, BMI and depth of position of the pancreas (17).

There are also other studies which pointed out that individual regions of the pancreas (head, body or tail) in a diffuse pathological condition provided similar results (17). The results of elastography measurements can be affected by blood flow, pressure-related disease and breathing (18). Only a few studies have compared diagnostic performance of SWE with strain elastography (19), and although their diagnostic potential is similar, the strain elastography seems to be more sensitive. This fact may partly explain the statistical differences in our study.

There are several limitations in this study, particularly its single-center design, selection of patients with similar age and no comparison between operators. The results can indeed be affected by the infeasibility of obtaining adequate image property of the pancreas by transabdominal ultrasound in every patient. However, the shear-wave elastography and strain ratio histogram of the pancreas is a noninvasive, objective method with great further potential in daily practice.

Conclusion

For the first time, we described normal values for pancreatic stiffness in healthy volunteers using ultrasound elastography by 2D-SWE and strain elastography. We demonstrated high feasibility for all methods with the best results for the combination of ultrasound and elastography. Our results indicate changes in values depending on BMI and depth of the pancreas position which may suggest the potential presence of early changes in pancreatic elasticity. More in-depth studies and exploration may further enhance our understanding of this relationship and clinical utility of this tool.

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Received August 8, 2023.
Accepted September 20, 2023.