European Journal of Therapeutics

DOI: 10.5152/eurjther.2020.20043

Original Research

Strain Wave Elastography Imaging for the Evaluation of Pancreas in Healthy Volunteers

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ABSTRACT

Objective: The objective of this study is to evaluate the normal elastography values of the three anatomical regions (head, corpus, and tail) of the pancreas in the normal adult population using strain elastography (SE) imaging.

Methods: The study included 93 (35 males and 58 females) healthy volunteers. In the healthy volunteers, we semi-quantitatively assessed the pancreatic elasticity by measuring the SE images based on age and gender in the healthy individuals. We also compared the elasticity measurements with respect to gender and age. A threshold value was derived for the healthy volunteers.

Results: In the healthy volunteers, the strain ratio (SR) values were compared with respect to gender and age (before and after 40 years). The elastography values were determined separately for each region of the pancreas. Then, the elastography values before and after the age of 40 years were determined. Importantly, we compared the pancreatic elastography values between the genders, pancreatic areas, and before and after the age of 40 years. The significance value of p was taken at 0.05.

As a result, there was no significant difference between males and females. The average SR values in women and men were 1.86±0.98 (0.26–4.54) and 1.76±1.20 (0.43–5.26), respectively. There was no significant difference between the SR values measured with respect to age before and after 40 years (p=0.293). The average SR value did not differ between woman and men (p=0.751). Only the measurements of pancreas corpus were slightly different before and after the age of 40 years (p=0.018).

Conclusion: SE imaging can be used as an efficient technique for the evaluation of pancreatic elasticity. This study determined the normal elasticity values of the pancreas in healthy volunteers. Information obtained from the healthy adults can serve as a baseline against which pancreatic diseases can be examined in clinical practice.

Advances in knowledge: Designing the value of SR of pancreas parenchyma in healthy volunteers will lead to further elastography studies that can be used in the differential diagnosis of pathological tissues in the pancreatic tissue, leading to future monitoring of other pathologies.

Keywords: Elastography, pancreas, strain index, strain ratio

INTRODUCTION

The pancreas is an organ that has both exocrine and endocrine secretory functions. In total, 85% of the entire pancreas comprises the exocrine portion, 2% is the endocrine portion, and the rest is the extracellular matrix and vascular structure (1, 2). The pancreas shares a close relationship with many organs and structures in terms of localization (2).

The pancreas is an organ in which many malignant and benign diseases can occur (3). Many diseases ranging from diabetes mellitus to pancreatic carcinoma can be observed in the pancreas (1). Sonographic elastography (USE), which is used in the diagnosis of diseases by measuring tissue stiffness, especially for the distinguishing malignant and benign diseases, has witnessed a recent and frequent usage for the diagnosis of may pancreatic diseases.

USE is a new procedure that shows the stiffness of the tissue under examination. This procedure assists in obtaining information about the stiffness of the observed lesion or tissue and revealing the difference of the examined tissue from the normal tissue (1,4-5). Many studies have been conducted on elastography so far, with several of them examining the usefulness of elastography. It is not only used in the examination of superficial organs, but also in the examination of many organ tissues (6-9). Although there are many elastography studies on organs, there are very few publications and research on the USE studies of the pancreas. Because the location of the pancreas and its smaller size as compared to other organs are some of the reasons that led to only a few studies in this region (7-9). However, new studies report that USE is technically more useful. Especially, the use of elastography in the pancreatic tissue, where the biopsy material is difficult to obtain, is more important (7-9)

How to cite: Menzilcioğlu MS, Çitil S. Strain Wave Elastography Imaging for the Evaluation of Pancreas in Healthy Volunteers. Eur J Ther 2020; 26(3): 229–32.

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Received: 10.05.2020 • **Accepted:** 06.07.2020

There are two importantly known USE modalities. The first one is strain elastography (SE), which can perform a qualitative or semi-quantitative measurement. This technique is performed by applying and compressing the tissues from the body surface with the help of a probe and obtaining information about tissue's hardness. The tissue is compressed by the practitioner who apply rhythmic pressures at the intervals of every two seconds with the aid of a probe. B-mode, color map, and compression–decompression wave appear on the same screen. Then, a color image indicating the stiffness of the examined tissue is shown and the semi-quantitative strain index (SI) is determined. After the SI of neighboring tissues is taken as a reference, the indices of the target tissue and adjacent tissue are proportioned for obtaining the strain ratio (SR). Hence, information about the stiffness of the tissue is secured (9, 10).

The second method is sharewave elastography (SHE). In this method, independent of the user, the velocity of the wave (m/s), or the pressure value (Kpa) of the wave, which is obtained by the parallel movement of the waves sent to the tissue, is measured. Therefore, the faster travel of the wave in the tissue indicates the respective hardness in the tissue, and the information about this tissue is numerically obtained (9, 10).

In the light of all these information and references, we determined the normal elastographic values of the three anatomical regions (head, corpus, tail) of the pancreas in the normal adult population using SE technique in our study. Moreover, we aimed to guide the further elastography studies that can be later used in the differential diagnosis of pathological tissues in the pancreatic tissue, along with the monitoring of many other pathologies.

Main Points:

- Sonoelastography is a new imaging modality that canquantitatively measure tissue elasticity with the use of sonography. Strain elastography assesses tissue elasticity by comparing local tissue displacements before and after the application of a compressive force. Basically hard tissues show less deformation than soft tissues under transducer compression (strain).
- Elastography is a useful, quick, non invasive method inthe diagnosis of tissue and organs lesions but it needs specifictraining as well as acknowledging technical andpathological factors which may influence it. Elastography is to be considered as an additional tool tocomplete ultrasound evaluation in all the organs studied such as Thyroid, Breast, Renal and pancreas.
- The pancreas is an organ in which many malignant and benign diseases can ocur. Sonographic elastography (SE), which is used in the diagnosis of diseases by measuring tissue stiffness, especially for distinguishing malignant and benign diseases, has recently been used in pancreatic diseases. Strain Elastography imaging can be used as an efficient technique for the evaluation of pancreas elasticity. This study determined normal elasticity values of the pancreas in healthy volunteers. Information obtained from healthy adults can serve as a baseline against which pancreatic diseases can be examined.

METHODS

Informed consent form was obtained from all the patients, and we performed this study was performed in accordance with the ethical guidelines of the Helsinki Declaration. We received no financial support for this study.

Pancreatic SE was performed on the healthy volunteers (35 males and 58 females) who were free from any known diseases. The average age and height of the participants were 36.13±17.27 years (18–81) and 166.81±9.50 cm (150–190 cm), respectively. Additionally, the average weight and body mass index averages of the participants were 61.75±11.47 kg (40–90 kg) and 22.36±3.44 cm/m^2 (14.30–29.30), respectively.

After the clear and careful evaluation of pancreas of each volunteer on the gray scale under ultrasonography, SE was performed on the head, trunk, and tail regions of the pancreas. The procedures were performed by a radiologist with at least five years of experience in this field. The procedure was performed with a 3.5–5 MHz convex probe using a Toshiba Aplio 500 device (Toshiba Medical Systems, Co., Ltd., Otawara, Japan) with two presses per second to the three areas of the pancreas. While taking the samples, the probe was placed in the tissue in a parallel position. The screen is divided into three main regions. On the left, it shows the degree of stiffness of the tissue and the tissue is observed in color with the gray scale on the right. The lower part displays the waveform showing compression–decompression and supporting our adjustment of the rhythm (Figure 1). Then, the three samples were separately taken from the pancreatic head, trunk, and tail regions. While taking the samples, the SR values were

Figure 1. Shows the elastography US image of the pancreas. The monitor is divided into three windows. The right window shows the gray scale US image, left window shows the color-coded US elastography image and the bottom window shows the sinusoidal wave of compression–decompression. The circles indicate the ROIs. The upper ROI is on the parapancreatic tissue and the lower ROI is on the pancreas. The vertical white line on the sinusoidal wave indicates the point of measurement

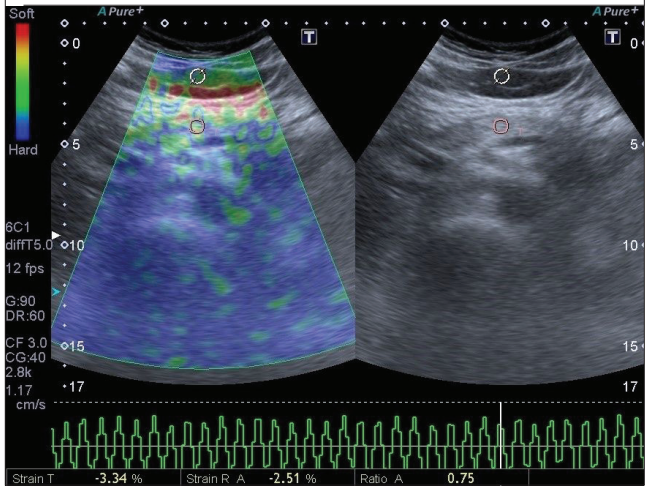

Table 1. Baseline description in the healthy volunteers who underwent strain elastography. Average values are expressed as mean±standard deviation, and range is shown as minimum–maximum. A threshold value was derived for the detection of changes in the pancreatic elasticity between the men and women on (Mann–Whitney U test was used because the data are non–parametric). The significance of P value was defined at 0.05

	Men (Average value)	Women (Average value)	p
Head	2.10±1.97 (0.15–6.95)	1.85–1.87 (0.00–9.06)	0.337
Corpus	1.56±1.45 (0.15–6.40)	1.60±1.66 (0.20–7.59)	0.555
Tail	1.93±1.39 (0.13–5.83)	1.84±1.57 (0.26–7.67)	0.523
Average	1.86±0.98 (0.26–4.54)	1.76±1.20 (0.43–5.26)	0.293

Table 2. Pancreatic SR measurements by age groups (Mann–Whitney U test was used because the data is non–parametric). P significance value was taken as 0.05

	<40 years (58 volunteers)	≥40 years (35 volunteers)	p
Head	1.93±1.84 (0.12–9.06)	1.97±2.02 (0.00–6.52)	0.629
Corpus	1.43±1.64 (0.15–7.59)	1.84±1.45 (0.46–6.53)	0.018
Tail	1.68±1.28 (0.13–5.87)	2.19±1.78 (0.31–7.67)	0.490
Average	1.68±1.04 (0.26–5.26)	2.00±1.22 (0.43–4.97)	0.279

found by placing the target ROI in the tissue and the reference ROI of the adjacent connective tissue. The SR values were recorded and calculated for all the patients (Figure1).

Statistical Analysis

We used IBM SSPS 2.1 software program for statistical analyses in the study (SPSS Inc.; Chicago, IL, USA). We separately wrote gender, age, and weight of all patients and recorded their values. We took three samples from the pancreatic head, trunk, and tail sections, and compared the SR values with respect to gender and age (before and after 40 years). We separately determined the values for each region of the pancreas. Thereafter, the values before and after the age of 40 years were found. Finally, we compared the pancreatic elastography values between the genders, among the pancreatic areas, and before and after the age of 40 years. The significant p value was taken at 0.05 for this study.

RESULTS

The average SR values in women and men were 1.86±0.98 (0.26–4.54) and 1.76±1.20 (0.43–5.26), respectively. There was no significant difference between the SR values measured with respect to age before and after 40 years (p=0.293) and between male and female genders. The average SR value did not differ between woman and men (p=0.751).

There was only a slight difference in the pancreas corpus measurements between before and after the age of 40 years (p=0.018) (Tables 1, 2).

DISCUSSION

There has been an increase in the popularity of the sonographic elastography technique, which is used in both superficial and deep tissues as well as organs such as breasts, thyroid, liver, other digestive organs, and kidney tissues from deep organs (6-9). However, there are only fewer number of studies on pancreas (8, 9).

Many studies have been conducted with different UES techniques. UES, which basically has two different types, is performed by SHE and can make quantitative measurements. Other semi-quantitative technique is SE. Although both principles have their own differences, both these techniques provide us with valuable results about tissue stiffness. However, SE depends on the person and is semi-quantitative and difficult to be performed in very deep tissues. Although SHE is independent of the individual, it also shows anisotropy in the heterogeneous tissue structure, which is its main disadvantage (5, 7-10). Our study was performed with a SE technique, which has been used in a relatively few studies. Due to the measurements in the three separate areas of the pancreas, other studies that can be performed in the normal population will be able to shed light on this topic. Moreover, our study would make the comparison process easier.

There are only a few studies related to the pancreas. As in other tissues, due to fibrosis and changes in tissue in chronic inflammatory processes and malignancies, tissue elasticity disappears, thereby hardening the tissue. In those cases, the tissue will be hard whenever elastography is performed (9-13). Also, it can be difficult to distinguish between pancreatic cancer and pancreatitis with multi-slice computed tomography and magnetic resonance imaging. This situation causes the need for biopsy. However, a biopsy of an organ such as pancreas is not always easy. There have been many publications showing that SE is used in the differential diagnosis of many tissues. SE has been used successfully in the differential diagnosis of malignant lesions of the breast, and fibroadenomas have been found to be softer than breast cancer (13-15). It has been shown that elastography significantly reduces the number of fine needle aspiration biopsy in the detection of thyroid diseases (8, 14-16). Additionally, the importance of elastography has been demonstrated in showing the degree of musculoskeletal diseases and liver fibrosis (17, 18). Therefore, diseases such as pancreatitis and pancreas can be recognized with the help of elastography. Thus, a differential diagnosis of focal pancreatitis and tumors that can provide mass images has been attempted. The studies were conducted with USE to develop a noninvasive method according to endoscopic sonography. Thus, a study emphasized that USE is a usable method (14).

Some studies show that the diagnosis increased above 90% in the B-mode combination of UES and sonography (14, 19). A study with a capacity of 121 patients found high specificity and sensitivity of UES in the differential diagnosis of malign and benign lesions (14, 20).

In addition, USE has been used in other diseases of the pancreas, diabetes mellitus, and similar diseases (21).

CONCLUSION

In our study, we found the normal elastography values of the pancreas that can shed light on the USE studies that can save the patients with pancreatic disorders from biopsy, which is difficult and sometimes impossible to perform. With the increase in new studies, it appears to be certain that elastography will provide a promising avenue in the future.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Kahramanmaraş Sütçü İmam University Faculty of Medicine Ethics Committee (14.09.2015/01).

Informed Consent: Informed consent was obtained from patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - M.S.M.; Design - M.S.M.; Supervision - Ç.S., M.S.M.; Resources - M.S.M., Ç.S.; Materials - Ç.S.; Data Collection and/or Processing - Ç.S.; Analysis and/or Interpretation -M.S.M., Ç.S.; Literature Search - M.S.M., Ç.S.; Writing Manuscript - M.S.M.; Critical Review- M.S.M., Ç.S.; Other -M.S.Ç., Ç.S.

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

Financial Disclosure: The authors declared that this study has received no financial support.

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