ACOUSTIC RADIATION FORCE IMPULSE (ARFI) ELASTOGRAPHY OF PANCREAS AND THE IMPACT OF GENDER, AGE AND OBESITY ON THE ARFI ELASTOGRAPHY VALUES AT PUDUCHERRY

Nidhin J. K.[1], Dilip Phansalkar[2], George Kurian[3]

[1]Fellow in Cardiovascular Radiology, Amrita Institute of Medical Sciences, Kochi, Kerala.
[2]Professor and Head, Department of Radiology, Pondicherry Institute of Medical Sciences, Puducherry.
[3]Professor and Head, Department of Gastroenterology, Pondicherry Institute of Medical Sciences, Puducherry.

ABSTRACT

BACKGROUND
Acoustic radiation force impulse (ARFI) elastography is evolving as a promising ultrasound imaging modality in the diagnosis of pancreatic diseases due to its non-invasive nature and employability as a screening technique in diagnosing early tissue changes in the pancreas. We wanted to establish the normal shear wave velocity values of the pancreas in an adult Indian population and correlate age, gender and obesity with ARFI-VTTQ (virtual touch tissue quantification) values of pancreas.

METHODS
A hospital-based, cross-sectional study was conducted on 278 normal individuals attending for a health check-up or referred for evaluation from various departments. US device S 2000 ACUSON (Siemens) with a 1-4 MHz convex array transducer was used for quantification of shear wave velocity values. Association of age, gender and obesity with the mean shear wave velocity values was evaluated statistically.

RESULTS
The overall mean shear-wave velocity (SWV) value (m/s) of 9 measured sites of the pancreas was 1.1±0.17 m/s. There was no significant difference between the mean SWV values measured in different regions of the pancreas (p value=0.473). The mean SWV Values (m/s) showed an increasing trend with advancement of age and showed no significant differences among the male and female participants (p=0.98). There was no significant association or positive correlation between the obesity parameters namely BMI and skin fold thickness and the shear wave velocity values.

CONCLUSIONS
The study affirmed that the shear wave velocity values are not significantly influenced by gender or obesity but by age.

KEYWORDS
Acoustic Radiation Force Impulse, Pancreas, Shear Wave Velocity

BACKGROUND

Elastography is a sonographic imaging modality which has gained importance since its inception due to its feasibility and non-invasive nature. This modality evaluates the stiffness of tissues in target organs.[1] It has been reported from various studies that it is useful in describing parenchymal stiffness in various organs like the liver, thyroid and breast.[2,3,4,5] Pancreas is a retroperitoneal, deep-seated abdominal organ is difficult to image by ultrasonography.[6] Elastography as an imaging modality evaluates the stiffness

of tissues in target organs. There are two types of Elastography viz: Strain elastography and shear wave elastography. Strain elastography is a modification of ultrasonography which estimates the stiffness of target tissue by measuring the grade of strain generated by external pressure, for eg: aortic pulsation on the pancreas. There is negative correlation between the grade of strain and the stiffness of target tissue: the greater the strain, the softer the stiffness of target tissue is.[7,8] Shear wave elastography is another type of ultrasound-based technique which emits the focused ultrasound, so called acoustic radiation force impulse (ARFI), from the probe to the target tissue of the specific studied organ. This ARFI generates a transverse wave called shear wave` and the stiffness of the target tissue is estimated by measuring the propagation speed of shear wave. These images often produce a wider contrast in disease states in comparison to that of B- mode imaging. There is positive correlation between the propagation speed of the shear wave (shear wave velocity) and the stiffness of target tissue: the faster the shear wave velocity, the harder the target tissue is. Since ARFI is

generated, it can be used at any target of interest when desired. Thus, this study aimed at establishing the normal shear wave velocity values of the pancreas in an adult Indian population and correlating these values with age, gender and obesity.

METHODS

This cross-sectional study was conducted in the Department of Radiology, between October 2014 to February 2018 on 278 normal individuals with no past history of pancreatic disease or diabetes, attending for a general health check-up or referred for evaluation from various departments. The patients were subjected to Trans-abdominal Ultrasonogram B-mode to test the normality of the pancreas and were included only on showing homogeneous, finely granular, iso-echoic or slightly hyper-echoic pancreatic parenchyma compared to liver, absence of gallbladder calculi and no evidence of previously diagnosed cases of pancreatitis. Those with diabetes, pancreatic diseases, BMI less than 16 or more than 35 Kg/m^2 and abdominal symptoms were excluded from the study.

Initially permission was obtained from the Institutional Ethics Committee for the conduct of the study in the hospital. Only individuals who had intention to get evaluated with ultrasonogram or referred for relevant clinical evaluation were included in the study after they satisfied the inclusion criteria. None of the study subjects were included purely for the purpose of this research. The individuals selected for the study were explained in their local language about the procedure, its safety and confidentiality. When they were clear about the explained the details, informed consent was obtained from the participant.

A detailed history involving demographic details, weight, height, co-morbidities and past history about any pancreatic disorders were taken using a structured questionnaire. Patients were instructed to maintain fasting state 6 hours prior to ultrasound for better visualization. Scanning was visually done in multiple planes to allow examination of the entire pancreas in at least two views. Initially a baseline B-mode sonographic reference image was obtained to define the region of interest (dimension 15x20 mm) around a subtle region. The examination was performed in supine position. The convex transducer was placed on the epigastrium after using the conduction gel. Adequate angle is sought to locate the coeliac trunk. Further identification of the splenic vein (located more caudally) was also done, as this was another prominent landmark. For a good ARFI evaluation and value, pancreas must be seen as a near homogeneous easily identifiable, clearly defined organ on the B-mode image. Head is usually placed inferiorly towards the right and the tail is seen passing to the left and cephalad after the body. The splenic window was also used to measure the elastography values. Every time a value needs to be recorded; patient had to hold breathe or distend the abdomen. About ten values were recorded (3 in the head, 4 in the body and 3 in the tail region of the pancreas). Following this the mean was considered in each part. Approximate scan time was about 15 minutes. US device S

2000 ACUSON (Siemens) with a 1-4 MHz convex array transducer will be used for quantification of shear wave velocity values.

Statistical Analysis

Descriptive data for frequencies is presented as percentages and proportions. Chi square ($\chi 2$) test for trends was applied to see significant differences and associations of various parameters like age categories with Shear wave velocity values. Student independent t test and one-way ANOVA test were applied wherever comparison of two or more mean shear wave velocity values was necessary. For all tests a p-value of 0.05 or less was considered for statistical significance. Data entry and analysis was done in SPSS version 20.1

RESULTS

	Head		Body		Tail	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
11-20 Years	0.65	0.98	1.13	0.87	1.08	1.05
21-30 Years	0.98	1.05	1.07	1.06	1.09	1.01
31-40 Years	1.01	1.04	1.13	1.20	1.03	1.06
41-50 Years	1.03	1.07	1.14	1.23	1.08	1.18
51-60 Years	0.92	1.12	1.11	1.11	1.11	1.12
61-70 Years	1.06	1.21	1.18	1.30	1.16	1.07
71-80 Years	1.07	1.08	1.03	1.02	1.08	1.09
Mean±SD	0.99±0.21	1.07±0.2	1.12±0.18	1.18±0.2	1.08±0.2	1.1±0.22
p Value*	p=0.6		p=0.43		p=0.71	

Table 1. Age and Gender Wise Mean SWV Values (m/s) of the Head, Body and Tail of the Pancreas (n=278)

*Independent Sample t-test For Means between Males and Females

BMI (Kg/m2)	Number	Pancreas	Head	Body	Tail
<18	58	1.04±0.1	1.0±0.2	1.07±0.2	1.06±0.2
18-25	51	1.1±0.13	1.03±0.2	1.17±0.2	1.04±0.2
26-30	82	1.14±0.12	1.07±0.2	1.03±0.2	1.04±0.24
30-35	86	1.12±0.12	1.05±0.2	1.19±0.2	1.14±0.24
Total	278	1.09±0.12	1.03±0.2	1.15±0.19	1.10±0.21
F-Value			0.868	0.431	1.145	0.482
*P Value			0.458	0.731	0.332	0.695

Table 2. Obesity (BMI) and SWV Values of the Pancreas
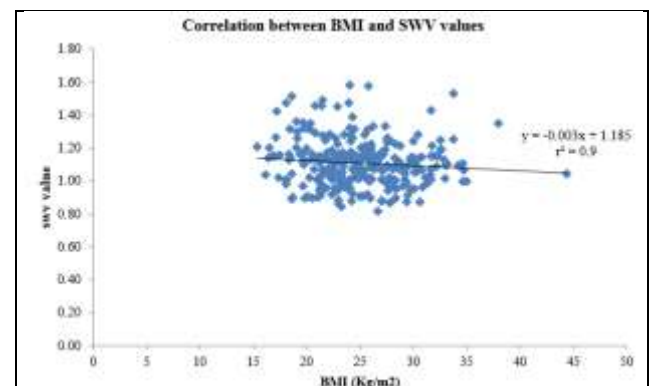
*One-way ANOVA test

Figure 1. Scatter Plot Showing Correlation Between SWV Values and BMI

Figure 2a

Figure 2b

Figure 2c

Figure 2a, 2b and 2c. Case 1. Ultrasound B Mode Images with ARFI Values (in Metre/Second) of the Head, Body and Tail of Pancreas in a 50-Year-Old Lady

Figure 3a

Figure 3b

Figure 3c

Figure 3a, 3b and 3c. Case 2- Ultrasound B Mode Images with ARFI Values (in Metre/Second) of the Head, Body and Tail of Pancreas in a 21-Year-Old Male

Figure 4a

Figure 4b

Figure 4c

Figure 4a, 4b and 4c. Case 3- Ultrasound B Mode Images with ARFI Values (in Metre/Second) of the Head, Body and Tail of Pancreas in a 55-Year-Old Male

The study included 278 participants, majority of them in the middle age group (Mean age= 42.7±12.3 years) and approximately equal proportions of male and female subjects. (Male, n=134: Female, n=144 ratio= 0.93:1). The overall mean shear-wave velocity (SWV) value (m/s) of 9 measured sites of the pancreas was 1.1±0.17 m/s. There was no significant difference between the mean SWV values measured in different regions of the pancreas (p value=0.473). The SWV values showed no significant

differences between males and females when measured in the head, body or tail of the pancreas (Table 1). There was no significant difference of SWV values between different areas of the pancreas showing that there is no difference in shear wave velocity based on obesity in various areas of the pancreas (Table 2).

DISCUSSION

Elastography is a modern advent marvel in the field of imaging which makes intra-abdominal tissue evaluation invasion free. The main scope of the study was to establish the normal shear wave velocity of the pancreas and its parts. The measured mean SWV value was high in the body (1.17±1.1 m/s) and the tail of the pancreas (1.1±0.2 m/s) compared to the head (1.05±0.25 m/s) of the pancreas. In the previous study by Yashima et al.[9] the documented cut off values of SWVs in the head, body, and tail of the pancreas were 1.23±0.34, 1.30±0.34, and 1.24±0.50 m/s respectively which was different when compared to the present study results. Further the previous study also documented the highest SWV value for the head of the pancreas which was not in conjunction with this study where a higher SWV value in the body of the pancreas is recorded. Yet another study by Itokawa et al.[10] reported that the SWVs in the head, body, and tail of the pancreas were 1.23 ± 0.34, 1.30 ± 0.34, and 1.24 ± 0.50 m/s, respectively. This was similar in lines with the results of the present study but the mean SWV values were proportionately higher in various parts of the pancreas compared to our study.

In the present study, the mean SWV values (m/s) showed an increasing trend with advancement of age with a peak increase in the middle age groups 40-60 years in the body of the pancreas.(p= 0.01). The overall mean SWV values of the pancreas which increased with advancement of age with a peak increase in the middle and in the 61-70 years age. (p= 0.004). (Table 1) This was similar to the findings in the previous study by Wendlik et al.[11] in which as the age increased higher, there was a significant (p<0.001) increase in ARFI-SWV values. The gender differences in SWV values of the pancreas were not significant in the present study and were comparable with previous studies.[10,11]

ARFI waves can penetrate to a maximum depth of 55 to 80 mm from the surface of the body. ARFI-VTTQ values are difficult to obtain in the presence of large pseudocysts, obese patients and thick/muscular subjects, in patients unable to hold breath long. The BMI values (Kg/m2) showed no significant (p=0.19) association with the pattern of the ARFI-SWV values in the various measured areas of the pancreas in this study. (Table 2) There was no significant correlation between the BMI and shear wave velocity values (r=-0.09, p value= 0.092) (Figure 1). In the previous study conducted by Yashima et al.[10] a similar correlation was made between the BMI and shear wave velocity values in individuals with healthy pancreas and the study results showed no significant correlation (r=-0.3273, p value= 0.0723).

CONCLUSIONS

The study affirmed that the shear wave velocity values are not significantly influenced by gender or obesity but by age. This study implicated the usage of normal shear wave velocity values of pancreas as a reference standard for further pancreatic evaluation in Indian subjects. Further studies are recommended to see the usage of ARFI-VTTQ technique in quantifying the shear wave values in various pancreatic pathologies and using them as reference values.

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