Case Report

Assessment of change in regional and global myocardial systolic function by 2 d longitudinal speckle tracking with increasing age

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Abstract

Background: Ageing results in lack of adaptive response to stress, increasing the risk of age related diseases. The present study was conducted to study the utility of speckle tracking and 2D longitudinal strain rate imaging in detecting early left ventricular dysfunction with increase in age. It compared this newer and more sensitive modality with conventional 2-dimensional echocardiography to assess left ventricular function in fur groups of patients categorized by increasing age and gender. **Methods:** 114 healthy individuals were enrolled from the outpatient cardiology department of Sir JJ Hospitals, Mumbai, India. They were grouped into < 60, 60-70, 70-80 and > 80 years with 25 patients in each subgroup. Detailed clinical examination, ECG and conventional 2D echocardiography and color Doppler were done to exclude subjects with any structural cardiac disease. **Results:** Left ventricular ejection fraction (LVEF) was similar in all age groups There was a increase in E/A ratio and E/E' velocity as the age advances. The longitudinal strain involving the basal ,mid and apical segments and the longitudinal global strains were reduced significantly as the age advances.. **Conclusion:** This study was done for profiling LV mechanics at different stages of aging using echocardiography. Left ventricular strain imaging is a sensitive echocardiographic technology which detects early left ventricular dysfunction before 2D conventional echocardiographic assessment using Simpson's and eyeballing.

Keywords: Ageing, Speckled tracking, Left ventricular dysfunction.

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INTRODUCTION

Improved medical care and social circumstances increase the proportion of elderly population in India. As ageing is progressive process, which results in lack of adaptive response to stress, thus increasing the risk of age related diseases. Despite decline in the rates of mortality due to heart disease in the past two decades, cardiovascular disease remains the most frequent single cause of death among persons over 65 years age[1]. With ageing of the myocardium, there is an increase in the size of myocytes and the rate of degenerative changes–lipid deposition, tubular dilatation, lipofuschin deposition, and a decrease in the mitochondrial oxidative phosphorylation[2,3,4] Detection of myocardial ischemia by visual assessment of wall motion is fraught with variability and low reproducibility. Wall motion can be quantified by TDI or strain echocardiography, respectively. To conclude, tissue velocity and strain echocardiography allow detailed interrogation of regional and global mechanics and offer substantial incremental information on myocardial function compared with conventional echocardiography. As strain information is not dependent on the Doppler angle and Strain and strain rate are less susceptible to cardiac translational motion and tethering. .Elderly people are either not or too weakly represented in strain studies. So, it was considered worthwhile to have a speckle tracking and longitudinal strain rate imaging echocardiographic information across health individuals across different age-groups, which may then be used for research on ageing.

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MATERIAL AND METHODS

114 healthy individuals were prospectively selected from the outpatient cardiology department of Sir JJ group of Hospitals, Mumbai, India. 14 patients were excluded after echocardiography due to poor acoustic windows as well as presence of significant findings on the echocardiogram. They were grouped into < 60, 60-70, 70-80 and > 80 years with 25 patients in each subgroup. Detailed clinical examination, ECG and conventional 2D echocardiography and color Doppler were done to exclude subjects with any structural cardiac disease such as valvular disease, LV hypertrophy, cardiomyopathy, or pericardial disease. Only individuals with normal ventricular function were included. Height, weight, body mass index and systolic blood pressure were obtained. Echocardiography was performed with a commercially available standard ultrasound scanner (Vivid 7, General Electric Medical Systems, Horten, Norway) with a 2.5-MHz transducer. All the images were obtained at a frame rate of 50 to 70 frames/s. The echo/Doppler examination included parasternal longandshort-axis views and three standard apical views. For each view, three consecutive cardiac cycles were recorded during quiet respiration. From the three apical planes, separate grey-scale second harmonic mode and color tissue Doppler mode were recorded. The Doppler pulse repetition frequency was 1 kHz. Color tissue Doppler mode was recorded at a mean frame rate of 100 s with underlying grey-scale images at a mean frame rate of 25 s. Grey scale recordings were optimized for evaluation of the LV at a mean frame rate of 44 s. Echocardiographic data were stored digitallyand analyzed subsequently. Using M- mode echocardiography in parasternal long axis views, LV dimensions in diastole and systole along with septal and posterior wall thickness were obtained. LV volumes and ejection fraction are obtained using Simpsons biplane view in apical four chamber and two chamber views. Mitral E velocity and E/A ratio was obtained using the pulsed Doppler velocity across the Mitral valve in apical four chamber view and E' velocity obtained at the lateral mitral annulus using DTI. Off –line 2D speckle tracking was performed by a single blinded operator. At end-systole endocardium was determined by aortic valve closure and the software automatically tracked the myocardial motion in apical parasternal view, two chamber and 4-chamber views. Operator manually adjusted the endocardial limit if the automatic tracking was poor. The longitudinal strain was measured in each of the 12 segments (4 segments in each view) and the basal, mid and apical longitudinal strain values were recorded individually and averaged to give the global strain. Strain rate by speckled trace is age independent.

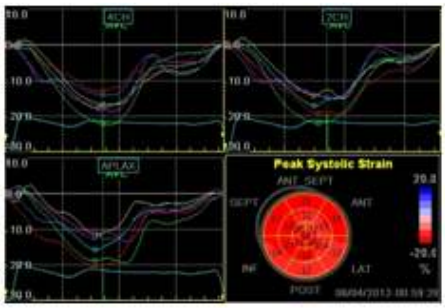

Figure 1: Strain in all cardiac segments in single cardiac cycle

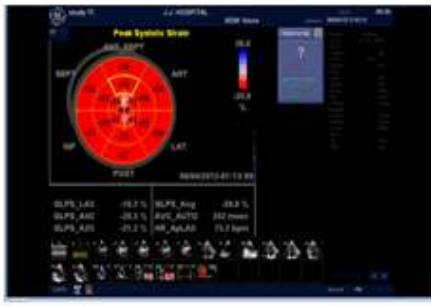

Figure 2: Bulls eye diagram showing peak systolic strain in all cardiac segment

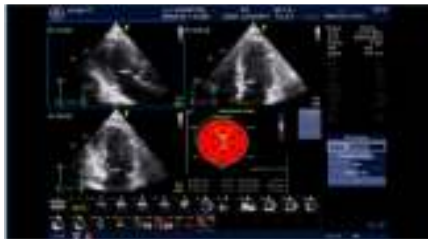

Figure 3: Apical, parasternal long axis, apical four chamber, apical two chamber view for speckled tracking analysis with strain

OBSERVATION AND RESULTS

Our study included 100 healthy patients divided in 4 groups according to age in years <= 60, 61 to 70, 71 to 80, >= 81; 25 patients in each group. Our study has 36% females. Patient characteristics and the echocardiographic parameters are shown in Tables 1 and 2.

Table 1:

Age (yrs)		Sex		Total
		Female	Male	
<= 60	No.	9	16	25
	%	36.0%	64.0%	100.0%
61 to 70	No.	10	15	25
	%	40.0%	60.0%	100.0%
71 to 80	No.	9	16	25
	%	36.0%	64.0%	100.0%
>= 81	No.	8	17	25
	%	32.0%	68.0%	100.0%
Total	**No.**	**36**	**64**	**100**
	%	**36.0%**	**64.0%**	**100.0%**

LV Morphology, Systolic, and DiastolicFunctions by Conventional Echocardiographic Parameters

In comparison with in all four groups, there was no significant difference in the parameters, diastolic BP (mmHg), systolic BP (mmHg), heart rate, LVIDd, LVEF; Diastolic function measured from mitral inflow velocity(E/A) and tissue Doppler(E/E') showed significant increase in values between groups with increasing age, suggesting gradually rising filling pressures with age.

Table 2

Variables	Age <= 60 yrs (n=25)		Age 61 to 70 yrs (n=25)		Age 71 to 80 yrs (n=25)		Age >= 81 yrs (n=25)		P value
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Age	47.76	4.66	65.48	3.06	75.28	2.56	86.60	4.47	NS
Diastolic BP (mmHg)	78.48	5.72	77.44	6.21	78.00	6.71	80.24	6.28	NS
Systolic BP (mmHg)	126.88	8.53	124.24	7.71	129.84	7.77	126.00	7.23	NS
HR	72.04	10.79	65.44	7.54	66.60	6.55	64.52	5.19	NS
LVIDd	43.44	3.08	41.96	4.05	43.00	4.02	43.48	3.91	NS
LVEF	65.92	5.17	63.84	4.31	65.40	5.80	62.72	4.74	NS
E/A	1.07	0.17	1.00	0.28	0.88	0.27	0.76	0.21	<0.05

Variables	Age-groups (yrs)	Mean	SD	P value
E/E'	<= 60	5.61	0.60	< 0.05
	61 to 70	6.35	0.58	< 0.05
	71 to 80	7.69	0.93	< 0.05
	>= 81	10.40	1.67	< 0.05

2D Strain Comparison of 2D strain values between groups:

Global longitudinal strain was significantly lower in elderly subjects **(**<= 60 - 17.95; 61 to 70 - 17.10; 71 to 80 - 16.93; >= 81 - 15.11)**P value < 0.05.** There was significant difference in longitudinal basal, Longitudinal mid, Longitudinal apical region strain rate, showing decreasing trend in all with increase in age (Table 3).

Table 3:

Variables	Age-groups (yrs)	Mean	SD	P value
Longitudinal basal	<= 60	17.90	0.31	<0.05
	61 to 70	17.07	0.56	<0.05
	71 to 80	16.94	0.60	<0.05
	>= 81	15.06	0.65	<0.05
Longitudinal mid	<= 60	17.96	0.33	<0.05
	61 to 70	17.09	0.58	<0.05
	71 to 80	16.94	0.62	<0.05
	>= 81	15.14	0.58	<0.05

Longitudinal apical	<= 60	17.97	0.37	<0.05
	61 to 70	17.15	0.63	<0.05
	71 to 80	16.92	0.62	<0.05
	>= 81	15.12	0.80	<0.05
Global stain	<= 60	17.95	0.30	<0.05
	61 to 70	17.10	0.56	<0.05
	71 to 80	16.93	0.59	<0.05
	>= 81	15.11	0.65	<0.05

DISCUSSION

Structural and biochemical alterations in the LV myocardium occur as the age advances resulting in both systolic and diastolic dysfunction. Diastolic dysfunction can be easily picked up using conventional color and tissue Doppler studies. Systolic dysfunction measured conventionally by eyeballing and LV ejection fraction is load dependent and is usually normal in elderly patients without any structural heart disease. The newer modality of strain rate imaging has been found to be more sensitive in the detection of early LV systolic dysfunction. Very few studies have used this modality to study LV function across the life span in different age groups. Our study is the first study to profile LV mechanics with increasing age. In the present study, we grouped the patients into four groups from <60 to > 80 years; LVEF was similar in all age groups with statistically insignificant difference. There was a increase in E/A ratio and E/E' velocity as the age advances. The longitudinal strain involving the basal, mid and apical segments and the longitudinal global strains were reduced significantly as the age advances; females were the majority in our study population; male and female gender differences could not be validated and is still controversial We compared LV function using conventional and strain rate imaging across four decades. We confirmed decline in global diastolic dysfunction and longitudinal deformation with increasing age. We showed a progressive increase in LV dyssynchrony with age. Further more nonuniform contraction of LV myocardial walls due to decreasing electromechanical synchronicity may result in myocardial inefficiency and could be an underlying contributor to these age-related impairments in LV myocardial mechanics. Crendal *et al* [6] reported an increase in circumferential longitudinal strain along with a decline in longitudinal strain and hypothesized this to be the cause of normal LVEF. Also unlike the previous studies where only males were included the study has nearly one-third patients which are female and shows a similar pattern of decline irrespective of the gender. W and t *et al*.[8] found a decrease in the longitudinal shortening by 20% from age 18 to 70 years. Ruan *et al* [9]studied the effect of age on the isovolumic acceleration rate, and found a positive correlation with age of this parameter only in men while Sujood *et al*.[7] found a decrease in the mid wall LV systolic performance only in women >65 years. In a similar study by Inelli *et al* [10,] they studied the mitral annulus velocity using the tissue Doppler in 246 patients divided in 7 subgroups represented in each decade and found an independent negative correlation of this parameter with age. Sun *et al* [11] studied a population composed of 100 healthy subjects from 18 to 76 years (15were > 60 years) there was a dependence on age of Doppler velocities and strain rates while displacement and global strain were less affected. Fonseca *et al* [12] used 3D MR tissue tagging and compared 15 younger (19–26 years) to 16 older(60–74 years) healthy adults, they found out a decrease in circumferential and longitudinal strain both to a greater extent in the apex than in the base resulting in an alteration of the patterns of regional non uniformity of myocardial relaxation. There are only few studies on strain imaging in elderly population. Zhang *et al* studied 45 elderly patients (75-95 years) without any structural heart disease and compared with younger population (17-45 years). There was no difference between the two groups considering LV ejection fraction (66 ± 6% vs. 65 ± 4%, P = ns). Feasibility of segmental 2D strain was 55.6% for circumferential strain, 63% for transversal strain, and 82% for longitudinal strain. Global longitudinal strain was significantly lower in elderly patients (–20.9 ± 1.9% vs.–22.2 ± 2.2%, P <0.01). Wang *et al*.[13] applied the 2D speckle tracking to measure longitudinal, radial and circumferential strain and twist in 50 patients (aged 58 ± 16 years) with heart failure, the longitudinal and radial stains were reduced while circumferential strain and twist were preserved in the group with preserved EF heart failure while all parameters were reduced in systolic heart failure.

CONCLUSION

Our study is the only study of its kind in the Asian population. It highlights the importance of newer echocardiographic modalities in detecting left ventricular systolic dysfunction and opens a whole new window for research in the initiation of early preventive and therapeutic strategies for prevention of progressive left ventricular systolic dysfunction with ageing.

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