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ORIGINAL ARTICLE

Normal Values of Left Ventricular Myocardial Deformation Assessed by Cardiovascular Magnetic Resonance Feature Tracking in a Healthy Egyptian population

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Abstract

Background: **Cardiovascular diseases (CVDs) is considered the most frequent cause of death worldwide responsible for about 17.9 million death in 2019; this study aimed to assess the left ventricle reference values of the global strain of Egyptian subjects using cardiovascular magnetic resonance (CMR) and to evaluate the effect of age, gender, BMI and BSA on strain measurements.**

Patients and methods: **50 healthy adult Egyptian volunteers who met the inclusion criteria were prospectively recruited from Aswan Heart center and Al-Hussein university hospital in Egypt. CMR exams were performed. Feature tracking global longitudinal strain from two long-axis SSFP cine images while circumferential and radial strains are derived from the short-axis cine images. Global LV strain measurements were analyzed using commercial cardiovascular post-processing software.**

Results: **We analyzed the peak global circumferential, longitudinal and radial strain using feature tracking in 50 healthy Egyptian subjects. LV Mean global circumferential, longitudinal and radial strain values in healthy Egyptians were recorded and correlated with effect of age and gender. LV strain values are higher in females than males. No significant association between age and LV global strains in our study, which needs further studies.**

Conclusion: **Using a CMR-FT with great consistency and a sizable healthy Egyptian population of participants, our work gives reference values for heart deformation. In a typical clinical situation, these values may be utilised to assess LV myocardial function or the early beginnings of failure.**

The LV global circumferential and longitudinal strain readings from CMR-FT were greater in females than in males.

Keywords: Egyptian population, Left ventricular myocardial deformation, LV strain values, Magnetic resonance feature tracking

1. Introduction

Cardiovascular diseases (CVDs) is considered the most frequent cause of death worldwide responsible for about 17.9 million death in 2019. The World Health Organisation (WHO) also demonstrated that CVDs account for 32% of all fatalities worldwide. Furthermore, it is the most costly disease accounting for 237$ billion dollars yearly and it is supposed to be 368$ billion by 2035.[1–3] CVDs refers to one of the four entities such as Coronary artery disease (CAD) which is also known as Coronary Heart Disease (CHD) in which there is a decrease in myocardial perfusion causing myocardial infarctions, Cerebrovascular disease including strokes, Peripheral artery disease (PAD)

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which affects limbs and causes claudication attacks, and aortic atherosclerosis.[2] Thus the prevention of CVDs has a crucial role in reducing the disability and mortality rates among patients in addition to improving the overall quality of life and the survival of patients.[4] In 2020, The American Heart Association (AHA) released a preventive strategy plan for CVDs, which demonstrated that proper application of this preventive strategy plan yields an overall 20% reduction in CVD and its mortality rate.[5]

Visualizing the cardiac muscle, scar, and fibrous tissue has become one of the most important modalities to evaluate and predict the CVDs. Moreover, cardiac imaging may have a beneficial role in the guidance of cardiac invasive procedures. These cardiac imaging methods include magnetic resonance imaging (MRI), nuclear scintigraphy for myocardial perfusion, computed tomography (CT), and coronary angiography for the visualization of coronary arteries.

The modality of choice in visualizing cardiac scars and it's transmurality is the late gadolinium enhancement (LGE) sequence. The viability of cardiac tissue is determined according to the percentage of fibrous tissue. The segmental area is considered not viable if more than 50% of that area was affected.[6] Previous studies reported that the left ventricular parameter had both diagnostic and prognostic roles in assessing CVDs. Echocardiography is the gold standard technique that measures all heart dimensions and evaluates its systolic function. However, MRI shows much better contrast and spatial resolution compared to echocardiography.[7]

We aim in this study to assess the left ventricle reference values of the global strain of Egyptian subjects using cardiovascular magnetic resonance (CMR) and to study the effect of age, BMI, sex, and BSA on strain measurements.

2. Patients and methods

In the present prospective study, we included 50 healthy adult volunteers who were recruited from Aswan Heart center and Al-Hussein university hospital in Egypt.

2.1. Eligibility criteria

We included healthy adult volunteers who are symptomless without any cerebrovascular disease. The included individuals should also have negative history of diabetes mellitus, hypertension, or dyslipidemia. Their electrocardiogram and physical examination should be normal. Finally, they must have no contraindications to CMR.

We excluded all individuals who had any valvular diseases or wall motions disorders detected on CMR.

2.2. Patient preparation before CMR

All subjects are requested to fast for 6 h before the CMR examination, a written safety list to exclude any MRI contraindications is read, filled out and signed by the subject, the examination is explained in full detail to the subject by the attending physician, subjective are instructed to leave all metallic objects outside the scanner.

2.3. During the procedure

We examined the participants in the supine position. Head first with no movement in order to ensure that the planned scan region matches the region actually scanned, the patient's breath-hold exercises are performed under the nurse supervision, hearing protection is provided, four ECG leads are connected and a cardiac coil is applied.

2.4. Image acquisition

We conducted CMR exams using 1.5 T S machine Magnetom Aera, Siemens Medical Systems, Erlangen, Germany and 1.5 T Achieva, Philips Healthcare, Netherlands. We used specific phased array cardiac coil, ECG, and respiratory-gated. To evaluate the ventricles function and volume, long-axis The images were obtained using a retrospective ECG-gated cine SSFP during breath-hold with the following parameters: echo time = 1.3 msec, Repetition time = 40 msec, section thickness = 6 mm, flip angle = 60°, slice gap = 9 mm, matrix size = 256 208, and field of view = 360 mm. The images covered both ventricles from the base to the apex of the heart.

2.5. Image analysis

We used Philips IntelliSpace Portal post processing software to assess the ventricular volume and function. Endocardial and epicardial LV contours were manually traced along all short axis cut sections in the end diastolic and end systolic phases and ejection fractions of all patients and controls were calculated. The visual assessment of the myocardial wall movement abnormalities in the form of dyskinesia, hypokinesia, or akinesia were done using short and long-axis cine images.[8]

Peak global circumferential strain analysis and radial strain measurement were used to examine short axis SSFP cine pictures. Global strain values were determined as the average of all 16 segmental values for each participant. For each of the three myocardial levels. Segment software feature tracking generated the results automatically. The strian circumferential indicates the ejection decrease of the LV diameter as seen from the short axis yielding a negative strain value while the radial strain contributes to the systolic thickening was then created as a positive strain value of the LV myocardium. Longitudinal shortening: implying the decreased base-apex dimension in systole, mainly due to the shortening of the longitudinal sub-endocardial fibers along the long axis of the LV.

The longitudinal strain observed in the 2-, 3-, and 4-chamber perspectives was examined in this work using the typical 17-segment AHA model 9. The four chamber long-axis cine image's end-diastolic was isolated from the apical, mid-cavity, and basal planes. In order to analyse the radial and circumferential strain of LV short-axis images, we employed the modified 16-segment model (which does not contain the apical cap) and the RV insertion location which represent reference points for the LV septum junction and anterior wall. The base slice was chosen for the short axis strain analysis because it still displayed the LV cavity during systole.[9]

2.6. Statistical analysis

We conducted data analysis using SPSS version 21. Quantitative data was provided as mean, standard deviation, median, and interquartile range, whereas qualitative data was reported as number and percentage. The χ^2 test was employed for non-parametric data, and the Fischer exact test was utilised for both parametric and non-parametric significance testing. ANOVA and the student *t*-test are tests for parametric data. Pearson To identify associations between parametric data variables, correlation tests were utilised. The threshold for significance was fixed at $P = 0.05$ or less.

3. Results

Tables 1 and 2.

This (Table 2) shows: The myocardium strain of the LV in males, mean LV Ecc, LV Ell and LV Err was 16.70 ± 4.73, 20.18 ± 3.10, and 35.17 ± 10.46%, respectively. In females, LV Ecc, mean LV Ell and LV Err was 19.54 ± 1.86, 22.39 ± 2.62, and 43.93 ± 12.92%, respectively. There is statistically significant difference between gender and strain values; LV global strain values are larger in females than males, circumferential strain and longitudinal strain means are larger (considering sign) in females than males (P = 0.009,0.06) and radial strain is also larger in females P = 0.013 (Fig. 1 and Table 4). These tables show that: We found no statistically significant correlation between age and BMI and strain values (Table 3 and Fig. 1). This table shows: Circumferential strain has statistically significant moderate positive correlation with body surface area, P = 0.024, r = 0.319. No statistically significant correlation between BSA and other strain value (Table 5).

Table 1. Gender and age distribution.

	Frequency/Mean ± SD	Percent/Range
Sex		
Male	22	44.0
Female	28	56.0
Total	50	100.0
Age	27.98 ± 9.826	2−62

SD, standard deviation.

4. Discussion

This trial provided wide-scale evidence that used feature tracking to examine the peak global longitudinal, radial, and circumferential strain in 50 healthy Egyptian participants. LV In healthy Egyptians, the mean global circumferential, longitudinal, and radial strain values were measured and linked with the effects of age and gender. Females have greater LV strain levels than males. In our investigation, there was no evidence of a connection between age and LV global stresses.

Our study showed higher levels of circumferential, longitudinal and radial LV strain in females; (ii) a significant association between body surface area and LV circumferential strain; (III) no relation between age and LV global strain; and (IV) this study provides quantitative ranges for LV strains in healthy Egyptians based on CMR feature tracking results.

Augustine et al.[10] studied the magnetic resonance feature tracking measurements of global and local left ventricular myocardial deformation in healthy volunteers. Although neither longitudinally nor radially oriented, FT measurements of circumferential global strain showed acceptable inter-observer repeatability and reasonable agreement with tagging. At the global, regional, and segmental levels, we keep track of the preliminary ranges of FT deformation parameters. They demonstrate gender and cardiac region differences in the volunteers tested, but have not yet been put up against segmental tagging measures. Their findings revealed geographical variance, gender disparities, and more strain at the base than at the peak apex. Myocardial strain, segmental velocity, and displacement parameters are produced using the

Table 2. Gender difference in global strain.

	Sex	*N*	Mean	Std. deviation	Std. error mean	*P* value
Circumferential. Strain	Male	22	−20.18023	3.109660	0.662982	0.009
	Female	28	−22.39250	2.624408	0.495966	
Radial. Strain	Male	22	35.1795	10.46705	2.23158	0.013
	Female	28	43.9364	12.92596	2.44278	
Longitudinal. Strain	Male	22	−16.7073	4.73980	1.01053	0.06
	Female	28	−19.5471	1.86922	0.35325	

N, number and Std, standard.

Feature Tracking software in a relatively rapid manner for image capture and post-processing. The method eliminates the extra time required for tissue phase mapping or tagging and opens the door to a retrospective analysis of current CMR datasets.

There are still disagreements over how age and gender affect heart deformation. The study by Vo et al. showed that there was no effect of age and gender on the left and right ventricular diameter. On the other hand, several studies reported a relation between left ventricular size and the female gender. They found that females were associated with greater strain.[10–12]

LV circumferential strain and radial strains showed weak correlation with the age. As people get older, their systolic pressure drops. An increased correlation between LA strain and age compared to LV strain points to a greater clinical impact of age on LA strain. Conversely, the increase in radial strain may be due to systolic wall thickening compensating for LV stiffens that increased in relation to aging.[13]

While our results disagree with those of Taylor et al.[11] who found that circumferential strain increased with age, they do agree with those of Dalen et al.[14] and Kuznetsova et al.[15] who found that longitudinal strain decreased with age.

Age and gender alone may not fully explain the discrepancy, which is why our findings show statistically significant but modest impacts of age.

The study by Liu et al.[16] was performed to define normal values for RV and RA peak longitudinal strain and strain rate in an adult population.

4.1. Limitations

Future research may need to concentrate on the normal values of the studied populations following classification by risk factors because very old patients are more likely to having risk factors include hypertension, diabetes, atherosclerosis, and high cholesterol. It is necessary to do more study to understand how risk factors including drinking

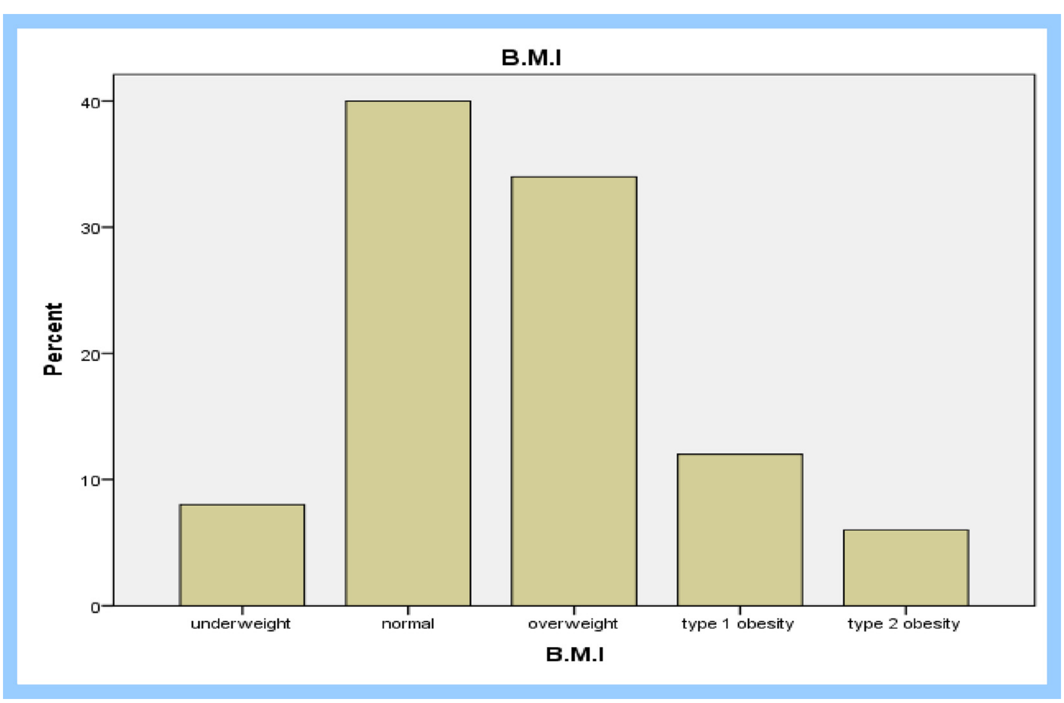

Fig. 1. Shows the BMI of the included participants.

Table 3. BMI difference in global strains.

BMI	*N*	Mean	Std. deviation	Std. error	95% Confidence interval for mean		Min	Max	*P* value
					Lower bound	Upper bound			
Circumferential. Strain									
Underweight	4	−22.08250	1.656349	.828174	−24.71812	−19.44688	−23.530	−20.400	0.702
Normal	20	−21.05825	3.583645	.801327	−22.73545	−19.38105	−27.555	−12.690	
Overweight	17	−22.07353	3.043384	.738129	−23.63829	−20.50877	−28.740	−17.440	
Type 1 obesity	6	−20.19500	2.303039	.940212	−22.61189	−17.77811	−23.310	−16.250	
Type 2 obesity	3	−21.68000	.876185	.505866	−23.85656	−19.50344	−22.610	−20.870	
Total	50	−21.41910	3.028196	.428252	−22.27970	−20.55850	−28.740	−12.690	
Radial. Strain									
Underweight	4	33.6025	6.88589	3.44294	22.6455	44.5595	24.71	41.21	0.226
Normal	20	38.8705	10.21796	2.28480	34.0883	43.6527	21.65	61.70	
Overweight	17	44.9629	14.52175	3.52204	37.4965	52.4293	31.78	94.40	
Type 1 obesity	6	33.3017	16.38748	6.69016	16.1041	50.4993	4.78	55.43	
Type 2 obesity	3	42.7233	2.71773	1.56908	35.9721	49.4745	40.17	45.58	
Total	50	40.0834	12.58169	1.77932	36.5077	43.6591	4.78	94.40	
longitudinal. Strain									
Underweight	4	−17.2400	.74989	.37494	−18.4332	−16.0468	−18.25	−16.66	0.961
Normal	20	−18.6450	1.83478	.41027	−19.5037	−17.7863	−22.36	−15.15	
Overweight	17	−18.0059	5.89992	1.43094	−21.0393	−14.9724	−23.19	3.62	
Type 1 obesity	6	−18.6033	2.30478	.94092	−21.0221	−16.1846	−21.90	−15.78	
Type 2 obesity	3	−18.4333	1.92003	1.10853	−23.2030	−13.6637	−20.36	−16.52	
Total	50	−18.2976	3.68526	.52117	−19.3449	−17.2503	−23.19	3.62	

Correlation

		BMI
BMI	PCC	1
	Number	50
Circumferential strain	PCC	0.033
	Sig. (2-tailed)	0.818
	Number	50
Radial strain	PCC	0.152
	Sig. (2-tailed)	0.291
	Number	50
Longitudinal strain	PCC	−0.004
	Sig. (2-tailed)	0.975
	Number	50

BMI, body mass index; Max, maximum; Min, minimum; *N*, number; PCC, Pearson correlation coefficient; Std, standard.

Table 4. Age difference in global strains.

	Age
Age	
PCC	1
Number	50
Circumferential. Strain	
PCC	−0.093
Sig. (2-tailed)	0.519
Number	50
Radial. Strain	
PCC	0.076
Sig. (2-tailed)	0.602
Number	50
Longitudinal. Strain	
PCC	0.241
Sig. (2-tailed)	0.092
Number	50

PCC, Pearson correlation coefficient.

Table 5. BSA difference in global strains.

	BSA.Mostellerm2
BSA.Mostellerm2	
PCC	1
Number	50
Circumferential. Strain	
PCC	0.319
Sig. (2-tailed)	0.024
Number	50
Radial. Strain	
PCC	−0.102
Sig. (2-tailed)	0.479
Number	50
Longitudinal. Strain	
PCC	0.199
Sig. (2-tailed)	0.165
Number	50

PCC, Pearson correlation coefficient.

alcohol, smoking, and having high blood pressure will affect the strain measurements.

4.2. Conclusion

Using a CMR-FT with great consistency and a sizable healthy Egyptian population of participants, our work gives reference values for heart deformation. In a typical clinical situation, these values may be utilised to assess LV myocardial function or the early beginnings of failure.

The LV global circumferential and longitudinal strain readings from CMR-FT were greater in females than in males. No significant relationship between age and LV strain values was found in our study, which may have been due to the restricted age range. Therefore, more research with a wide age range is required.

Conflicts of interest

Authors declare that there is no conflict of interest, no financial issues to be declared.

References

1. Dunbar SB, Khavjou OA, Bakas T, et al. Projected costs of informal caregiving for cardiovascular disease: 2015 to 2035: a policy statement from the American Heart Association. *Circulation*. 2018; 137:e558–e577. https://doi.org/10.1161/CIR.0000000000000570.
2. Benjamin EJ, Virani SS, Callaway CW, et al. Heart disease and stroke statistics—2018 update: a report from the American heart association. *Circulation*. 2018;137:e67–e492. https://doi.org/10.1161/CIR.0000000000000558.
3. Cardiovascular diseases (CVDs). https://www.who.int/en/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds. Accessed September 29, 2022.
4. Stewart J, Manmathan G, Wilkinson P. Primary prevention of cardiovascular disease: a review of contemporary guidance and literature. *JRSM Cardiovasc Dis*. 2017;6, 204800401668721. https://doi.org/10.1177/2048004016687211.
5. Lloyd-Jones DM, Hong Y, Labarthe D, et al. Defining and setting national goals for cardiovascular health promotion and disease reduction. *Circulation*. 2010;121:586–613. https://doi.org/10.1161/CIRCULATIONAHA.109.192703.
6. Roes SD, Mollema SA, Lamb HJ, van der Wall EE, de Roos A, Bax JJ. Validation of echocardiographic two-dimensional speckle tracking longitudinal strain imaging for viability assessment in patients with chronic ischemic left ventricular dysfunction and comparison with contrast-enhanced magnetic resonance imaging. *Am J Cardiol*. 2009;104:312–317. https://doi.org/10.1016/j.amjcard.2009.03.040.
7. Hundley WG, Bluemke DA, Finn JP, et al. ACCF/ACR/AHA/NASCI/SCMR 2010 expert consensus document on cardiovascular magnetic resonance. *J Am Coll Cardiol*. 2010;55: 2614–2662. https://doi.org/10.1016/j.jacc.2009.11.011.
8. Scatteia A, Baritussio A, Bucciarelli-Ducci C. Strain imaging using cardiac magnetic resonance. *Heart Fail Rev*. 2017;22: 465–476. https://doi.org/10.1007/s10741-017-9621-8.
9. Taylor RJ, Umar F, Panting JR, Stegemann B, Leyva F. Left ventricular lead position, mechanical activation, and myocardial scar in relation to left ventricular reverse remodeling and clinical outcomes after cardiac resynchronization therapy: a feature-tracking and contrast-enhanced cardiovascular magnetic r. *Heart Rhythm*. 2016;13:481–489. https://doi.org/10.1016/j.hrthm.2015.10.024.
10. Augustine D, Lewandowski AJ, Lazdam M, et al. Global and regional left ventricular myocardial deformation measures by magnetic resonance feature tracking in healthy volunteers: comparison with tagging and relevance of gender. J Cardiovasc Magn Reson. 2013 Jan 18;15(1):8. https://doi.org/10.1186/1532-429X-15-8.
11. Taylor RJ, Moody WE, Umar F, et al. Myocardial strain measurement with feature-tracking cardiovascular magnetic resonance: normal values. Eur Heart J Cardiovasc Imag. 2015 August;1 6(8):871–881. https://doi.org/10.1093/ehjci/jev006.
12. Lawton JS, Cupps BP, Knutsen AK, et al. Magnetic resonance imaging detects significant sex differences in human myocardial strain. *Biomed Eng Online*. 2011;10:76. https://doi.org/10.1186/1475-925X-10-76.
13. Peng J, Zhao X, Zhao L, et al. Normal values of myocardial deformation assessed by cardiovascular magnetic resonance feature tracking in a healthy Chinese population: a multicenter study. Front Physiol. 2018 Sep 3;9:1181. https://doi.org/10.3389/fphys.2018.01181.
14. Dalen H, Thorstensen A, Aase SA, et al. Segmental and global longitudinal strain and strain rate based on echocardiography of 1266 healthy individuals: the HUNT study in Norway. Eur J Echocardiogr. 2010 March;11(2):176–183. https://doi.org/10.1093/ejechocard/jep194.
15. Kuznetsova T, Herbots L, Richart T, et al. Left ventricular strain and strain rate in a general population. *Eur Heart J*. 2008; 29:2014–2023. https://doi.org/10.1093/eurheartj/ehn280.
16. Liu B, Dardeer AM, Moody WE, Edwards NC, Hudsmith LE, Steeds RP. Normal values for myocardial deformation within the right heart measured by feature-tracking cardiovascular magnetic resonance imaging. *Int J Cardiol*. 2018;252:220–223. https://doi.org/10.1016/j.ijcard.2017.10.106.