ISSN: 0975-833X

Available online at http://www.journalcra.com

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

International Journal of Current Research
Vol. 13, Issue, 05, pp.17215-17219, May, 2021

DOI: https://doi.org/10.24941/ijcr.40969.05.2021

RESEARCH ARTICLE **OPEN ACCESS**

THE ROLE OF SPECKLE TRACKING FOR DIFFERENTIATING PATIENTS WITH HYPERTROPHIC CARDIOMYOPATHY FROM ATHLETE'S WITH MODERATE LEFT VENTRICULAR HYPERTROPHY

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ARTICLE INFO

Article History:
Received 14th February, 2021
Received in revised form
05th March, 2021
Accepted 19th April, 2021
Published online 15th May, 2021

Key Words:
Speckle Tracking,
Hypertrophic Cardiomyopathy,
Athlete's with Moderate LVH.

ABSTRACT

Background: Differentiation between types of left ventricular hypertrophy (LVH) whether physiological or pathological is essential for Management and/or follow up. **Purpose:** To examine the accuracy of 2D and 3D strain and LV dyssynchrony for differentiating athletes with moderate LVH (13—15 mm) from patients with hypertrophic cardiomyopathy (HCM). **Patients & Methods:** A prospective case control study carried out at Benha University Hospitals, Cardiology Department and National Heart Institute during the period from March 2019 to September 2020.The study included 100 subjects divided into four groups:First Group: 25 competitive athletes with moderate LVH (13—15 mm),Second Group: 25 competitive athletes without LVH, Third Group: 25 patients with HCM and moderate LVH (13—15 mm), andFourth Group: 25 sedentary healthy subjects (control group). **Results:** Our result reported thatthere is a significant difference between athletes with LVH and HCM group regarding 2D & 3D GLS, GRS and GAS (where these measures were higher in athletes with LVH). Also, there is a significant difference between Athletes without LVH and HCM group GRS and GAS (where these measures were higher in athletes without LVH) while no significant difference between groups regarding GCS. Also, LV end-diastolic diameter has the highest sensitivity (98%) with cutoff < 54 mm for distinguishing HCM from athletes with or without moderate LVH with high significance ($p < 0.001$). **Conclusion:** We demonstrated that a preserved 2D and 3D longitudinal strain function and the absence of LV dyssynchrony can be used to exclude HCM, while abnormal longitudinal function associated with dyssynchrony is specific to HCM.

Citation: Ahmed Y. Nammour, Hisham Aboul-Enein, Mohamed Osama Taha Hussein, Kerolus Kamel Gad and Eman Saeed El-Keshk. "The Role of Speckle Tracking for Differentiating Patients with Hypertrophic Cardiomyopathy from Athlete's with Moderate Left Ventricular Hypertrophy", *2021. International Journal of Current Research*, *13*, *(05)*, *17215-17219.*

INTRODUCTION

Differentiation between types of left ventricular hypertrophy (LVH) whether physiological or pathological is essential for Management and/or follow up. Recognition of that hypertrophic cardiomyopathy (HCM) is the main cause of sudden cardiac death in young athletes. However, the diagnosis of HCM in athletes can be challenging because 1.5—8% of top-level athletes have moderate LVH (defined by a septal wall thickness of 13—15 mm) and some athletes with early stage HCM can excel in sport *(Kim et al., 2012).* Usually, clinical history, electrocardiogram (ECG) abnormalities and standard two dimensional (2D) echocardiography allow the identification of patients with HCM. However, cardiac remodeling and ECG features can vary widely depending on the sporting activity and the athlete's ethnicity *(Elliott et al., 2014).* This explains the difficulty in differentiating an athlete's heart with moderate LVH from early stage HCM with conventional echocardiography and ECG. Recent studies have suggested that tissue Doppler imaging and 2D and three-dimensional (3D) speckle tracking-derived strain might be used to better characterize patients with HCM and the hearts of athletes (Yiu *et al., 2012;* Monte *et al., 2015).*

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Strain analysis provides an accurate and reproducible assessment of longitudinal function and left ventricular (LV) dyssynchrony derived from strain curves may be used to assess the consequence of myocardial disarray and hypertrophy on LV function *(*Lim *et al., 2008)*. The purpose of this study was to examine the accuracy of 2D and 3D strain and LV dyssynchrony for differentiating athletes with moderate LVH (13—15 mm) from patients with HCM.

PATIENTS AND METHODS

A prospective case control study carried out at Benha University Hospitals, Cardiology Department and National Heart Institute during the period from March 2019 to September2020.

The study included 100 subjects divided into four groups:

- **First Group:** 25 competitive athletes with moderate LVH (13—15 mm),
- **Second Group:** 25 competitive athletes without LVH,
- **Third Group:** 25 patients with HCM and moderate LVH (13—15 mm), and
- **Fourth Group:** 25 sedentary healthy subjects (control group).

Inclusion criteria: Patient fit Criteria for Athletes: were recruited from professional players of the Body Building games and sports. All athletes were screened annually by ECG and echocardiography and none had a history of cardiovascular disease. They had all undertaken endurance (running with interval training) as well as power (bodybuilding) training for > 10 hours/week for at least the past 8 months. The only specific criterion for the inclusion of athletes was septal thickness for athletes with moderate LVH. Patient fit Criteria for HCM: was defined by a wall thickness of ≥ 13 mm plus one of the following: a family history of HCM, a positive genetic screening or when a systolic anterior movement of the anterior mitral valve leaflet was present (with or without left ventricular outflow tract [LVOT] gradient). Patients with HCM were selected from our local cohort of patients with proven HCM without LVOT obstruction at rest before alcohol septal ablation or myomectomy.

Patient fit Criteria for control group: consisted of sedentary healthy subjects without a history of cardiac disease, with no specific criteria for inclusion.

Exclusion criteria

- Patients with atrial fibrillation.
- Patients with wide QRS duration (≥ 120 msec.).
- Patients with an implanted pacemaker.
- Patients with a suspected cause of HCM other than sarcomeric etiology.
- Patients with LV dysfunction (left ventricular ejection fraction [LVEF] ≤ 50%) were excluded.

METHODS

All subjects had been subjected to history taking, clinical examination, laboratory investigation, ECG, standard Echocardiographic, speckle tracking and dyssynchrony measurements.

Speckle tracking measurements: 3D echocardiography assessment had been carried out according to the AHA/ACC and European guidelines included an LV full volume acquisition using multi-beat modality (four cardiac cycles) from the apical view. LV volumes and LVEF were computed using semi-automated software (3D auto left ventricular quantification, Q lab, Philips). Speckle tracking and dyssynchrony measurements 2D and 3D strain components were computed from apical views using speckle-tracking analysis. The temporal resolutions for 2D and 3D data were 53 ± 3 and 22 ± 7 frames per cardiac cycle, respectively. Analysis was performed offline using dedicated 2D and 3D Q Lab software (Philips).

Automated function imaging for 2D imaging and auto left ventricular quantification for 3D imaging used a block-matching model to compute strain data. Endocardial delineation was obtained after manual positioning of the mitral valve plane and LV apex. The region of interest was adjusted manually to provide optimal wall tracking and segments that were inadequately tracked were discarded. For strain processing, the peak of the R wave was used as the end-diastolic reference point. 2D global longitudinal strain (GLS) was obtained by averaging the 16 regional longitudinal strain curves computed from the 2D apical views (4 C, 2 C, and 3 C) and 3D GLS and circumferential strain components by averaging the 17 regional strain curves separately. 3D global radial and area strain components were derived by the software from longitudinal and circumferential curves. For better comprehensibility, all strain data are expressed as absolute values.

Statistical analysis: Data were collected, analyzed and presented by suitable tables and graphs using SPSS (Statistical Program for Social Science) version 20.Qualitative data was presented as number and percentage.Quantitative data was presented as mean ± standard deviation (SD) if normally distributed, and median and range if skewed. ANOVA and Post Hoc test used to compare the significance between groups. The accepted significance level was below 0.05.

Ethical committee approval: The study was approved by the Ethics Board of Benha University and an informed written consent was taken from each participant in the study.

RESULTS

Our results showed that there is a high significant difference between athletes with and without LVH and HCM ($p < 0.001$) regarding age while there is no significant difference between groups considering BMI, Body surface area, HR, SBP_{Rest} , $SBP_{Post\text{-}Ex}$, DBP_{Rest} and $DBP_{Post\text{-}Ex}$(Table 1). There is a significant difference between groups regarding LV end-diastolic diameter, LV volume/mass and Relative wall thickness. Also, there is a significant difference between athletes with moderate LVH and HCM &control groups considering LV end-systolic diameter and LVEF. There is a significant difference between athletes with moderate LVH and HCM group as regards IVS while no significant difference between groups regarding Left atrial diameter and Stroke volume index (Table 2).

Table 1. Demographic and clinical data of study groups

	Athletes with LVH	Athletes without LVH	HCM group	Control group	ANOVA test	Post Hoc test
Age (year)	25.61 ±12.4	27.23 ±14.7	47.53 ±15.7	31.29 ±11.2	< 0.001**	P1 <0.001** P2 <0.001** P3 <0.001**
BMI (kg/m^2)	22.73 ±5.8	23.81 ±5.2	23.52 ±5.8	25.16±7.2	0.173	-
Body surface area (m^2)	2.1 ± 1.6	2.2 ± 1.4	1.8 ± 1.7	1.8 ± 1.6	0.326	-
HR (b/min)	82.33 ±35.6	75.17 ±31.2	78.51 ±30.6	71.26 ±28.1	0.531	-
SBP_{Rest} (mmHg)	128.64±14.2	122.81±11.6	124.22±12.8	118.64±14.2	0.286	-
$SBP_{Post\text{-}Ex}$ (mmHg)	186.2±8.5	174.2±11.3	181.7±10.1	166.4±12.5	0.715	-
DBP_{Rest} (mmHg)	77.50 ±14.6	79.42 ±15.2	74.18 ±12.4	77.26 ±16.2	0.426	-
$DBP_{Post\text{-}Ex}$ (mmHg)	57.10±18.1	60.23±16.4	59.82±17.5	62.51±19.7	0.742	-

P1= Athletes with LVH vs HCM P2= Athletes with LVH vs control P3= Athletes without LVH vs HCM ** High significant

Table 2. Comparison of ECHO characteristics between study groups

	Athletes with LVH	Athletes without LVH	HCM group	Control group	ANOVA test	Post Hoc test
LV end-diastolic diameter (mm)	60.14 ±15.6	52.33 ±12.4	47.14 ±18.7	45.88 ±19.2	<0.001**	P1 <0.001** P2 <0.001** P3 <0.001**
LV end-systolic diameter (mm)	34.62 ±12.7	31.38±14.4	27.13±17.2	24.35 ±19.4	<0.001**	P1 <0.001** P2 <0.001** P3 = 0.146
LV volume/mass (g)	305.34±58.4	197.61±33.5	157.52±54.8	144.04±21.2	<0.001**	P1 <0.001** P2 <0.001** P3 = 0.031*
Left atrial diameter (mm)	38.17 ± 15.2	35.74 ± 17.6	43.29 ± 13.3	35.52 ± 17.9	0.172	-
IVS (mm)	12.53 ± 5.6	10.17 ± 5.6	11.81 ± 6.2	8.54 ± 5.3	0.025*	P1 =0.133 P2 =0.018* P3 =0.181
Relative wall thickness	0.42 ± 0.04	0.33 ± 0.05	0.57 ± 0.03	0.35 ± 0.06	<0.001**	P1 <0.001** P2 <0.001** P3 <0.001**
LVEF (%)	57.36 ±5.4	60.57 ±4.2	62.18 ±6.4	65.50 ±5.3	<0.001**	P1 <0.001** P2 <0.001** P3 = 0.417
Stroke volume index (mL/m2)	42.13 +7.1	46.27 +4.8	35.24 +9.3	42.82 +6.5	0.071	-

P1= Athletes with LVH vs HCM* significant
P2= Athletes with LVH vs control** High significant
P3= Athletes without LVH vs HCM

Table 3. Comparison of tissue spectral Doppler imaging characteristics between study groups

	Athletes with LVH	Athletes without LVH	HCM group	Control group	ANOVA test	Post Hoc test
E wave (cm/s)	82.15 ±42.7	94.31 ±37.5	80.29 ±45.2	85.55 ±39.1	0.248	-
A wave (cm/s)	55.16 ±25.2	51.35 ±33.7	72.21 ±30.2	53.14 ±27.5	0.041*	P1 =0.002* P2 =0.317 P3 =0.129
E/A ratio	1.5 ±0.4	1.8 ±0.2	1.1±0.6	1.6 ±0.4	0.003*	P1 =0.001* P2 =0.145 P3 =0.072
E time deceleration (msec.)	164.24 ±62.2	192.81±74.6	241.15 ±83.2	176.52 ±68.5	0.013*	P1 =0.011* P2 =0.253 P3 =0.183
TDI éwave (cm/s)	12.56 ±1.9	12.87 ±2.7	9.18 ±2.4	13.71 ±2.5	<0.001**	P1 <0.001** P2 =0.162 P3 <0.001**
TDI á wave (cm/s)	7.74 ±1.6	7.41 ±2.5	6.71 ±2.9	9.26 ±1.7	0.261	-
TDI é/á ratio	1.6 ±0.5	1.7 ±0.4	1.4 ±0.7	1.6 ±0.5	0.613	-
TDI swave (cm/s)	7.13 ±2.2	9.44 ±1.5	8.74 ±1.8	10.21 ±1.2	0.181	-

P1= Athletes with LVH vs HCM* significant P2= Athletes with LVH vs control** High significant P3= Athletes without LVH vs HCM

Table 4. Comparison of speckle tracking echocardiography characteristics between study groups

		Athletes with LVH	Athletes without LVH	HCM group	Control group	ANOVA test	Post Hoc test
Global longitudinal strain (GLS) (%)	2D	17.31 ±3.60	19.85 ±2.12	14.81 +1.32	18.63 ±2.61	0.002*	P1 =0.001* P2 = 113 P3 =0.151
	3D	17.53 ±3.49	18.06 ±3.18	14.12 ±1.51	18.15 ±2.52	0.001*	P1 =0.003* P2 =0.322 P3 =0.518
3D global radial Strain (GRS) (%)		47.53 ±13.49	46.17 ±12.63	40.12 ±15.66	50.92 ±11.25	0.001*	P1 <0.001** P2 = 0.291 P3 =0.026*
3D global area strain (GAS) (%)		31.44 ±13.49	31.72 ±13.28	25.66 ±15.19	32.31 ±12.11	0.001*	P1 <0.001** P2 = 0.411 P3 =0.013*
3D global circumferential strain (GCS) (%)		17.24 ±4.16	18.66 ±3.11	17.45 ±4.03	18.32 ±3.26	0.183	-

P1= Athletes with LVH vs HCM P2= Athletes with LVH vs control P3= Athletes without LVH vs HCM* Significant
** High significant

Table 5. Receiver Operator Characteristics Analysis for distinguishing Hypertrophic Cardiomyopathy from athlete's heart

	Cutoff	AUC	Sensitivity (%)	Specificity (%)	p-Value
LV end-diastolic diameter (mm)	< 54	0.961	98%	96%	< **0.001****
Left atrial diameter (mm)	<42	0.927	92%	75%	< **0.001****
A-wave (cm/s)	> 45	0.735	73%	68%	< **0.001****
TDI e\ (cm/s)	< 11.8	0.817	84%	64%	< **0.001****

** High significant

Considering Doppler imaging, there is a significant difference between athletes with LVH and HCM group regarding A wave (HCM has higher measure 72.21 vs 55.16 cm/s), E time deceleration (HCM has higher measure 241.15 vs 164.24 msec.), E/A ratio (athletes with LVH has higher measure 1.5 vs 1.1) and TDI e\wave (athletes with LVH has higher measure 12.56 vs 9.18 cm/s). However, there is no significant difference between groups considering E wave, TDI a\wave, TDI e\/a\ratio and TDI swave (Table 3). Regarding speckle tracking echocardiography, there is a significant difference between athletes with LVH and HCM group regarding 2D & 3D GLS, GRS and GAS (where these measures were higher in athletes with LVH). Also, there is a significant difference between Athletes without LVH and HCM group GRS and GAS (where these measures were higher in athletes without LVH) while no significant difference between groups regarding GCS (Table 4). LV end-diastolic diameter has the highest sensitivity (98%) with cutoff < 54 mm for distinguishing HCM from athletes with or without moderate LVH with high significance ($p < 0.001$) (Table 5).

DISCUSSION

Differentiation between physiological and pathological left ventricular hypertrophy (LVH) is essential, as hypertrophic cardiomyopathy (HCM) is the main cause of sudden cardiac death in young athletes (Kim *et al*., 2012). Our study reported a large experience in Athlete's with moderate LVH and differentiating them from patients with Hypertrophic cardiomyopathy (HCM). Their early diagnosis will be then compared to the results of those with HCM. As regarding Comparison of ECHO characteristics between study groups, the following parameters differed significantly between groups First and third groups (LV end-diastolic diameter, LV end-systolic diameter, Relative wall thickness, LVEF). There was no significant difference regrading IVS, it was only noted between Athletes with LVH vs control. Similar Echo results were observed in the study of Ternacle *et al*., (2017) They concluded that, LVH Indexed septal wall thickness > 7 mm/m2was observed in12% ($n = 3$) of athletes with moderate LVH and in 24% of patients with HCM. Compared to athletes with moderate LVH, patients with HCM were more likely to have LV end-diastolic diameter < 51 mm with a concentric remodeling (RWT 0.54 ± 0.07 vs. 0.45 ± 0.05; $P = 0.0001$) and smaller 2Dand 3D LV volumes (Table 1). No difference was observed for left atrial diameter. Compared to athletes with moderate LVH, patients with HCM had a delayed relaxation pattern (E/A < 1) and a longer E wave deceleration time. Regarding comparison of tissue spectral Doppler imaging characteristics between study groups, there was statistically significant difference between Athletes with LVH vs HOCM (P1) regarding (A wave, E/A ratio, E time deceleration, TDI e\ wave). TDI e\ wave also differentiated between Athletes without LVH vs HOCM. This parameter showed great efficacy in diagnosing and excluding HCM in athletes. These results were concomitant with Utomi (2015), they reported that, despite the lack of between group differences in TDI data, we observed that highly trained RT had a lower peak longitudinal ε and peak SRS than ET, although neither RT or ET were significantly different from CT. Whilst there is limited data related to STE in athletes, the current ET data agrees with Stefani *et al* who reported no differences in LV STE measurements between 20 endurance athletes and 18 controls (Stefani *et al*., 2009). We found additional aid in the differential diagnosis from analysis of the pulsed Doppler and TDI markers of LV diastolic function, in that the LV filling pattern was normal in all athletes but altered in about 25% of patients with HC. The present analysis confirms, therefore, the potential utility for the diagnosis of Doppler-derived indexes, as previously reported by (Lewis *et al*., 1992) and suggest that the e\ (early diastolic) peak-velocity threshold of <11.5 cm/sec on TDI may be useful to raise suspicion for non-physiologic LV hypertrophy. This finding confirms that LV remodeling in athletes is associated with normal or increased indexes of myocardial relaxation, as an expression of normal or increased elastic recoil, different from patients with HC, in whom diastolic dysfunction may be the first expression of the disease and may precede the development of LV hypertrophy (Kitaoka *et al*., 2013). To assess three-dimensional speckle tracking echocardiography for the preclinical diagnosis of hypertrophic cardiomyopathy, Kleijn *et al*., (2012) concluded that detection early changes in myocardial mechanics in hypertrophic cardiomyopathy (HCM) mutation carriers, three-dimensional speckle tracking echocardiography (3DSTE) was used for screening of family members in the HCM population. Eighty subjects were divided as: HCM mutation carriers (n = 23), manifest HCM patients (n = 28), and normal controls (n = 29). They prospectively underwent 3DSTE for left atrial (LA) and left ventricle (LV) strain analysis. HCM mutation carriers showed significantly higher LA minimum volume (ml/m^2) (17 ± 6 vs. 14 ± 4, respectively, P = 0.03) and a significantly lower peak atrial longitudinal strain (PALS) (%), (27 ± 5 vs. 31 ± 7, respectively, P = 0.02) when compared to controls. However, no differences were found in global or regional LV systolic myocardial deformation between both groups.

Conclusion

Most of conventional echocardiography methods can be used to differentiate patients with HCM and athletes with moderate LVH, but none of them had enough sensitivity or specificity to exclude HCM. We demonstrated that a preserved 2D and 3D longitudinal strain function and the absence of LV dyssynchrony can be used to exclude HCM, while abnormal longitudinal function associated with dyssynchrony is specific to HCM.

REFERENCES

Kim, J. H., Malhotra, R., Chiampas, G., d'Hemecourt, P., Troyanos, C., Cianca, J. *et al*. 2012. Cardiac arrest during long-distance running races. New England Journal of Medicine, 366(2), 130-140.

Elliott, P. M., Anastasakis, A., Borger, M. A., Borggrefe, M., Cecchi, F., Charron, P. *et al*. 2015. 2014 ESC guidelines on diagnosis and management of hypertrophic cardiomyopathy. Revista Espaola de Cardiolog*La* (English Edition), 1(68), 63.

Yiu, K. H., Atsma, D. E., Delgado, V., Ng, A. C., Witkowski, T. G., Ewe, S. H., *et al*. 2012. Myocardial structural alteration and systolic dysfunction in preclinical hypertrophic cardiomyopathy mutation carriers. PLoS One, 7(5), e36115.

Monte, I. P., Mangiafico, S., Buccheri, S., Bottari, V. E., Lavanco, V., Arcidiacono, A. A., *et al*. 2015. Myocardial deformational adaptations to different forms of training: a real-time three-dimensional speckle tracking echocardiographic study. Heart and vessels, 30(3), 386-395.

Lim, P., Buakhamsri, A., Popovic, Z. B., Greenberg, N. L., Patel, D., Thomas, J. D., *et al*. 2008. Longitudinal strain delay index by speckle tracking imaging. Circulation, 118, 1130-1137.

Kim, J. H., Malhotra, R., Chiampas, G., d'Hemecourt, P., Troyanos, C., Cianca, J., *et al*. 2012. Cardiac arrest during long-distance running races. New England Journal of Medicine, 366(2), 130-140.

Ternacle, J., Bremont, C., d'Humieres, T., Faivre, L., Doan, H. L., Gallet, R., *et al*. 2017. Left ventricular dyssynchrony and 2D and 3D global longitudinal strain for differentiating physiological and pathological left ventricular hypertrophy. Archives of cardiovascular diseases, 110(6-7), 403-412.

Utomi, V. S. 2015. The "Athletic Heart": Insights From Modern Imaging Tools In Caucasian And West African Athletes (Doctoral dissertation, Liverpool John Moores University).

Stefani L, De Luca A, Toncelli L, Pedrizzetti G, Galanti G. 2014. 3D strain helps relating LV function to LV and structure in athletes. Cardiovasc Ultrasound.;12:33.

Lewis, J. F., Spirito, P., Pelliccia, A., & Maron, B. J. 1992. Usefulness of Doppler echocardiographic assessment of diastolic filling in distinguishing "athlete's heart" from hypertrophic cardiomyopathy. Heart, 68(9), 296-300.

Kitaoka, H., Kubo, T., Hayashi, K., Yamasaki, N., Matsumura, Y., Furuno, T., *et al*. 2013. Tissue Doppler imaging and prognosis in asymptomatic or mildly symptomatic patients with hypertrophic cardiomyopathy. European Heart Journal–Cardiovascular Imaging, 14(6), 544-549.

Kleijn, S. A., Pandian, N. G., Thomas, J. D., Perez de Isla, L., Kamp, O., Zuber, M. *et al*. 2015. Normal reference values of left ventricular strain using three-dimensional speckle tracking echocardiography: results from a multicentre study. European Heart Journal-Cardiovascular Imaging, 16(4), 410-416.

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