NORSKE ABSTRAKTER PRESENTERT PÅ EUROECHO-IMAGING 2017

Automatic measurements of left ventricular longitudinal function for inexperienced users

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Introduction: Automatic measurements of indices reflecting left ventricular (LV) function could be advantageous for inexperienced users of pocket-sized ultrasound devices when evaluating patients with suspected or known LV dysfunction. We have developed an automatic algorithm that measures the mitral annular plane systolic excursion (MAPSE) from color tissue Doppler (CTD) recordings.

Purpose: To compare automatic MAPSE measurements from recordings by medical students with minimal training with reference measurements by clinicians, and to evaluate the potential of using the automatic measurements to detect LV dysfunction.

Materials and methods: Stationary ultrasound scanners were used. Medical students (n=39) were given a 15 minute instruction on how to acquire an apical four-chamber view. Patients (n=75) underwent a conventional echocardiographic examination by clinicians, who evaluated LV function according to guidelines. LV dysfunction was defined as ejection fraction <50% or signs of elevated filling pressure. The clinicians measured MAPSE using M-mode. Each patient was subsequently examined by a student, and their CTD recordings were stored. The image quality was graded from 1 to 6, where a score ≥3 was defined as adequate, and these recordings were included in the further analysis (off-line). The performance of the automatic MAPSE measurements (applied to the students recordings) to detect LV dysfunction was evaluated by receiver-operating characteristics (ROC) analysis.

Results: The median number of patients examined by the students was 2 (1st–3rd quartile: 1–2). Adequate quality was seen in 66 (88%) of the students' recordings, of which 20 (27%) patients had LV dysfunction. The automatic algorithm correctly identified and tracked the mitral annulus in 48 (73%) of the adequate recordings. 32 (82%) of the students acquired at least 1 adequate recording where the algorithm tracked the mitral annulus. The mean difference ± standard deviation between automatic and reference measurements of MAPSE was -0.4±3.2 mm. The area under the ROC curve (AUC) was 0.861. Automatic MAPSE ≤11 mm provided 80% sensitivity, 78% specificity, 62% positive predictive value and 90% negative predictive value for detection of LV dysfunction.

Conclusion: With minimal training, 82% of the medical students were able to acquire an adequate four-chamber view with successful automatic MAPSE measurement. The discriminating ability between normal and LV dysfunction was good, despite moderate agreement with the reference measurements of MAPSE. Along with more training in image acquisition, the algorithm can be helpful for inexperienced ultrasound operators when assessing patients.

Early morphological changes in preadolescent athletes assessed by three-dimensional echocardiography

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Background: Athlete's heart is a term used to describe the morphological and functional changes in the hearts of athletes competing in endurance sports. Recent studies suggest that these changes may occur even in preadolescent athletes.

Purpose: This study aims to further describe the morphological and functional changes in the left ventricle (LV) of preadolescent endurance athletes using three-dimensional (3D) echocardiography.

Methods: Seventy-six cross-country skiers aged 12.1±0.2 years were compared to a control group of 25 non-competing individuals aged 12.1±0.30 years. Echocardiography was performed in all subjects, including 3D acquisitions and 3D LV volumes, ejection fraction (EF), stroke volume, cardiac output and LV mass were assessed.

Results: The cross-country skiers engaged in on average 7.0±2.4 hours of endurance training per week, while the non-competing individuals

self-reported on average 1.8±2.4 hours of physical exercise per week. There were no differences between the two groups with regards to 3D LV volumes, EF and stroke volume (Table). However, 3D LV mass and 3D LV mass corrected for BSA yielded significant differences.

Conclusion: The results of this study support the notion that changes related to athlete's heart can be seen as early as in preadolescence and is the first study to describe these early morphological changes using 3D echocardiography.

Table. *Left ventricular three-dimensional echocardiographic data.*

	Athletes (n=76)	Controls (n=25)	p-value
Resting heart rate, bpm	72±12	80±20	0.01
LV end-diastolic volume, ml	100±14	96±14	0.23
LV end-systolic volume, ml	44±7	41±7	0.11
Ejection fraction, %	56±3	57±3	0.19
Stroke volume, ml	56±8	55±8	0.52
Cardiac output, l/min	3.9±0.9	4.4±0.9	0.03
LV Mass, g	92±10	87±8	0.03
LV Mass/BSA, g/m^2	69±6	64±7	0.001

Data expressed as mean±SD. Right column shows P-values for Student's t-test.

Early morphological changes and myocardial function assessed by strain echocardiography in preadolescent athlete's heart

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Background: Few studies have examined changes in myocardial deformation in preadolescent athletes competing in endurance sports. Previous studies are reporting conflicting results with both increased and decreased longitudinal deformation with or without changes in circumferential deformation.

Purpose: This study aims to improve our understanding of the changes occurring in the preadolescent athlete's heart with the use of strain echocardiography and traditional echocardiographic measures.

Methods: Seventy-six cross-country skiers aged 12.1±0.2 years were compared to a control group of 25 non-competing individuals aged 12.1±0.30 years. Echocardiography was performed in all subjects including speckle-tracking strain echocardiography. Peak longitudinal strain was assessed in 18 LV segments; peak circumferential strain was assessed in 6 LV segments. Left ventricular (LV) mass was calculated by the Devereux' formula.

Results: The cross-country skiers engaged in on average 7.0±2.4 hours of endurance training per week, while the non-competing individuals self-reported on average 1.8±2.4 hours of physical exercise per week. The athletes had a significantly increased E/A-ratio, inter-ventricular septal thickness, LV posterior wall thickness and LV mass (Table). There was no difference in LV end-diastolic diameter, ejection fraction, E/e`, global longitudinal and circumferential strain between the groups.

Conclusion: Athletes had thicker myocardium and greater LV mass compared to non-competing individuals, while cardiac function including longitudinal and circumferential function did not differ. This study supports the notion that myocardial function at rest remains unchanged in preadolescent athletes with physiological, adaptive remodeling of the heart.

Table.

	Athletes (n=76)	Controls (n=25)	p-value
Interventricular septum thickness, cm	0.75±0.09	0.68±0.16	0.01
Left ventricular end-diastolic diameter, cm	4.40±0.43	4.33±0.39	0.45
Left ventricular posterior wall diameter, cm	0.67±0.10	0.61±0.13	0.01
LV Mass/BSA, g/m^2	68±19	57±13	<0.001
E/A-ratio	2.14±0.47	1.75±0.39	<0.001
E/e'	12±2	12±1	0.71
Ejection fraction, %	56±3	57±3	0.19
Global longitudinal strain, %	-23.0±2.0	-23.0±2.3	0.96
Global circumferential strain, %	-23.7±4.7	-23.0±2.9	0.52

Data expressed as mean±SD. Right column shows P-values for Student's t-test.

Absolute measures of right ventricle, but not indexed values, are markers of ventricular arrhythmia in female arrhythmogenic cardiomyopathy patients

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Background: Arrhythmogenic cardiomyopathy (AC) is an inheritable heart disease associated with high risk of life-threatening ventricular arrhythmias. Disease penetrance in AC is higher in men, and most studies on markers for ventricular arrhythmia include predominantly male subjects. Task Force Criteria of 2010 suggests indexing diameters by body surface area, but the applicability to female patients is not studied.

Purpose: To explore echocardiographic Task Force Criteria

of 2010 parameters and their relation to ventricular arrhythmias in female AC patients.

Methods: We examined female AC patients by echocardiography. Right ventricular (RV) fractional area change (RV FAC) was measured, along with RV basal diameter (RVD) and RV outflow tract diameter (RVOT) which were reported as absolute and indexed values. We also assessed left ventricular ejection fraction (LVEF). Ventricular arrhythmia was defined as sustained ventricular tachycardia or fibrillation, aborted cardiac arrest or appropriate therapy from an implantable cardioverter-defibrillator.

Results: We included 79 female AC patients (42% probands, age 42±16 years), of which 26 (33%) had experienced ventricular arrhythmia (Table). RV FAC was worse in women with than without ventricular arrhythmia. RVOT and RVD were markers of ventricular arrhythmia only as absolute values. LVEF did not differ between the groups.

Conclusions: RV FAC and absolute RV dimensions were markers of ventricular arrhythmia, while indexed dimensions were not. Evaluation of female AC patients should not rely on indexed values established in predominantly male studies. Further studies on imaging markers in female AC patients are warranted.

	No VA, n=53	VA, n=26	p-value
RVD (mm)	36±5	45±9	<0.001
RVDi (mm/m²)	19±4	21±3	0.28
RVOT (mm)	31±5	36±9	0.01
RVOTi (mm/m²)	17±4	17±4	0.71
RV FAC (%)	46±7	35±9	<0.001
LVEF (%)	58±5	58±7	0.83

Values are mean ± SD, compared by Students t-test. LVEF = left ventricular ejection fraction, RV FAC = right ventricular fractional area change, RVDi = indexed right ventricular diameter, RVOTi = indexed right ventricular outflow tract diameter, VA = ventricular arrhythmia.

Harmful effects of exercise intensity and exercise duration in patients with arrhythmogenic cardiomyopathy

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Background: Vigorous exercise accelerates and aggravates arrhythmogenic cardiomyopathy (AC), but there is no data separating the harmful effects of exercise intensity and duration in these patients.

Purpose: To explore the impact of exercise intensity and duration on the prevalence of abnormal cardiac function in AC.

Methods: In a cross-sectional study of AC patients diagnosed between 2008 and 2016, exercise history prior to diagnosis was recorded by standardized interviews. Exercise intensity was categorized according to the reported physical activity, and exercise >6 metabolic equivalents (METs) was defined as high intensity. Exercise duration was recorded as hours/week, and categorized as long if above median. By echocardiography, left ventricular (LV) dysfunction was defined as ejection fraction <54% (females) or <52% (males), or global longitudinal strain, defined as the average peak negative strain from 16 LV segments, worse than -18%. Right ventricular (RV) dysfunction was defined as fractional area change ≤40% or tricuspid annular plane systolic excursion <17mm, and RV dilation was defined as RV basal diameter >41mm or proximal RV outflow tract in parasternal short-axis view ≥32mm.

Results: We included 173 AC patients (53% probands, 44% female, age 41±16 years) with detailed exercise information for a median of 10 (range 3-70) years until the time of diagnosis. Median weekly exercise duration was 2.5 (range 0.2-20.0) hours, and mean exercise intensity was 6.7±1.8 METs. 91 subjects (52%) reported high

Radar plots from 173 AC patients

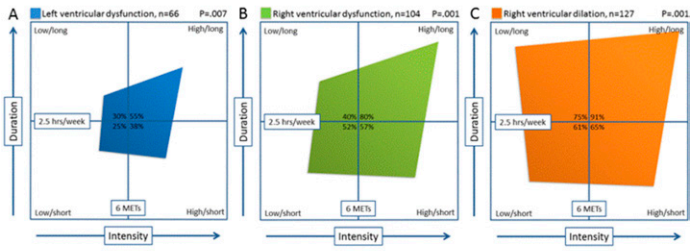

Figure – Modified radar plots of the distribution of LV dysfuncion (A), RV dysfuncion (B) and RV dilation (C) in 173 AC patients cathegorized into four groups of exercise intensity high or low (above/below 6 METs) and exercise duration long or short (more/less than 2.5 hours per week). P-values by Chi-Square test.
AC = arrhythmogenic cardiomyopathy, LV = left ventricle, METs = metabolic equivalents, RV = right ventricle.

intensity exercise. LV dysfunction was evident in 66 patients (38%), and was most prevalent in patients with high intensity and long duration exercise (Figure, panel A). High intensity exercise was associated with LV dysfunction independently of long duration (adjusted Odds Ratio (OR) 2.2 (95%CI 1.1-4.5), p=0.03). RV dysfunction was found in 104 patients (60%), and was associated with high intensity exercise (Figure, panel B) independently of long duration exercise (adjusted OR 2.6 (95%CI 1.2-5.3), p=0.01). RV dilation was observed in 127 patients (73%) and was associated with long duration exercise (Figure panel C) independently of high intensity exercise (adjusted OR 3.2 (95%CI 1.3-7.6), p=0.008).

Conclusions: High intensity exercise was a strong and independent marker of LV and RV dysfunction, and long duration exercise was a strong and independent marker of RV dilation. These important insights add to our understanding of the harmful effects of exercise in AC, and may guide exercise advice to these patients.

Echocardiography in prediction of life-threatening ventricular arrhythmia in patients with arrhythmogenic cardiomyopathy

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Background: Arrhythmogenic cardiomyopathy (AC) is an inheritable heart disease characterized by high risk of life-threatening ventricular arrhythmias (VA). Echocardiography is useful in diagnosis, but the prognostic value of abnormal findings in early disease is poorly documented.

Purpose: To explore the value of echocardiographic parameters for predicting VA in AC.

Methods: In this prospective single center study, echocardiography was performed in all AC patients at time of diagnosis. Right ventricular (RV) basal diameter (RVD) and RV outflow tract (RVOT) diameter were measured. RV longitudinal strain (RVLS) was defined as the average peak negative strain from 3 RV free wall segments, and RV mechanical dispersion was defined as the standard deviation of time from Q/R on ECG to peak negative strain in 6 RV segments. Left ventricular (LV) function was assessed by ejection fraction (EF) and LV global longitudinal strain (GLS) defined as the average peak negative strain from 16 LV segments. LV mechanical dispersion was defined as the standard deviation of the times from Q/R on ECG to peak negative strain in 16 LV segments. VA was defined as sustained ventricular tachycardia, ventricular fibrillation, aborted cardiac arrest or appropriate therapy from an implantable cardioverter-defibrillator. Patients with previous VA were excluded, and the time from diagnosis to first VA during follow-up was recorded prospectively.

Results: Of 178 AC patients, 61 (34%) were excluded due to VA at or prior to presentation and therefore, 117 patients (29% probands, 50% female, age 40±17 years) were followed for a median of 6.0 (range 0.1-18.6) years. 18 (15%) patients experienced VA during follow-up. RV dimensions were greater and parameters of RV and LV function were worse in patients with future VA than in patients without future VA (RVD 45±7mm vs 38±6mm; p<0.001, RVOT 38±8mm vs 33±6mm; p<0.001, RVLS -18.4±5.7% vs -25.9±5.8%; p<0.001, RV mechanical dispersion 47±20ms vs 33±17ms; p=0.004, LVEF 52±12% vs 58±5%; p=0.001, GLS -16.7±4.3% vs -20.0±2.4%; p<0.001, LV mechanical dispersion 62±31ms vs 36±13ms; p<0.001). RVLS and LV mechanical dispersion were independent risk markers of future VA (adjusted Hazard Ratios 1.1 (95%CI 1.0-1.2, p=0.02), and 1.2 (95%CI 1.0-1.4, p=0.04), respectively). ROC analyses suggested optimal cut-off value for RVLS worse than -23% and for LV mechanical dispersion ≥45ms to identify future VA (Figure, left panel). Patients with both these markers had the worst prognosis, while those without these markers had favorable outcome (Figure, right panel).

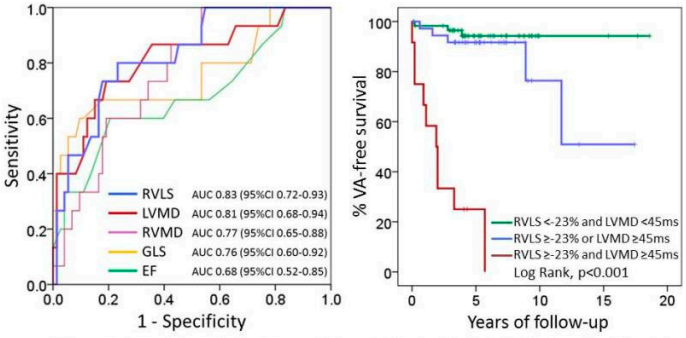

Figure – ROC curves (left panel) of parameters of myocardial function in detection of life-threatening VA during follow-up of 117 AC patients. Kaplan-Meier curves of VA-free survival of the same AC patients divided by the optimal cut-off values: RVLS better or worse than -23% and LVMD above or below 45ms (right panel). AC = arrhythmogenic cardiomyopathy, EF = ejection fraction, GLS = global longitudinal strain, LS = longitudinal strain, LV = left ventricle, MD = mechanical dispersion, RV = right ventricle, VA = ventricular arrhythmia.

ROC and KM-curves of 117 AC patients

Conclusions: LV mechanical dispersion and RVLS were excellent and independent predictors of VA in patients with AC. The combination of these markers indicated most unfavorable prognosis and may be helpful in risk stratification of VA in AC patients.

Echocardiography can differentiate between athlete's heart and hypertrophic cardiomyopathy genotype positive with mild phenotype

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Background

Hypertrophic cardiomyopathy (HCM) is an important cause of sudden cardiac death in athletes.

It is well known that severe HCM and athlete's heart differ in volumes, wall thickness and diastolic function. The differentiation, however, between athlete's heart and mild phenotypic HCM is not fully explored by novel echocardiographic techniques.

Purpose

To assess the role of speckle tracking and 3D echocardiography in differentiation between athlete's heart and HCM genotype positive with mild left ventricular hypertrophy.

Methods

We included volunteer healthy competitive endurance elite and elite master athletes and compared them to otherwise healthy, untrained HCM genotype positive with a mild HCM phenotype of maximal LV wall thickness 12-16 mm. Patients with concomitant valvular disease, left ventricular outflow tract obstruction, atrial fibrillation, hypertension, coronary artery disease, diabetes mellitus or pacemaker/ICD were excluded. We assessed left ventricular (LV) volumes, ejection fraction (EF) and mass by 3D-echocardiography. Global longitudinal strain (GLS) was calculated as the average of peak longitudinal shortening from a 16 LV segments model. Mechanical dispersion was defined as the standard deviation of time from onset of Q/R on ECG to peak longitudinal strain in 16 segments.

Results

We included 30 competitive endurance athletes (7% female, age 41±9 years). Of 92 mutation-positive family members identified by cascade genetic screening, 20 patients (15% female, age 51±12 years) were self-reportedly healthy with a mild HCM phenotype with maximum LV wall thickness 13±1 mm. Athletes and HCM genotype positive had similar indexed LV mass (66±7g/m^2 vs 62±9g/m^2, p=0.13) and LVEF (55±5% vs 57±6%, p=0.16), but athletes had greater indexed LV volumes (end-diastolic volume 90±16 ml/m^2 vs 56±9 ml/m^2, p<0.001) and superior diastolic function (e' 11±2cm/s vs. 7±2cm/s, p<0.001, and E/e' 5.5±1.2 vs. 9.8±4.5, p<0.001). Athletes and HCM genotype positive had similar GLS (-18.9±1.8% vs. -18.1±3.7, p=0.28), but mechanical dispersion was more pronounced in HCM (40±11ms vs. 54±16ms, p=0.001). By ROC analysis, LV mechanical dispersion ≥44ms optimally discriminated between athletes and HCM genotype positive (area under the curve, 0.78, 95% confidence interval 0.65-0.91).

Conclusion

In athletes and HCM genotype positive with similar LV mass, 3D LV volumes were lower and mechanical dispersion higher in HCM genotype positive. These results may help differentiation in early phase of HCM disease.

Favorable diastolic function and increased left ventricular volumes in hypertrophic cardiomyopathy patients engaging in vigorous exercise

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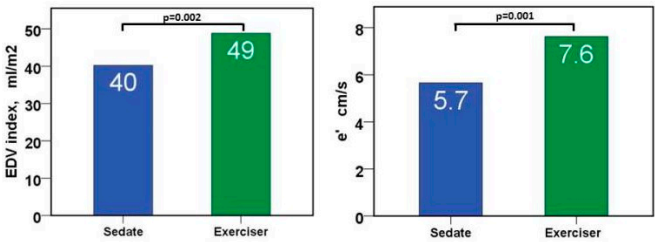
Introduction

Vigorous exercise is associated with left ventricular (LV) dilation and better diastolic LV function in healthy subjects. It is not known how vigorous exercise affects LV morphology and function in patients with hypertrophic cardiomyopathy (HCM).

Mean end-diastolic volume index (left panel) and mean e' (right panel) in 87 sedate (blue bars) and 34 vigorously exercising (green bars) Hypertrophic cardiomyopathy patients.



HCM exerciser barcharts

Purpose

We aimed to evaluate the impact of vigorous exercise on LV morphology and function in HCM patients.

Methods

We invited HCM patients from our cardiomyopathy clinic to complete a questionnaire on physical activity. Vigorous exercise was defined as physical activity with intensity ≥6 metabolic equivalents and we calculated ongoing weekly hours of vigorous exercise. We defined patients with ongoing vigorous exercise as regular exercisers

By echocardiography, we measured maximum wall thickness (MWT), indexed LV enddiastolic volume (EDVi) and end systolic volume (ESVi). Systolic LV function was assessed by ejection fraction (EF) and global longitudinal strain (GLS). Diastolic LV function was evaluated by transmitral pulsed wave Doppler and average e' tissue Doppler samplings.

Results

Physical activity questionnaire was completed by 121 HCM patients (age 55±13 years, 39% female). Thirtyfour (28%) were regular exercisers and 87 (72%) did not vigorously exercise. Regular exercisers had median weekly vigorous exercise 2.8 (range 0.8 12.0) hours/week, while nonexercisers did not engage in vigorous exercise. Age was similar between regular exercisers and nonexercisers (51±13 vs. 56±14years, p=0.09) and gender was equally distributed (p=0.18).

Regular exercisers had larger EDVi (49±16 ml/m2 vs. 40±12ml/m2, p=0.002), greater ESVi (19±7 ml/m2 vs. 15±6ml/m2, p=0.001) and thinner MWT (17±3mm vs. 20±4mm, p=0.004) compared to nonexercisers. Regular exercisers and non exercisers had similar EF (60±5% vs. 62±7%, p=0.12) and GLS (17.3±3.6% vs. 16.3±3.5%, p=0.15). Regular exercisers had higher e' (7.6±3.1cm/s vs. 5.7±2.3cm/s, p=0.001) and lower E/e' (10.6±4.2 vs. 16.0±9.2, p=0.004) than nonexercisers.

Conclusions

HCM patients engaging in regular vigorous exercise had larger left ventricular volumes, thinner MWT and better diastolic function than nonathletes. Our findings indicate no harmful remodelling of exercise and might indicate favourable effects of active exercise in HCM

Feasibility and reliability of focused echocardiographic imaging by nurses supported by interpretation via telemedicine in an outpatient heart failure clinic

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Background/introduction

Telemedicine has the potential to reduce geographical diversity challenges and health care expenditure. Including telemedicine at remote outpatient clinics may allow for better diagnostics by providing a platform for expert support

Purpose

To evaluate the feasibility and reliability of focused echocardiographic imaging of heart failure (HF) patients by caregiving nurses in an outpatient clinic, supported by near real-time telemedical interpretation via an experienced cardiologist by telemedicine.

Methods

Three nurses examined 50 HF patients from an outpatient clinic with focused echocardiography by assessment of, among others, left atrial (LA) and ventricular (LV) size and function. The recordings were transferred to a cloud data storage model by dedicated software, for near real-time interpretation by an out of hospital cardiologist. Reference method was echocardiography by one of four experienced physician echocardiographers.

Results

Median (range) age of the 50 HF patients (46% women) was 79 (33-95) years. By the telemedicine approach the assessment LA and LV structures and function were feasible in >94%. The time spent on echocardiographic recordings by the nurses and for the total telemedicine approach was median (range) 0.5 (0.3-1.2) hours and 1.3 (0.8-2.4) hours, respectively. Additional data is shown in the table below. The correlations with reference for quantification of LV end-diastolic volume, LV ejection fraction, LV internal

	Telemedicine approach, mean (SD)	Reference method, mean (SD)	P-value difference
LV end-diastolic volume (ml)	110 (33)	112 (38)	0.63
LV ejection fraction (%)	42 (12)	43 (11)	0.33
LV internal end-diastolic diameter (mm)	49 (8)	53 (11)	***<0.001***
LA end-systolic volume index (ml/m^2)	62 (19)	60 (12)	0.34
Mitral inflow early velocity (cm/s)	86 (46)	83 (47)	0.24

Abbreviations: LV; left ventricle, LA; left atrium

diameter, indexed LA end-systolic volume and mitral early inflow velocity were r = 0.74-0.96.

Conclusions

Echocardiographic imaging obtained by nurses in an outpatient HF clinic, supported by the interpretation of echocardiographic recordings by a cardiologist via a telemedical approach was feasible and reliable. This may reduce geographical disparities and allow for more patients benefiting from the advantages of implementing focused echocardiography by non-cardiologists in diagnostics and follow-up.