

A Prospective Assessment of Myocardial Contractility in Young African Americans: Does Ethnicity Impact the Wall Stress-Heart Rate–corrected Velocity of Circumferential Fiber Shortening Relationship?

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Background: The end-systolic wall stress (ESS)-heart rate–corrected velocity of circumferential fiber shortening (VCFc) relationship provides a load-independent assessment of systolic function. Previously published indices may not be appropriate for studies where ethnicity may introduce bias.

Objective: We sought to investigate potential differences in the ESS-VCFc relationship between the African American (AA) and Caucasian population.

Methods: In all, 50 AAs and 72 Caucasians, age 3 months to 17 years, were studied. Arterial pulse tracing, phonocardiogram, electrocardiogram, and M-mode of the left ventricle were recorded. Left ventricular dimensions, functional indices, ESS, and

ESS-VCFc relationships were compared between groups.

Results: AAs had decreased indexed left ventricular end-systolic dimensions and increased septal and posterior wall thickness. AAs had increased percent fractional shortening, VCFc, and decreased ESS. Meridional ESS-VCFc relationships for the groups were similar.

Conclusions: Young AAs have slightly thicker ventricles with increased VCFc, lower systolic volumes, and diminished ESS compared with control subjects. Despite differences, the meridional ESS-VCFc relationships were similar and correlated closely to previously reported normal indices. (J Am Soc Echocardiogr 2005;18:743–748.)

Echocardiography continues to play a key role in the evaluation and monitoring of ventricular function in routine clinical practice. Fractional shortening and ejection fraction are the most commonly used ejection phase indices for assessment of left ventricular (LV) systolic function. Both are highly dependent on and influenced by myocardial loading conditions independent of changes in myocardial function and, therefore, may not accurately assess contractility with altered load states. To assess myocardial performance more accurately other noninvasive echocardiographic measurements of ventricular function have been developed. Extensive literature exists using the meridional end-systolic wall stress

(ESSm) to heart rate–corrected velocity of circumferential fiber shortening (VCFc) relationship as a means of assessing LV contractility. This index relationship is a sensitive measurement of intrinsic myocardial performance that is independent of preload, normalized for heart rate, and incorporates afterload. Since its introduction, this technique has been used to study myocardial mechanics in several clinical and pathophysiologic settings.^{1–4} In each instance the ESSm-VCFc relationship has been compared with normal indices previously established by Colan et al.⁵ The population that comprised the normal reference relationship for Colan et al.⁵ was predominantly Caucasian, between the ages of 3 and 70 years. Those data demonstrated no difference in the ESSm-VCFc relationship between different age groups or sexes; however, the study group was racially homogeneous and ethnicity was not examined as a potential variable. Therefore, these normal indices may not be appropriate for comparison in studies where ethnicity may introduce bias.

African American (AA) adolescents and adults have been shown to have an increased incidence of hypertension and higher resting systolic and mean blood pressure (BP).^{6–8} Because end-systolic wall

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stress (ESS) is proportional to end-systolic pressure, we hypothesized that the ESSm-VCFc indexed relationship may be different in AAs compared with Caucasians. Therefore, the goal of this study was to determine whether the ESSm-VCFc indexed relationship is similar in AA children and adolescents compared with an age-matched control group of Caucasian children. The determination of a contractility index for AA patients may be beneficial as a reference for future studies assessing myocardial performance in race-specific disease processes.

METHODS

Study Population

This was a prospective study consisting of 122 healthy participants: 50 AAs between the ages of 3 months and 17 years, and 72 Caucasians aged 1 to 17 years, all of whom were recruited from the general population. None of the participants had known cardiovascular disease on the basis of history, physical examination, electrocardiogram, or complete 2-dimensional echocardiography. No participant was taking cardiovascular medications at the time of enrollment. The study protocol was reviewed and approved by the institutional review board and informed consent was obtained for each participant.

Recordings

Complete 2-dimensional Doppler and M-mode echocardiograms were performed on each patient. Each study was performed at rest without sedation to confirm normal anatomy and function. The detailed methodology used in this study has been previously described.⁵ Briefly, simultaneous indirect carotid or brachial arterial pulse tracing, phonocardiogram, electrocardiogram, and M-mode tracing of the LV short axis were recorded on a hard copy at high speed (100 mm/s) (Figure 1). Peripheral BP was recorded simultaneously using a vital signs monitor (Dinamap 8100T, Critikon Inc, Tampa, Fla). The average of 3 to 5 BP readings was used for data analysis. All measurements made for calculation of functional indices and ESS were blinded to participant ethnicity.

Circumferential ESS (ESSc) and ESSm were calculated from data obtained by averaging 3 consecutive cardiac cycles (Appendix). End-systolic pressure was estimated through linear interpolation onto the arterial tracing at a time in the cardiac cycle just before aortic valve closure (S_2 on phonocardiogram). LV wall thickness and internal dimensions were measured in the short-axis M-mode plane at end systole and end diastole. End-diastolic measurements were made at the time of maximal LV dimensions. The LV-corrected ejection time was measured from the arterial tracing from the onset of rapid upstroke to the onset of the dicrotic notch and normalized to a heart rate of 60/min by dividing by the square root of the R-R interval on the simultaneously recorded electrocardiogram. LV

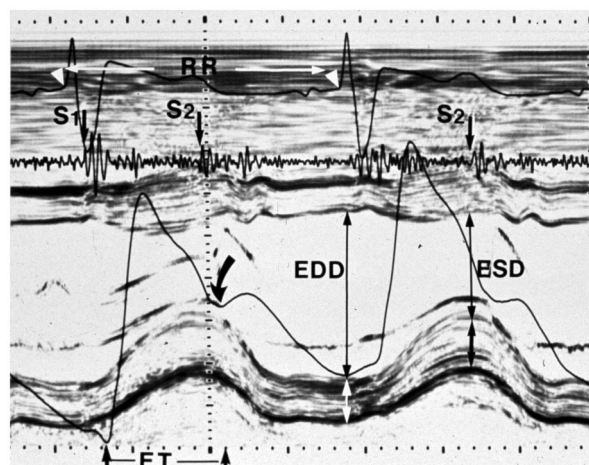


Figure 1 Simultaneous hard copy recording of electrocardiogram, phonocardiogram, arterial pulse tracing, and M-mode tracing of left ventricle (LV). *Arrow on pulse tracing*, end-systolic blood pressure; *black and white arrows on M-mode tracing*, LV posterior wall dimensions in systole and diastole; *EDD*, LV end-diastolic dimensions; *ESD*, LV end-systolic dimensions; *ET*, ejection time (milliseconds); *R-R* interval time (milliseconds) between consecutive QRS complexes, S_1 atrioventricular valve closure and S_2 semilunar valve closure.

shortening fraction and VCFc were calculated using standard mathematic formulae.

Statistical Analysis

Demographic and dimensional data are reported as mean $\pm$ SD. Comparison of normally distributed variables between groups was performed using Student *t* test. Simple linear regression by the least squares method was used to calculate ESS-VCFc equations for both ESSm and ESSc. Comparison of ESSm and ESSc was performed using the Bland-Altman graphic technique. Regression models were used to compare the ESS-VCFc relationship for the AA and Caucasian control groups.

RESULTS

Patient Demographics

A total of 122 participants underwent complete echocardiographic evaluation (Table 1). There were no significant differences in age, sex distribution, body surface area (BSA), or heart rate between groups.

M-Mode Echocardiography

Dimensional data. LV dimensional results are presented in Table 2. There was no difference between groups for the following measurements: LV end-diastolic dimensions, LV end-systolic dimensions, LV

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