Light to Moderate Habitual Alcohol Consumption Is Associated with Subclinical Ventricular and Left Atrial Mechanical Dysfunction in an Asymptomatic Population: Dose-Response and Propensity Analysis

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Background: The effects of light to moderate alcohol consumption on cardiac mechanics remain poorly understood. The aim of this study was to investigate the dose-response relationship between alcohol consumption and left ventricular (LV) and left atrial (LA) function using myocardial deformation.

Methods: In total 3,946 asymptomatic participants (mean age, 49.7 ± 10.7 years; 65% men) were consecutively studied using comprehensive echocardiography and two-dimensional speckle-tracking in a cross-sectional, retrospective manner. Global LV longitudinal and circumferential strain and LA strain were assessed and related to habitual alcohol consumption pattern (fewer than one, one to six, or more than six drinks per week) before and after propensity matching.

Results: With increasing weekly alcohol consumption, participants displayed greater LV eccentric remodeling, impaired diastolic function, and more attenuated global longitudinal strain, LA strain (adjusted coefficients, −1.07 [95% CI, −1.95 to −0.19] and −3.73 [95% CI, −5.36 to −2.11]), and early diastolic strain rates (adjusted coefficients, 0.07 [95% CI, 0.03–0.11] and 0.33 [95% CI, 0.24–0.42]) for one to six and more than six drinks per week, respectively ($P < .05$ for all) in a dose-response manner. Participants with recent alcohol abstinence displayed cardiac mechanics intermediate between those of nondrinkers and current drinkers. After propensity matching ($n = 1,140$), participants currently consuming more than one drink per week continued to have significantly attenuated global longitudinal strain and all LA mechanics compared with those consuming fewer than one drink per week ($P < .05$ for all).

Conclusions: Habitual alcohol consumption, even at light to moderate doses, is associated with both reduced LV and LA mechanics in a dose-dependent manner. Whether such observations are reversible or related to future atrial fibrillation deserves further study. (J Am Soc Echocardiogr 2016;■:■-■.)

Keywords: Alcohol, Diastolic dysfunction, Left atrial systolic function, Strain, Longitudinal strain

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Abbreviations

AF = Atrial fibrillation

CAD = Coronary artery disease

DTI = Doppler tissue imaging

GCS = Global circumferential strain

GLS = Global longitudinal strain

ICC = Intraclass correlation coefficient

LA = Left atrial

LAS = Left atrial longitudinal strain

LV = Left ventricular

LVEF = Left ventricular ejection fraction

ROI = Region of interest

SR = Strain rate

SRa = Late diastolic strain rate

SRe = Early diastolic strain rate

SRs = Systolic strain rate

Chronic excessive alcohol consumption is known to be associated with detrimental effects on cardiac structure and function.[1,2] The extreme manifestation of the toxic effects of alcohol on the heart has been termed "alcoholic cardiomyopathy," in which left ventricular (LV) systolic function is severely impaired.[3,4] However, disruptions in myofibrillary architecture, fibrosis,[5] and subclinical reductions in myocardial contractility[1,4,6] may occur with alcohol consumption, even before overt LV systolic dysfunction.[7] Furthermore, moderate doses of alcohol consumption have recently been shown to be associated with incident atrial fibrillation (AF).[8] Thus, preclinical LV and left atrial (LA) functional alterations may be detected with lower doses of alcohol before the development of overt heart failure or AF and may carry important implications for targeted preventive management.

Accordingly, we aimed to study the association of light to moderate habitual alcohol consumption with changes in cardiac structure and function in clinically asymptomatic participants. We hypothesized that myocardial deformation would enable the detection of subclinical cardiac functional changes[9] and that these changes would be detectable in a dose-response fashion. Further recognizing that alcohol consumption may be associated with lifestyle factors, metabolic changes, and blood pressure effects that can affect cardiac structure and function,[10] we used propensity matching to account for these covariates and assessed the independent effect of alcohol on cardiac mechanics.

METHODS

Study Setting and Population

Our study population consisted of consecutive participants in an ongoing cardiovascular health screening program from June 2009 to December 2012 at a tertiary medical center in Northern Taipei, Taiwan. All participants underwent detailed physical examination, baseline anthropometric measurements, biochemical studies, and comprehensive echocardiography. The primary goal of this program was to test the hypothesis that several clinical key demographic characteristics, biochemical data, or lifestyle factors (such as smoking and alcohol consumption) are related to cardiac remodeling or subclinical cardiac dysfunction in terms of worsened myocardial deformation measures in an ethnic Asian population. The study design in our present work relating the dose of alcohol use and deformational functional changes was cross-sectional and conducted in a retrospective manner. The clinical significance of strain measures is further addressed in the section "Speckle-Tracking Analysis Protocol." A 260-item structured questionnaire was used to obtain baseline clinical information, symptoms and signs, medical history, and lifestyle factors. The exclusion criteria were entry into this screening program before the feasibility of myocardial deformation analysis, inadequate images for myocardial deformation analysis, specific clinical conditions and diseases, and missing data (Supplemental Figure 1). This study was approved by the local ethics board committee (14MMHIS202).

Standard Conventional Echocardiographic Protocol

Echocardiography was uniformly performed using the Vivid i system (GE Healthcare, Little Chalfont, United Kingdom) equipped with a 2- to 4-MHz transducer (3S-RS) during the recruitment period of the present analysis. The standard echocardiographic imaging protocol included measurement of LV end-diastolic and end-systolic diameter, wall thickness, LV mass (per American Society of Echocardiography criteria),[11] and LA and LV volumes (using the biplane Simpson method). LV ejection fraction (LVEF) and LA emptying fraction were calculated as 100 × (maximal volume − minimal volume)/maximal volume. LV diastolic function was determined by pulsed-wave Doppler of the early (E) and late diastolic (A) LV filling velocities at the tip of the mitral leaflets from the apical four-chamber view. Doppler tissue imaging (DTI)–based mitral annular contraction (S′) and relaxation velocity (E′) were assessed at the lateral mitral annulus using spectral Doppler techniques, with LV filling pressure estimated using the E/E′ ratio.

Speckle-Tracking Analysis Protocol

Assessment of LV and LA Deformation. We assessed LV deformation using baseline two-dimensional images from three LV apical views for longitudinal strain, three short-axis views for LV circumferential strain, and LV twist analysis (EchoPAC version 10.8; GE Vingmed Ultrasound AS, Horten, Norway), as described in our previous work.[12] Baseline two-dimensional images were analyzed using offline endocardial border manual tracing by the same experienced technician, using proprietary software (EchoPAC version 10.8). The mean frame rate in all studied participants was between 60 and 80 frames/sec. On the basis of automated speckle-tracking algorithms, LV global longitudinal strain (GLS) was then averaged from three individual LV apical views (two-chamber, four-chamber, and three-chamber views). Global circumferential strain (GCS) curves were similarly obtained by averaging values from three individual short-axis levels (mitral valve, papillary muscles, and apical layer), with LV twist derived by subtracting rotation from the LV mitral annulus (negative value) to the LV apical level (positive value).

Speckle-tracking analyses for LA function were also performed, ensuring that image acquisition was carefully optimized in the apical four-chamber and two-chamber views to avoid foreshortening, with offline analyses performed as previously described.[13] LA longitudinal strain (LAS) and strain rate (SR) curves (systolic SR [SRs], early diastolic SR [SRe], and late diastolic LA SR [SRa]) were generated for each atrial segment from LV apical two- and four-chamber views (Supplemental Figure 2). The representative LA deformation indices in each study participant were then derived from the mean of both LV apical two- and four-chamber data. Larger strain or SR measures on the basis of the absolute values indicated better myocardial contractile function. The detailed methodology for the measurement of LV and LA deformation is further addressed in the Supplemental Materials.