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Research Article

What is the association between left ventricular diastolic dysfunction and 6-minute walk test in hypertensive patients?

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Abstract

Heart failure (HF) is a major health problem. Hypertension is an important cause of HF. Most hypertensive patients have some degree of left ventricular (LV) diastolic dysfunction. The 6-minute walk test (6MWT) provides objective data about the exercise tolerance. We aimed to find the association between the degree of LV diastolic dysfunction and the functional capacity assessed by 6MWT in hypertensive patients. The study included 200 asymptomatic hypertensive patients. All patients had undergone full history taking, complete clinical examination, electrocardiography, echocardiography for assessment of LV dimensions, systolic and diastolic dysfunction, and 6MWT. Patients were classified into two groups according to the presence or absence of LV diastolic dysfunction. Clinical and echocardiographic data were comparable between the two groups. Regarding 6MWT, at the end of the test, patients with diastolic dysfunction had significantly higher systolic ($P = .0088$) and diastolic ($P = .019$) blood pressure and higher Borg score for dyspnea ($P < .00001$). The distant walked and percentage of the distance to predicted value were significantly lower in patients with diastolic dysfunction ($P = .0322$ and .0002, respectively). Incidence of abnormal 6MWT was significantly higher in patients with diastolic dysfunction ($P = .00041$). Compared to patients with grades I and II, patients with grade III diastolic dysfunction had significantly higher Borg score ($P = .013$), lower distance walked ($P = .039$), and lower percentage of distance to predicted vale ($P = .009$). Independent predictors for abnormal 6MWT were as follows: E/E' ≥15 ($P = .0022$), E'/A' <1 ($P = .0081$), and deceleration time of E-wave <160 ($P = .013$). The presence of LV diastolic dysfunction in hypertensive patients has a bad effect on 6MWT. The degree of LV diastolic dysfunction was correlated with 6MWT results. It may be important to investigate LV diastolic function in asymptomatic hypertensive patients. J Am Soc Hypertens 2017;■(■):1–7.

Keywords: Diastolic dysfunction; heart failure; hypertension; six minute walk test.

Introduction

Heart failure (HF) is a major worldwide health problem and a substantial cause of morbidity and mortality.[1] Hypertension is an important and well-established risk factor for developing HF. When compared to nonhypertensive population, hypertensive patients were found to have a 2-fold to 3-fold risk of HF.[2]

Among patients with HF, the prevalence of HF with preserved ejection fraction (HFpEF) was found to be high.[3] Hypertension was found to be the most important risk factor for developing HFpEF, and the prevalence of hypertension among HFpEF patients was found to be 55%–84%.[4] The main pathophysiological aspect in developing HFpEF is impairment of left ventricular (LV) diastolic function.[3] Moreover, most hypertensive patients have some degree of LV diastolic dysfunction even before the development of symptoms.[5] So, it might be useful to search for subclinical LV diastolic dysfunction among hypertensive patients before the development of overt HF.

Conflict of interest: The authors declare that there is no conflict of interest.

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The 6-minute walk test (6MWT) was emerged by the American Thoracic Society for assessment of the functional capacity and exercise tolerance in patients with pulmonary cardiovascular diseases.[6] The 6MWT is a simple, easily performed test that does not require high technology and provides objective data about the exercise tolerance like the distance walked in 6 minutes and oxygen saturation.[7]

The aim of our study was to find the association between the degree of LV diastolic dysfunction and the degree of functional capacity as assessed by 6MWT in hypertensive patients.

Patients and Methods

This cross-sectional study was done in the Cardiology Department, Faculty of Medicine, Zagazig University, during the period between January 2014 and June 2015. The study population consisted of 200 asymptomatic hypertensive patients. Hypertension was defined according to the JNC 7 report as systolic blood pressure $\geq$140 mm Hg, diastolic blood pressure $\geq$90 mm Hg, and/or continuous use of antihypertensive drugs.[8] The patients were considered as poorly controlled hypertension if the systolic blood pressure $\geq$140 mm Hg for patients younger than 60 years or $\geq$150 mm Hg for patients aged 60 years or older, or the diastolic blood pressure $\geq$90 mm Hg.[9]

Patients were excluded from our study if one or more of the following were present:

- Severe pulmonary disease with forced vital capacity $<$ 50%.[10]
- LV systolic dysfunction with ejection fraction (EF) $<$ 50%.
- Known coronary artery disease, previous myocardial infarction, or revascularization.
- More than mild valvular stenosis or regurgitation.
- Atrial fibrillation.
- Any musculoskeletal disorder that may interfere with walking.

The study protocol had been approved by the Institutional Review Board of our institution. After having a written informed consent from every patient, we did the following procedures to them:

1) Full history taking and complete clinical examination.
2) Complete standard 12-lead electrocardiography.
3) Pulmonary function test with measuring of forced vital capacity for exclusion.
4) Six-minute walk test: the test was performed in the corridor of the Cardiology Department, which is 30 meters long. All tests were done in afternoon between 3 PM and 4 PM. After having a rest on chair for at least 10 minutes, we placed a finger probe on the index finger of every patient to measure oxygen saturation (Petas KMA 800; Petas, Ankara, Turkey). We then encouraged the patient to walk going and coming back through the corridor for 6 minutes. We measured the total distance walked in 6 minutes, and the walked distance was then calculated as a percentage of the normal predicted distance which was calculated for men and women according to the formulas developed by Enright and Sherrill. The test was considered as normal if the patient could achieve 80% of the normal predicted distance for his age and body mass index (BMI).[11] Dyspnea was assessed according to the Borg modified scale from 0 (no dyspnea) to 10 (maximal dyspnea).[12]
5) Echocardiography: echocardiographic studies were done for all patients within 7 days of the 6MWT, using GE VIVID E9 machine with 2.5 MHz transducers. The studies were performed by two operators unaware of each other measures and of patients' clinical data. The following measures were taken:
   - Left atrial (LA) diameter, left ventricular end-diastolic and systolic dimensions, EF, fraction of shortening, left ventricular mass, and left ventricular mass index (LVMI) were obtained by two-dimensional guided M-mode from the left parasternal long axis view. Left ventricular hypertrophy (LVH) was defined as LVMI $\geq$95 g/m^2 in women and 115 g/m^2 in men.[13]
   - Mitral valve flow velocities by pulsed Doppler; E-wave, A-wave E/A ratio, E-wave deceleration time (DT), and isovolumetric relaxation time.
   - Tissue Doppler of the septal segment of mitral valve annulus was done from the apical four-chamber view with measuring of the peaks systolic wave (S′), early (E′), and late diastolic waves (A′). E'/A′ and E/E′ were calculated.

   Diastolic function was assessed by combining all measured parameters. The diastolic function was categorized as following[14]:
   - Normal diastolic function: E/A $\geq$ 1, DT between 160 and 240 ms, E'/A' $\geq$ 1, and E/E' $<$ 15.
   - Grade 1 diastolic dysfunction (impaired relaxation): E/A $<$ 1 and DT $>$ 240 ms, plus either E'/A' $<$ 1 or E/E' $\geq$ 15.
   - Grade 2 diastolic dysfunction (pseudonormal): E/A between 1 and 2, and DT between 160 and 240 ms, plus either E'/A' $<$ 1 or E/E' $\geq$ 15.
   - Grade 3 diastolic dysfunction (restrictive filling): E/A $>$ 2 and DT $<$ 160 ms, plus either E'/A' $<$ 1 or E/E' $\geq$ 15.
6) Statistical analysis: All data were analyzed using the SPSS for Windows package program (version 20.0; Armonk, NY, USA: IBM Corp.). Differences between patients' group and control group were analyzed using χ^2 test and student's t test. Differences among more than two groups were done using the analysis of variance test. A P value $<$ .05 was regarded as being statistically significant.