

Mitral Annular Velocity Predicts Exercise Tolerance in Patients with Impaired Left Ventricular Systolic Function

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Background: Left ventricular (LV) diastolic function is known as one of determinants of exercise tolerance in patients with heart failure. The early diastolic velocity of the mitral annulus (Ea: cm/s) obtained by tissue Doppler imaging has been proposed for evaluating LV filling pressures; however, the relation of this index to exercise tolerance is unknown in patients with impaired LV systolic function.

Methods: To assess the feasibility of evaluating exercise tolerance using tissue Doppler imaging, we studied 48 consecutive patients (34 males and 14 females; mean age: 57 ± 14 years) with LV ejection fraction $< 50\%$ (mean: $37 \pm 9\%$). We measured the peak early diastolic velocity of transmitral flow (E: cm/s), the flow propagation velocity of LV inflow (Vp: cm/s), and Ea at the lateral border of the mitral annulus; and then calculated the ratios of E to Vp and E to Ea. After Doppler echocardiography, we measured peak oxygen consumption (ml/min/kg) and anaerobic threshold (AT: ml/min/kg) by cardiopulmonary exercise testing. The correlations of these Doppler indices with peak oxygen consumption or AT were evaluated.

Results: Twenty-four (50%) of the patients had a history of congestive heart failure. Thirty-nine (81%) had exertional dyspnea (New York Heart Association functional class II (n = 30) and III (n = 9)). Fourteen (29%) achieved AT < 8 ml/min/kg. Exercise tolerance correlated weakly with Vp and LV ejection fraction, and did not correlate with conventional Doppler indices, LV size, LV wall thickness, or left atrial size. Peak oxygen consumption correlated well with Ea ($r = 0.64$, $p < 0.001$) and E/Ea ($r = -0.65$, $p < 0.001$). Among all the echo parameters measured, the best individual correlate of AT was E/Ea ($r = -0.72$, $p < 0.001$). Using AT = 8 ml/min/kg as a cutoff to separate severe exercise intolerance from normal, mild, or moderate exercise intolerances, a receiver operating characteristic curve showed that E/Ea > 11.3 had the best combination of sensitivity (86%) and specificity (85%) for AT < 8 ml/min/kg. The area under the receiver operating characteristic curve using E/Ea to predict AT < 8 ml/min/kg was 0.89.

Conclusion: Exercise tolerance was related to Ea and E/Ea in patients with impaired LV systolic function. Thus, evaluation of LV diastolic function using tissue Doppler imaging is useful for predicting exercise tolerance in patients with heart failure.

僧帽弁輪速度は左室収縮能低下患者の運動耐容能を予測する

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【背景】組織ドプラ法より得られる僧帽弁輪拡張早期波速度 (Ea) と運動耐容能との関係は左室収縮能低下患者においては不明である。

【方法】組織ドプラ法を用いて運動耐容能を評価する可能性を検討するために、左室駆出分画 < 50% (平均: $37 \pm 9\%$) の連続 48 例 (男性 34 例、女性 14 例、平均年齢: 57 ± 14 歳) を対象とした。左室流入血流速波形の拡張早期波最大速度 (E)、左室内血流伝播速度 (Vp) および左室側壁側の Ea を測定した。心エコー後、呼気ガス分析にて最大酸素摂取量および無酸素閾値 (AT) を測定した。

【結果】最大酸素摂取量は Ea ($r = 0.64, p < 0.001$) および E/Ea ($r = -0.65, p < 0.001$) と良好な相関を示した。E/Ea が AT と最も良好な相関を示した ($r = -0.72, p < 0.001$)。E/Ea > 11.3 が AT < 8 ml/min/kg を予測する感度は 86%、特異度は 85%であった。

【結語】組織ドプラ法を用いた左室拡張能評価は心不全患者の運動耐容能の予測に有用である。

質疑応答

質問 1 Vp の計測はどのように行ったのか。

応答 折り返し速度を 45cm/s に設定し、僧帽弁口部から 4cm 心尖部方向までの折り返し領域の赤青境界の傾きを計測した。45cm/s の折り返し速度で折り返しが生じない症例では E 波の 50~75%に折り返し速度を設定した。

質問 2 Ea は左室側壁側と中隔側とではどちらの方が相関がよいと考えられるか。

応答 中隔側 Ea は壁運動異常を有する症例では当てにならないため左室側壁側 Ea を用いた方がよいと考えられる。肺動脈楔入圧と E/Ea との相関を検討した研究では左室側壁側 Ea を用いた場合に最も良好な相関が得られたという報告もある。