

METABOLIC SYNDROME AND MYOCARDIAL CONTRACTILE RESERVE

SEONG HWAN KIM, MD, PHD

DIVISION OF CARDIOLOGY, DEPARTMENT OF INTERNAL MEDICINE, KOREA UNIVERSITY ANSAN HOSPITAL, ANSAN, KOREA

REFER TO THE PAGE 176-182

Metabolic syndrome (MetS) is a clustering of cardiovascular risk factors including hyperglycemia, dyslipidemia, and hypertension, which have been shown to increase cardiovascular (CV) morbidity and mortality.^{1,2} In addition, it is well known that the association between the presence of MetS and adverse CV outcomes is independent of diabetes mellitus (DM) and arterial hypertension.^{3,4} Since the MetS is a strong predictor of future CV events, the changes of left ventricular (LV) structure and function in patients with MetS are considered one of mechanisms explaining the link between the MetS and CV morbidity and mortality. The previous studies have already reported the LV geometry and function by demonstrating increased LV mass and subclinical LV systolic and/or diastolic dysfunction impaired in the MetS patients.⁵⁻⁷ However, the most studies were conducted in the resting state, not during exercise. Considering that most patients with type 2 DM and/or hypertension have symptoms during exercise, the study by Ha et al.⁸ suggests that the patients with MetS might also have decreased LV functional reserve during dynamic exercise. A total of 112 hypertensive patients complaining of exertional dyspnea were included and divided into two groups according to the existence of MetS. Exercise stress echocardiography using supine bicycle was performed and a variety of Doppler parameters were measured at baseline, at each stage of exercise, and during recovery. There was a significant difference in E/E' parameter, that is an index of LV filling pressure, in MetS patients at resting state. The increased E/E' value was maintained during dynamic exercise test, which is similar to the result of a prior study.⁹ A unique result to this study is that LV longitudinal functional reserve, defined as the change in tissue Doppler imaging (TDI), S' (longitudinal tissue velocity) from baseline to peak exercise was significantly lower in MetS patients even though there was no significant difference in baseline TDI S' velocity between the two. After adjusting for

known CV risk factors, an independent relationship between the presence of MetS and LV systolic functional reserve was observed.

The recent use of TDI, strain, and strain rate at resting state allows detecting earlier subclinical dysfunction and providing essential mechanisms in understanding the development of heart failure. In addition, TDI parameters such as S', E', A', and E/E' have been known to have independent prognostic values in various cardiac diseases,¹⁰ even in low risk population.¹¹ However, there is a study showing that resting LV TDI parameter did not add any incremental prognostic impact over the clinical data in patients with type 2 DM.¹² Thus, even though exercise capacity is already recognized as a significant predictor of CV diseases, the LV TDI measurements acquired by stress echocardiography seem to be more reliable and stronger in detecting the presence of subclinical CV disease¹³ and predicting clinical outcome,¹² compared with resting TDI values. Nevertheless, measuring Doppler parameters including TDI during exercise stress echocardiography for the evaluation of longitudinal diastolic functional reserve is still challenging, especially at peak stress, because the mitral velocities summate as the heart rate increases. In this study, no differences in longitudinal diastolic functional reserve may be due to these limitations in addition to a small sample size. Although the exact mechanism related to abnormal contractile reserve in patients with MetS is still unknown, it seems that multiple factors including sympathetic nervous system, renin-angiotensin-aldosterone system, myocardial metabolism, and coronary flow reserve contribute to subclinical dysfunction of longitudinal myocardial contraction during exercise.

In summary, MetS is associated with LV systolic and diastolic dysfunction at resting state and decreased LV longitudinal contractile reserve during exercise despite of similar values at baseline examination. Although larger studies to confirm the results of this study are needed, the assessment of longitudinal functional reserve in MetS patients, using exercise stress echocardiography, is helpful for earlier identification of sub-

• Received: December 6, 2011 • Revised: December 12, 2011 • Accepted: December 12, 2011

• Address for Correspondence: Seong Hwan Kim, Division of Cardiology, Department of Internal Medicine, Korea University Ansan Hospital, 123 Jeokgeum-ro, Danwon-gu, Ansan 425-707, Korea Tel: +82-31-412-5546, Fax: +82-31-412-5594, E-mail: cardioguy@korea.ac.kr

• This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/3.0>) which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

clinical dysfunction and more aggressive treatment strategies to prevent a progression to overt heart failure.

REFERENCES

1. Laaksonen DE, Lakka HM, Niskanen LK, Kaplan GA, Salonen JT, Lakka TA. *Metabolic syndrome and development of diabetes mellitus: application and validation of recently suggested definitions of the metabolic syndrome in a prospective cohort study. Am J Epidemiol* 2002;156:1070-7.
2. Lakka HM, Laaksonen DE, Lakka TA, Niskanen LK, Kumpusalo E, Tuomilehto J, Salonen JT. *The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA* 2002;288:2709-16.
3. de Simone G, Devereux RB, Chinali M, Best LG, Lee ET, Galloway JM, Resnick HE; Strong Heart Study Investigators. *Prognostic impact of metabolic syndrome by different definitions in a population with high prevalence of obesity and diabetes: the Strong Heart Study. Diabetes Care* 2007;30:1851-6.
4. Jeppesen J, Hansen TW, Rasmussen S, Ibsen H, Torp-Pedersen C, Madsbad S. *Insulin resistance, the metabolic syndrome, and risk of incident cardiovascular disease: a population-based study. J Am Coll Cardiol* 2007;49:2112-9.
5. de las Fuentes L, Brown AL, Mathews SJ, Waggoner AD, Soto PE, Gropler RJ, Dávila-Román VG. *Metabolic syndrome is associated with abnormal left ventricular diastolic function independent of left ventricular mass. Eur Heart J* 2007;28:553-9.
6. Gong HP, Tan HW, Fang NN, Song T, Li SH, Zhong M, Zhang W, Zhang Y. *Impaired left ventricular systolic and diastolic function in patients with metabolic syndrome as assessed by strain and strain rate imaging. Diabetes Res Clin Pract* 2009;83:300-7.
7. Burchfiel CM, Skelton TN, Andrew ME, Garrison RJ, Arnett DK, Jones DW, Taylor HA Jr. *Metabolic syndrome and echocardiographic left ventricular mass in blacks: the Atherosclerosis Risk in Communities (ARIC) Study. Circulation* 2005;112:819-27.
8. Ha TH, Seo HS, Choo WJ, Choi J, Suh J, Cho YH, Lee NH. *The effect of metabolic syndrome on myocardial contractile reserve during exercise in non-diabetic hypertensive subjects. J Cardiovasc Ultrasound* 2011;19:176-82.
9. Wong CY, O'Moore-Sullivan T, Fang ZY, Haluska B, Leano R, Marwick TH. *Myocardial and vascular dysfunction and exercise capacity in the metabolic syndrome. Am J Cardiol* 2005;96:1686-91.
10. Wang M, Yip GW, Wang AY, Zhang Y, Ho PY, Tse MK, Lam PK, Sanderson JE. *Peak early diastolic mitral annulus velocity by tissue Doppler imaging adds independent and incremental prognostic value. J Am Coll Cardiol* 2003;41:820-6.
11. Mogelvang R, Sogaard P, Pedersen SA, Olsen NT, Marott JL, Schnohr P, Goetze JP, Jensen JS. *Cardiac dysfunction assessed by echocardiographic tissue Doppler imaging is an independent predictor of mortality in the general population. Circulation* 2009;119:2679-85.
12. Kim SA, Shim CY, Kim JM, Lee HJ, Choi DH, Choi EY, Jang Y, Chung N, Ha JW. *Impact of left ventricular longitudinal diastolic functional reserve on clinical outcome in patients with type 2 diabetes mellitus. Heart* 2011;97:1233-8.
13. Akcakoyun M, Kaya H, Kargin R, Pala S, Emiroglu Y, Esen O, Karapinar H, Kaya Z, Esen AM. *Abnormal left ventricular longitudinal functional reserve assessed by exercise pulsed wave tissue Doppler imaging in patients with subclinical hypothyroidism. J Clin Endocrinol Metab* 2009;94:2979-83.